Species Status Assessment Addendum

for the

CANADA LYNX *(Lynx canadensis)*

Contiguous United States Distinct Population Segment

Photo by Keith Williams

December 2023

U.S. Fish and Wildlife Service

Regions 1, 2, 3, 5 and 6

Recommended Citation

U.S. Fish and Wildlife Service. 2023. Species Status Assessment Addendum for the Canada lynx (*Lynx canadensis*) Contiguous United States Distinct Population Segment. December 2023. Denver, Colorado. 122 pp.

Credits

This SSA addendum was produced by the Canada Lynx Species Status Assessment Team (Lynx SSA Team), which consists of a Core Team of Service biologists who work on lynx conservation across the DPS range, Service Region 6 Classification and Recovery and Decision Support personnel, and Service Headquarters SSA Science Support staff.

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Contents

Executive Summary

This addendum presents the results of an update to the 2017 species status assessment (SSA) for the contiguous United States distinct population segment (DPS) of Canada lynx (*Lynx canadensis*; lynx or DPS). It represents the U.S. Fish and Wildlife Service's (Service's) evaluation of relevant new scientific information that has become available since we completed the 2017 SSA regarding the biological status of lynx populations and the viability of the DPS. This addendum builds on the 2017 SSA and incorporates a climate vulnerability assessment, a structured resiliency analysis, and an assessment of lynx adaptive capacity to inform our understanding of current and future conditions for DPS populations and the current and potential future viability of the DPS in terms of the conservation biology principles of resiliency, redundancy, and representation (the "3Rs"). This addendum does not address or reevaluate policy issues such as the lynx's listing status under the Endangered Species Act or the designation of lynx in the contiguous United States as a single DPS.

In this addendum, we evaluate the current and potential future resiliency of lynx populations in focal areas (areas of known or modeled high quality habitat capable of supporting resident lynx) within six SSA Units that have been modified based on recent verified[1] occurrence data to represent the current distribution of lynx in the contiguous U.S. (Figure 1). We completed a climate vulnerability assessment to present a range of plausible global climate warming scenarios and their potential consequences for lynx habitat suitability based on recent advances in climate and lynx habitat modeling. We used a condition categorization framework that considers warming resulting from global climate change and key habitat and demographic variables that influence lynx populations and characterizes the current condition of those variables and the current and future resiliency of DPS populations. To address future uncertainty, we modeled three climate scenarios and used these to develop future plausible scenarios that capture the range of additional factors (i.e., regulatory mechanisms, vegetation management, wildland fire management, habitat loss and fragmentation, other factors) that may influence lynx populations in the future. We evaluated lynx population resiliencies in each focal area under each scenario and across four 20-year timesteps through the end of this century to assess the potential viability of the DPS at each timestep.

[1] Our definition of a verified lynx record is based on McKelvey et al. (2000a, p. 209): (1) an animal (live or dead) in hand or observed closely by a person knowledgeable in lynx identification, (2) genetic (DNA) confirmation, (3) snow tracks only when confirmed by genetic analysis (e.g., McKelvey et al. 2006, entire), or (4) location data from radio or GPS-collared lynx (79 FR 54816).

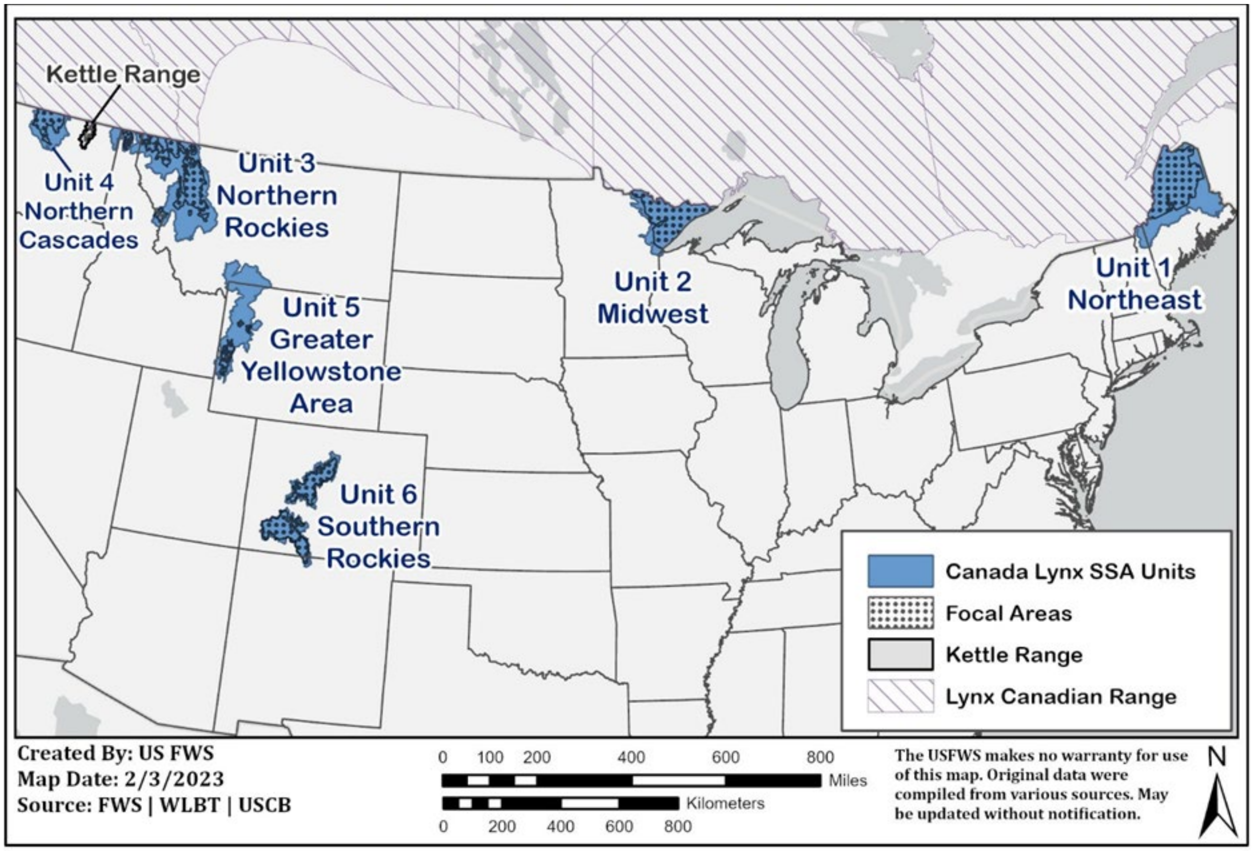

Figure 1. Six species status assessment (SSA) Units and the focal areas evaluated in this addendum for the contiguous United States distinct population segment of the Canada lynx. Focal areas support resident lynx populations and/or have habitat modeled as capable of doing so. The Kettle Range is the site of an ongoing lynx reintroduction effort, but it is not an SSA Unit or focal area for this assessment.

Climate - In the 2017 SSA, experts agreed that predicted climate warming is the factor most likely to influence future viability of the DPS but that the timing, extent, and magnitude of effects and their impacts on DPS lynx populations are uncertain. In this addendum, we review relevant climate science published since 2017, which reinforces our understanding that projected warming and related impacts – loss of temperature, snow, and vegetation conditions supportive of lynx populations; increases in the size, frequency, and severity of wildfires and vegetation-damaging insect outbreaks in lynx habitats – present the greatest challenge to the long-term viability of the DPS. We present the results of a climate vulnerability assessment based on a recent species distribution model for lynx (Olson et al. 2021, entire), which found that winter temperature and precipitation covariates were most important in accurately predicting the occurrence of resident lynx in the western contiguous U.S. Similar covariates were also found to be important in the Midwest and Northeast, although lynx in those areas were associated with colder temperatures, likely related to higher humidity there compared to the west, with colder temperatures needed to provide snow conditions favorable to lynx and their primary prey, snowshoe hares (*Lepus americanus*).

We modeled prevailing temperature conditions in the focal areas of each SSA unit during 2001–2020 and in 20-year timesteps (2021–2040, 2041–2060, 2061–2080, and 2081–2100) through the end of this century under three future climate scenarios. We found substantial projected loss of prevailing temperature conditions in half of the focal areas by mid-century and dramatic northward contraction of current temperature envelopes across the DPS by the end of this century, regardless of climate scenario (Figure 2, see Appendix 1 for maps of each scenario at each timestep). Declines occurred most quickly in the Northeast (Unit 1) and Northwest (Unit 4), with prevailing temperatures persisting longest in the Greater Yellowstone Area (GYA, Unit 5) and Southern Rockies (Unit 6). Lynx populations in the DPS occur at the southern periphery of the species' North American range, where current temperature conditions may approach upper thresholds for maintaining snow conditions, forest climatic and vegetation structural characteristics, and prey populations capable of supporting resident lynx populations. Modeled future warming is projected to cause a gradual but steady decline in habitat distribution and quality of all focal areas and, thus, a reduction in their ability to support persistent breeding populations in the future (see 6.1, Climate Vulnerability Assessment).

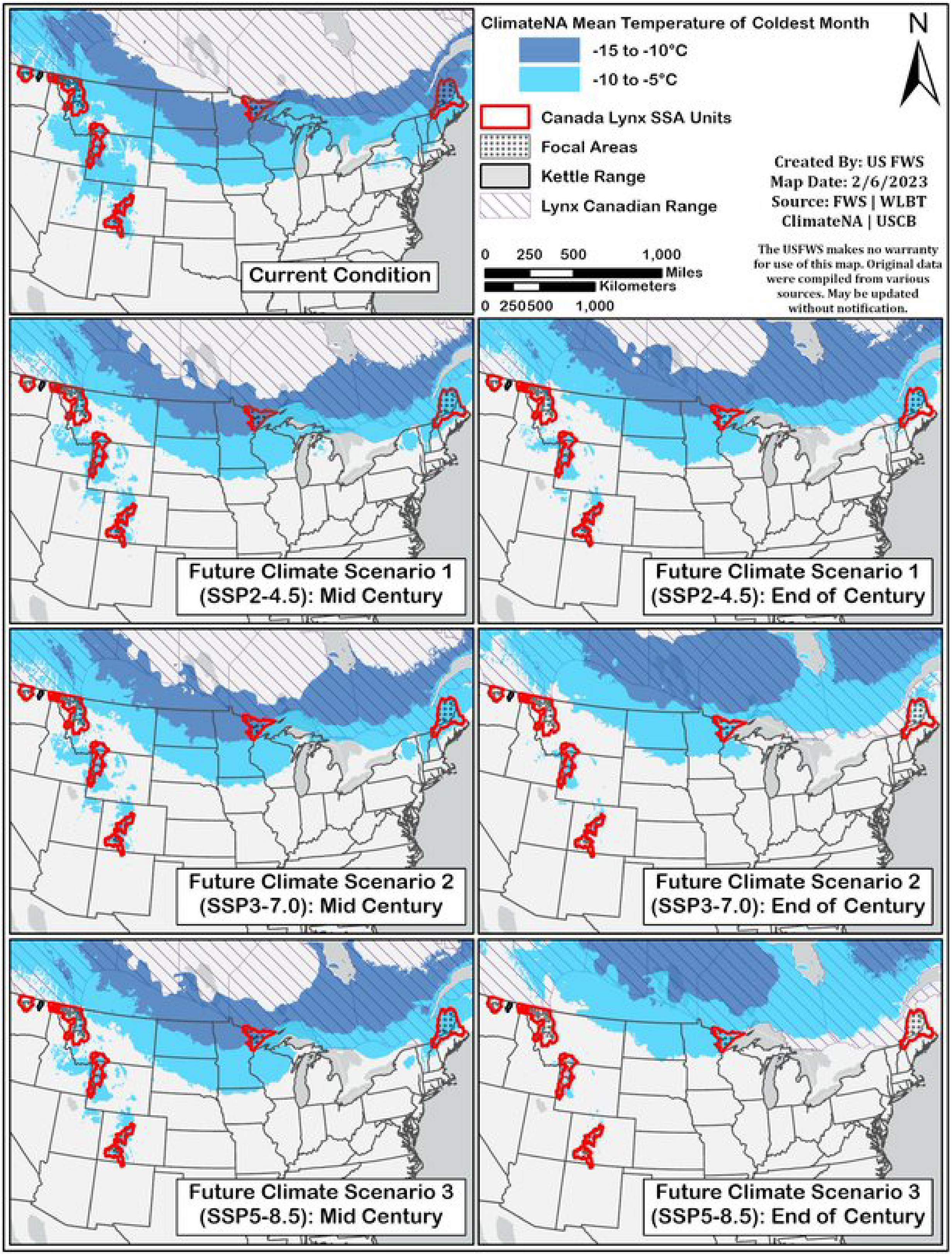

Figure 2. Modeled current and future (mid-century [2041–2060] and end-of-century [2081–2100]) temperature conditions for Canada lynx populations in SSA Units and focal areas under three future climate scenarios.

Population Resiliency – To assess the current resiliency of lynx populations in the six SSA Units, we applied a categorical scoring system for current climate conditions, the amount of mapped or modeled high-quality habitat (i.e., the size of the focal areas in each SSA unit), estimated lynx population sizes, and the relative connectivity of SSA Units to the core of the species' range. This resulted in current resiliency category scores ("High," "Moderate," "Low," or "Not Resilient/Functionally Extirpated") for the populations in each unit (see section 5.2, Tables 4 and 5). We then developed three plausible future scenarios with a range of conditions for climate and other factors thought capable of exerting population-level influences (see section 6.2, Table 9 for full descriptions of each scenario) and projected population resiliencies over the same four 20-year timesteps through the end of this century.

Using this system, we scored the lynx populations in three SSA Units (Northeast, Midwest, and Northern Rockies) as currently having high resiliency, two Units (Northern Cascades and Southern Rockies) as having moderate resiliency, and one unit (GYA) currently not resilient/functionally extirpated. As described in detail in the 2017 SSA (pp. 45–48), the historical presence of persistent resident breeding populations in the GYA and Southern Rockies is not strongly supported by verified records. However, the recent species distribution model predicted about 2,900 square kilometers (km^2) (1,120 square miles (mi^2)) of high-quality habitat in the southern portion of the GYA, and the 1999-2006 releases of 218 Canadian and Alaskan lynx into southwest Colorado has resulted in the establishment of a resident breeding population occupying two focal areas totaling over 19,000 km^2 (7,336 mi^2) of modeled high-quality habitat.

Projecting population resiliency into the future under the three scenarios resulted in only one unit (Unit 2, Midwest) retaining a highly resilient population at mid-century (2041–2060); two Units with moderately resilient populations; zero to one unit with low resiliency; and two to three populations not resilient/functionally extirpated. At the end of this century (2081–2100), no Units retained highly resilient populations, regardless of scenario; zero to two populations retained moderate resiliency; zero to one population had low resiliency; and three to six populations were not resilient/functionally extirpated, depending on scenario. These potential outcomes are illustrated in Table 1 and Figure 3, below. Full current and future resiliency analyses are presented in sections 5.1 and 6.3 and resiliency tables and maps for each future scenario and all timesteps are in Appendix 2.

Table 1. Current and plausible future resiliency of Canada lynx populations in six SSA Units in the contiguous United States under three future scenarios (Green = High resiliency; Yellow = Moderate; Pink = Low; Brown = Not resilient/functionally extirpated). SSA Units: Unit 1 = Northeast; Unit 2 = Midwest; Unit 3 = Northern Rockies; Unit 4 = Northern Cascades; Unit 5 = Greater Yellowstone Area; Unit 6 = Southern Rockies.

Unit	Current Resiliency	Future Scenario 1				Future Scenario 2				Future Scenario 3			
		2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100
1	High												
2	High												
3	High												
4	Moderate												
5	Extirpated												
6	Moderate												

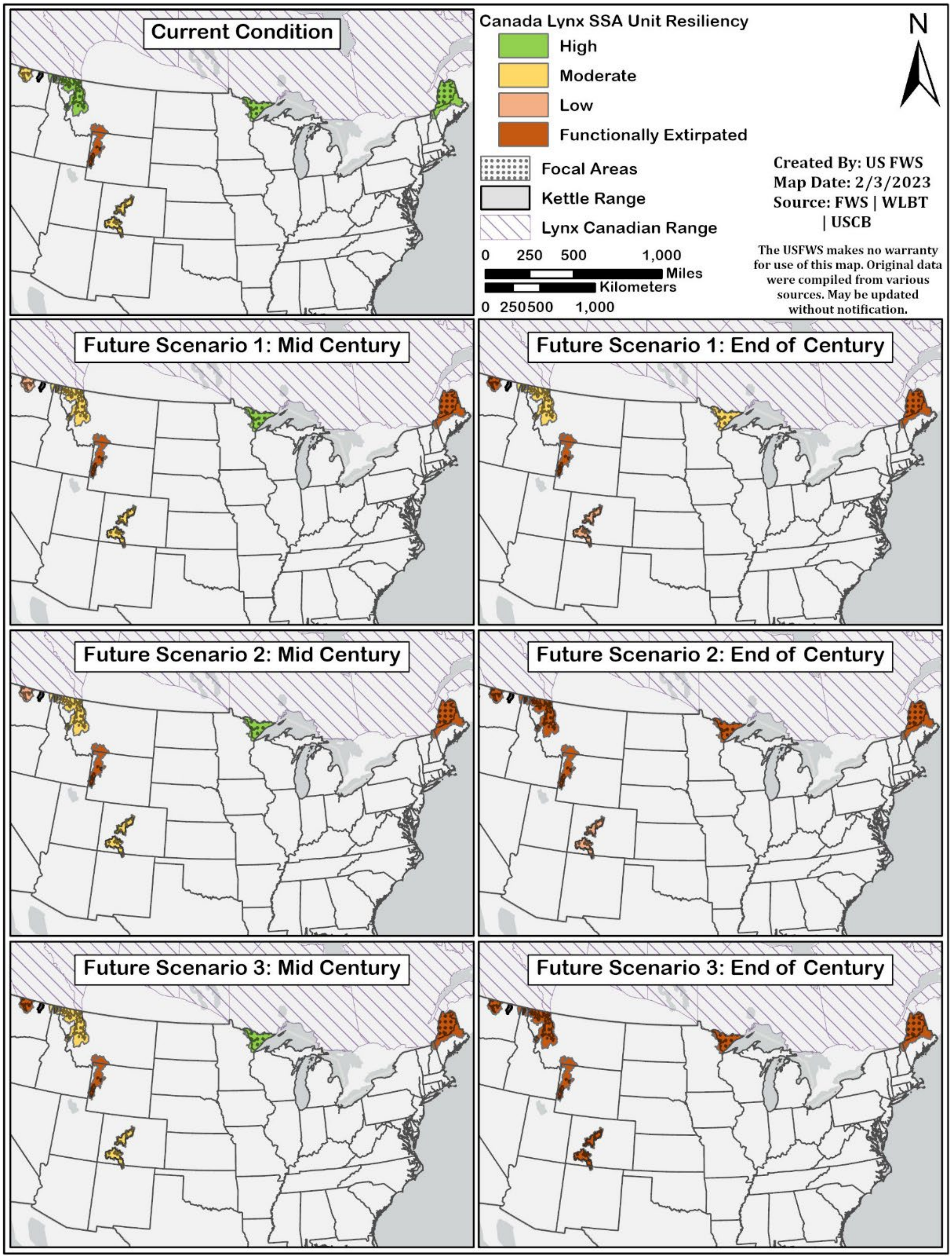

Figure 3. Current and projected (mid-century [2041–2060] and end-of-century [2081–2100]) resiliency of Canada lynx populations in the contiguous United States under three future scenarios.

DPS Viability – New information that has become available since publication of the 2017 SSA has not changed our assessment of the current condition of the DPS in terms of the conservation biology principles of resiliency, redundancy, and representation. Considering the best available information, we find no reliable evidence that the current distribution and relative abundance of resident lynx in the contiguous U.S. are substantially reduced from historical conditions. Based on the resiliency analysis presented in this addendum, three of five extant DPS populations (in Units 1, 2, and 3) currently have high resiliency and two (Units 4 and 6) have moderate resiliency. The GYA currently does not support a breeding population and it is uncertain whether it did so historically.

The current broad distribution of resident lynx in large, geographically discrete areas (redundancy) puts the DPS at very low risk of extirpation caused by catastrophic/stochastic events. Because we found no evidence that formerly persistent lynx populations have been lost from any large areas, it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. Similarly, resident lynx in the DPS appear to remain broadly distributed across the range of habitats that have supported them historically, suggesting maintenance of the breadth and diversity of ecological settings occupied within the DPS range (representation). Additionally, observed high rates of dispersal and gene flow and, therefore, naturally low levels of genetic differentiation across most of the lynx's range, including the DPS, indicate broad-scale maintenance of genetic health (representation). Because there are no indications of significant loss of or current stressors to the genetic health or adaptive capacity of lynx populations in the DPS, we find that the current level of representation within the DPS does not appear to indicate a decrease from historical conditions.

In the 2017 SSA, we concluded that all lynx populations in the DPS were likely to become smaller and more patchily distributed in the future due largely to projected climate-driven losses in habitat quality and quantity and related factors. We and the experts we consulted recognized that despite uncertainties about the timing, rate, and extent of habitat decline due to projected climate warming and corresponding effects to lynx populations, smaller, more isolated populations would be less resilient and more vulnerable to demographic and environmental stochasticity and genetic drift and, therefore, at higher risk of extirpation. To address these uncertainties we have, in this addendum, conducted a more structured assessment of current and future population resiliency (section 5.1 and 6.3), an assessment of the capacity of lynx on the southern periphery of the species' range to adapt to projected future conditions (section 5.3, Table 6), and a climate vulnerability assessment (section 6.1).

The results of these assessments indicate that:

- The current distribution of lynx populations in the DPS is strongly correlated with winter temperature and precipitation covariates;

- The climate conditions that currently prevail in areas supporting lynx populations are expected to diminish substantially through the end of this century due to projected climate warming;

- Because lynx are highly sensitive and broadly exposed to climate warming and have limited adaptive capacity to respond to it, they are vulnerable to and predisposed to be adversely affected by the projected impacts of continued warming; and

- The resiliency of DPS populations will likely decline substantially by mid-century and dramatically by the end of this century.

Despite improvements in our understanding of lynx habitat needs and recent advances and refinements in climate and habitat modeling, there remains uncertainty regarding the timing, extent, and magnitude of warming-mediated impacts to lynx and snowshoe hare habitats and the responses of populations of both species to those changes. Nonetheless, because DPS lynx populations exist at the southern periphery of the species' continental range, the areas they occupy likely already approach upper thermal thresholds for temperature and snow conditions supportive of persistent breeding populations. Recent modeling showing a strong correlation between resident lynx occupancy and winter temperature and snow conditions across the DPS range supports this hypothesis and suggest that warming will likely reduce the duration of the lynx's seasonal competitive advantage over other terrestrial predators of snowshoe hares. Even so, since the DPS was listed, resident lynx have expanded southward in Maine and westward into northern New Hampshire, as well as into northern Idaho; places at the boundaries between modeled favorable and unfavorable temperature conditions. Other recent research showing warming-mediated northward contraction of snowshoe hare distribution suggests the likelihood of future declines in the lynx's primary prey in focal areas. Therefore, despite potential lag times between warming temperatures and changes to the boreal and subalpine spruce-fir-pine vegetative communities that currently support lynx populations, the loss of favorable temperatures will likely result in reduced capacity of focal areas to support persistent breeding populations in the DPS range.

By mid-century, projected climate warming will likely result in substantial loss of favorable temperature and snow conditions in one or two of the five SSA Units that currently support resident lynx populations, depending on future scenarios. We expect this would reduce the resiliency of those populations substantially and, if it resulted in functional extirpation of any extant DPS populations, it would also reduce redundancy and representation in the DPS and, therefore, DPS viability (Table 1). By the end of this century, we expect substantial to dramatic loss of favorable climate conditions and associated loss of resiliency in at least two and perhaps all five of the SSA Units that currently support lynx populations. This would result in greater loss of resiliency, redundancy, and representation and a dramatic reduction in the DPS's viability (Table 1).

Chapter 1: Introduction

1.1 Background

Taxonomic update - The Canada lynx (order Carnivora; family Felidae) is one of four species within the genus *Lynx* (Kerr 1792), which also includes the bobcat (*L. rufus*, Schreber 1777), the Eurasian lynx (*L. lynx*, Linnaeus 1758), and the Iberian or Spanish lynx (*L. pardinus*, Temminck 1827). Some sources recognize three subspecies of Canada lynx: *Lynx canadensis canadensis* (Kerr 1792), *L. c. subsolanus* (Newfoundland lynx, Bangs 1897); and *L. c. mollipilosus* (Arctic lynx, Stone 1900) (Integrated Taxonomic Information System online database, http://www.itis.gov, retrieved July 27, 2023). However, the Cat Specialist Group, a component of the Species Survival Commission of the International Union for Conservation of Nature (IUCN), in 2017 determined that morphological, genetic, and biogeographical data do not support the subspecies divisions; they concluded that *L. canadensis* is a monotypic species (Kitchener et al. 2017, p. 41).

In 2017, the Service completed a species status assessment (SSA; USFWS 2017a, entire) for the contiguous United States distinct population segment (DPS) of the Canada lynx, which is listed as threatened under the Endangered Species Act (ESA). Based on the SSA and an assessment of foreseeable threats, the Service completed a 5-year status review that recommended the lynx DPS be delisted (USFWS 2017b, entire). In 2020, the Service was developing a proposed rule to remove the DPS from the list of threatened and endangered species in accordance with the ESA. We were concurrently working with state, tribal, and Federal partners to develop a Post-delisting Monitoring Plan, as required by the ESA, to track the DPS's status if and after it were to be delisted. However, based on an October 2021 settlement agreement in response to litigation on our decision to forgo development of a recovery plan for the lynx DPS, the Service ceased moving forward with delisting and maintained the DPS's threatened classification. We also committed to make a draft recovery plan available for public review by December 1, 2023, and to have a final recovery plan within a year of that.

In April 2022, the Service reached another settlement agreement with plaintiffs alleging the Service failed to revise lynx critical habitat in accordance with a 2016 court order that found fault with our 2014 final critical habitat rule. As a result of that settlement agreement, the Service will submit a proposed revised critical habitat rule for the lynx DPS to the *Federal Register* by November 21, 2024, and a final critical habitat rule within the statutory timeframe. To inform the recovery plan and critical habitat revision, we have completed this addendum as a supplemental update to our 2017 SSA for Canada lynx, which is available for download from our website at *https://ecos.fws.gov/ServCat/DownloadFile/213244*.

1.2 Addendum Scope

This SSA addendum is intended to provide a summary of new information and analyses that have become available since our 2017 5-year status review. It is not intended to be a comprehensive stand-alone document, but a supplement to the 2017 SSA Report. We focused on gathering information relevant to an assessment of the Canada lynx's current and future viability within the contiguous U.S. As such, new and relevant information on the current and future status of the DPS and potential threats has been incorporated into this SSA addendum. In addition to summarizing and evaluating new scientific information, this addendum includes a climate vulnerability assessment for the DPS and more structured resiliency and adaptive capacity analyses that consider projected climate warming and a suite of other factors that may exert population-level influences on the viability of DPS lynx populations in the future.

Geographical Extent - The boundaries of the SSA Units have been updated in this addendum, based on the best available information and recent verified lynx occurrence records, to better represent what we consider to be the current range of lynx in the DPS. However, our evaluations of current and future conditions are conducted on the focal areas within each SSA Unit (Figure 1 and Table 1). These are the areas known to contain the abiotic and biotic features necessary to support a resident breeding lynx population or modeled as having a high capability of doing so. In Units 1 and 2, focal areas are defined by designated critical habitat and other areas that meet the definition of critical habitat (i.e., areas excluded from critical habitat in accordance with section 4(b)(2) of the ESA). In Units 3-6, focal areas are defined as high-capability (potential high-quality) lynx habitat modeled by Olson et al. (2021, entire) and designated as Tier 1 (high quality; capable of supporting lynx residency) habitat areas by the interagency Western Lynx Biology Team (WLBT 2022, pp. 9-12, 18-23, 30).

Table 2. Sizes of Canada lynx SSA Units and focal areas used to assess the status of the species within the contiguous United States distinct population segment.

SSA Unit	Unit Size (km^2)	Focal Area Size (km^2)	Percent Focal Area
1 - Northeast	50,124	28,913	58
2 - Midwest	26,177	21,119	81
3 - Northern Rockies	57,672	20,606	36
4 - North Cascades	12,440	6,067	49
5 – Greater Yellowstone Area (GYA)	30,518	2,902	10
6 - Southern Rockies	27,606	19,411	70
Totals	**204,537**	**99,018**	**48**

The Kettle Range in northeastern Washington (Fig. 1) is not an SSA unit for the purposes of the evaluations included in this SSA addendum. This area was not occupied by lynx when the DPS was listed, has not been designated as critical habitat, has not recently supported natural (unassisted by humans) lynx residency, and its historical ability to support a resident lynx population remains uncertain. It is included in our maps and described in the addendum because it (1) is the site of an ongoing effort by the Confederated Tribes of the Colville Reservation to establish a resident population via releases of Canadian-trapped lynx over 5 winters (2021/22 – 2025/26) and (2) includes 732 km^2 (283 mi^2) of recently modeled high-capability habitat designated as Tier 1 by the WLBT.

Climate Vulnerability Assessment - In the 2017 SSA, we recognized that the lynx, as a boreal forest- and snow-adapted habitat and prey specialist, is probably broadly exposed and highly sensitive to the projected impacts of continued climate warming and has limited capacity to adapt to it. We concluded that lynx populations in the DPS are vulnerable (i.e., predisposed to be adversely affected) to the projected impacts of continued warming and related impacts, particularly increased wildfire and forest insect activity (USFWS 2017a, pp. 4–8, 20). We found that projected warming is likely to reduce the amount and quality of lynx habitats, lynx numbers, and the resiliency of lynx populations in the DPS, and we expect all DPS populations to become smaller and more patchily distributed in the future due largely to climate-driven losses in habitat quality and quantity (USFWS 2017a pp. 10, 67–83).

Given the significant challenge that climate warming is expected to present to the long-term resiliency of DPS lynx populations and, therefore, to the viability of the DPS as a whole, a more rigorous evaluation of the potential impacts of continued warming was needed. Therefore, a major part of this addendum to the lynx SSA is a climate vulnerability assessment intended to present a range of plausible warming scenarios and their potential consequences for lynx habitat suitability and population resiliency based on recent advances in climate and lynx habitat modeling (section 6.1 below).

Viability Analysis - In the 2017 SSA, our assessment of the resiliency of lynx populations within the DPS range was heavily informed by an expert elicitation process (USFWS 2017a, pp. 4–6, 166–227). In this addendum, we have included an updated assessment that uses a condition categorization framework now commonly used in SSA reports to assess current and future population resiliency and the redundancy and representation of the lynx DPS. This assessment considers key habitat and demographic variables and other factors that influence lynx populations and characterizes the current condition of those variables. To address future uncertainty, we then developed three plausible scenarios that capture the range of factors that may influence lynx populations in the future. We evaluated DPS population resiliencies under each scenario and across four timesteps through the end of this century to assess the potential future redundancy and representation of the DPS at each timestep.

1.3 Uncertainties and Assumptions

The uncertainties and assumptions defined in the 2017 SSA (USFWS 2017a, pp. 21–23) remain valid; they are repeated here for reader convenience, with some minor clarifications.

We assume that:

1. In general, habitat quality and contiguity and hare densities are naturally lower at the southern margin of the lynx's range (in both the contiguous United States and the southern portions of adjacent Canadian provinces) compared to the core of the species' range in Canada and Alaska. Hare populations in the DPS range are noncyclic or weakly cyclic and, although they do not exhibit the dramatic cyclic declines of their northern counterparts, they typically occur at densities on the lower end of those in the northern range. Because of this, lynx densities in most of the DPS range are typically similar to those in the core of the species' range during hare cycle lows.
2. As a consequence of generally lower habitat quality and hare densities, only some places within the DPS range are capable of supporting persistent resident lynx populations, while others may naturally support resident lynx only ephemerally, and yet other areas are naturally incapable of supporting resident lynx despite boreal-forest-like vegetation, the presence of some hares, and the occasional or intermittent presence of dispersing or transient lynx.
3. The status of lynx populations in individual SSA geographic Units are largely independent of those in the other geographic Units. This is clearly true for Units 1 and 2, and it is probably

true of the western geographic Units (3–6), despite likely historical north-to-south connectivity and dispersal from or through Unit 3 to Unit 5 and possibly Unit 6, and recent evidence of south-to-north connectivity and dispersal from Unit 6 to and through Units 5 and 3. We found no evidence of east-west connectivity or dispersal between Units 3 and 4.

4. Lynx populations in the DPS occur as the southern extensions of larger, cross-border populations or as relatively isolated subpopulations of the larger Canadian populations.
5. Lynx exhibit a metapopulation structure in which populations at the southern periphery of the species' range (including all DPS populations and some in southern Canada) receive periodic immigration of lynx dispersing from populations in the core of the Canadian range.
6. Connectivity with lynx populations in Canada is important, and the periodic immigration of lynx into the DPS from Canada contributes to the persistence of DPS populations, although the extent to which the demographic and genetic health of DPS populations may depend on immigration remains uncertain.
7. The lynx's morphology confers a competitive advantage in snowy conditions over other terrestrial hare predators; snow conditions (depth, consistency, and persistence) influence the distribution of lynx and its potential terrestrial competitors; and in the absence or loss of these conditions, lynx could be displaced by other terrestrial hare predators.
8. The lynx, as a boreal forest- and snow-associated predator that relies heavily on a single, similarly specialized prey species, and whose habitats are influenced by climate-mediated disturbance factors (e.g., wildfire, forest insects, wind/ice storms), is highly sensitive and broadly exposed to the impacts of climate warming and has limited adaptive capacity to respond to it. That is, despite some level of behavioral plasticity suggested by differences in snow conditions and specific vegetation communities and stand conditions across the DPS range, we expect that lynx lack the adaptive capacity to shift to non-boreal (e.g., temperate coniferous or deciduous) forests, non-snow-dominated climates, or to persist on alternate prey species where hare densities are or become inadequate. Therefore, we assume lynx populations in the DPS are vulnerable (sensitive, exposed, and with little capacity to adapt; therefore, predisposed to be adversely affected; IPCC 2014, p. 5) to the projected impacts of continued climate warming.
9. Lynx conservation measures and habitat management guidance adopted by the USFS and the BLM via formally amended or revised management plans or conservation agreements with the Service have had a positive influence on DPS lynx populations that occur on Federal lands and will continue to provide benefits as long as those measures and guidance are implemented.
10. We assume that Federal, State, and Tribal agencies and some private landowners will continue to manage for the conservation of resident lynx populations in those places that can support them in the DPS range. This assumption is based on the efforts of these entities since the DPS was listed to work with the Service to adopt science-based regulations and conservation measures to address the regulatory threat for which the DPS was listed. Within this framework, we are not aware of any instances in which the actions of these entities have resulted in substantial adverse impacts to lynx habitats or populations.

Additionally, for this addendum, we assume that:

11. Lynx populations in the DPS, because they occur at the southern margin of the species' range, exist at the species' climatic and vegetative limits. That is, we assume the climatic and vegetative characteristics that define the southern edge of the DPS's range represent the limits in the ability of those characteristics to support persistent and reproductively successful resident lynx populations. We assume that the loss or substantial degradation of those characteristics would represent a loss/degradation of an area's ability to support a resilient lynx population into the future.

12. Larger lynx populations that occupy larger geographical areas with higher habitat quality are more resilient than smaller populations that occupy smaller geographical areas with lower habitat quality.

13. DPS populations that are directly connected to populations and habitats in Canada are more resilient than populations that are not directly connected, and resiliency decreases with increasing distance from the core of the species' range in Canada.

14. There are inherent uncertainties regarding the accuracy of modeled variables (i.e., mean coldest month temperature, MCMT) when projecting into the future with different emission pathways (SSPs, RCPs, etc.), downscaling these variables to finer spatial resolutions, and with the SSPs themselves. In addition, the use of projected global circulation model (GCM) ensembles presents the average of the GCMs used in the ensemble and does not capture the minimum and maximum future conditions. We do not list all these uncertainties here but suggest readers review AdaptWest 2022 and IPCC 2022 for more details on these uncertainties.

15. Mean coldest month temperature (MCMT; December to February) was the strongest predictor of resident lynx occurrence in Olson et al. 2021, and a temperature envelope of -10 to -5°C accurately captures all known areas of resident breeding lynx in the western part of the DPS (SSA Units 3-6). Although no similar SDMs exist for the eastern portions of the DPS range, the distribution of resident breeding lynx in the Northeast (Unit 1) and Midwest (Unit 2) was also captured with a MCMT range from -15 to -10°C. We assume that (a) these MCMT envelopes are proxies for the snow and vegetation conditions favorable for lynx and their prey, (b) the colder temperatures necessary to maintain these conditions in the Northeast and Midwest are related to higher humidity in those areas relative to the western DPS range, (c) these temperatures on the southern periphery of the species' range represent thresholds above which conditions favorable to lynx will cease to persist, and (d) lynx lack the adaptive capacity to maintain resilient resident breeding populations at warmer temperatures than those that currently prevail in DPS focal areas.

16. Projecting a single covariate (MCMT) into the future represents the potential future distribution of lynx across the DPS. Given the strength of the relationship between MCMT of -10 to -5°C in Olson et al. 2021 and the distribution of breeding populations in the west, the similarity of results from a future SDM with all covariates (L. Olson, *personal communication*) to future MCMT in the western DPS, and the similar accuracy of MCMT (-15 to -10°C) in identifying current resident breeding lynx distribution in the Northeast and the Midwest, we believe using these MCMT envelopes to characterize the future distribution of resident lynx populations across the DPS is justified.

Whether each assumption is correct or not can influence the assessment of lynx population resiliency and DPS viability in one of two ways – either an overestimate of risk, resulting in an underestimate of resiliency and viability; or an underestimate of risk, resulting in an overestimate of resiliency and viability. Table 3 summarizes the potential consequences of the assumptions above being incorrect.

Table 3. Uncertainties, assumptions, and potential consequences of incorrect assumptions on the assessment of Canada lynx population resiliency and DPS viability.

Uncertainty	Assumption (Assumption Numbers)	Consequence if Assumption is Incorrect[1]
What limits lynx abundance, density, and persistence in the DPS?	Naturally marginal habitats and hare densities limit lynx abundance and persistence at the southern range periphery. (1, 2)	B
Are DPS lynx populations independent of one another?	DPS lynx populations are independent. (3)	A
Is connectivity of DPS lynx populations to Canadian populations important?	Connectivity to Canadian populations is important to DPS population viability. (4, 5, 6, 13)	B
Do snow conditions influence lynx distribution and competitive advantage?	Deep, unconsolidated ("fluffy"), and persistent snow favors lynx over other terrestrial predators of hares; a decrease in favorable snow conditions would reduce lynx competitive advantage. (7)	B
Is projected climate warming a threat to DPS lynx populations?	DPS lynx populations are highly sensitive and broadly exposed to climate warming and have limited adaptive capacity to respond to it; thus, they are predisposed to be adversely affected by continued warming. (8)	B
Have improved regulatory mechanisms reduced threats to lynx?	Improved regulatory mechanisms have benefitted DPS lynx populations and will continue to do so in the future. (9, 10)	A
Do DPS lynx populations currently exist at habitat and climatic thresholds?	Lynx in the DPS exist at habitat and climatic thresholds; any degradation in these factors reduces resiliency and viability. (11)	B
Are larger lynx populations occupying higher-quality habitat more resilient?	Larger lynx populations occupying higher-quality habitat are more resilient than smaller populations occupying lower-quality habitats. (12)	B
Do prevailing winter temperature envelopes at the southern periphery of lynx range limit the distribution of resident lynx populations in the DPS?	Prevailing winter temperature envelopes represent thresholds above which resident breeding DPS lynx populations will not persist. (14, 15, 16)	B

[1]A = Underestimate of risk, overestimate of resiliency/viability.
B = Overestimate of risk, underestimate of resiliency/viability.

Of the 16 assumptions listed above, three would result in an underestimate of risk and overestimate of resiliency and viability if incorrect, while 13 would result in an overestimate of risk and underestimate of resiliency and viability. However, these totals alone provide an incomplete picture of the relative degree of impact these assumptions may have. Overall, based on the range of plausible future scenarios evaluated (see section 6.2) and their consequences to our assessment if these assumptions are incorrect, the results presented in this addendum likely capture the plausible range of current and future risks to the lynx DPS.

Chapter 2: Methods

2.1 Literature Review and Evaluation

Since completion of the 2017 SSA, the Service's species and regional lynx leads have continued to compile new or previously unreviewed published research and unpublished survey results, etc., specific to lynx, snowshoe hares, climate change/modeling, wildfire, and insect outbreaks in lynx habitats. Periodic searches in Google Scholar and continued correspondence with lynx/hare researchers and managers resulted in the collection of 110 papers with potential relevance to current and/or future conditions for lynx populations or habitats in the DPS range. Additionally, on August 5, 2022, the Service published a notice initiating a 5-year status review for the lynx DPS and requesting new information on the species (87 FR 48037). In October 2022, the Service sent letters to state, Federal and tribal agencies and partners and the lynx research community notifying them of our intent to update the 2017 SSA to inform legal commitments regarding recovery planning and critical habitat revision. Those two requests resulted in submissions of additional survey results and other information potentially relevant to this SSA update.

2.2 Climate Modeling and Climate Vulnerability Assessment

The methods of the climate vulnerability assessment presented in this report are described in detail in Chapter 6. The climate vulnerability assessment was based primarily on the importance of co-variates used in an ensemble species distribution model for lynx in the Northern Rocky Mountains and the Pacific Northwest (Olson et al. 2021, entire). Sixteen covariates were used in the Olson et al. (2021, p. 11) model, and mean temperature of the coldest month (or Mean Coldest Month Temperature; MCMT) was by far the strongest covariate (most predictive of resident lynx occupancy), followed by snow water equivalent and winter (December – February) precipitation (see Fig. 9 in section 6.1). As described above, we assume these covariates are proxies for the snow conditions and moist spruce-fir forests that support resident populations of lynx and their primary prey species, snowshoe hare. MCMT was also found to be the strongest predictor of lynx occupancy in Maine (A. Sirén, *personal communication*), lending further support of the importance of this variable to the current distribution of lynx in the contiguous U.S., and by extension their potential future distribution. Winter temperature ranges like those in Maine also broadly encompass lynx distribution in Unit 2, but in the northeastern Minnesota core area, snow depth was the best predictor of lynx occupancy.

We obtained ensemble future projections of MCMT from AdaptWest (AdaptWest Project 2022, entire; Mahoney et al. 2022, entire; Wang et al. 2016, entire) for years 2021–2040, 2041–2060, 2061–2080 and 2081–2100 for three different emission pathways (SSPs) from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report. We used three emission scenarios, SSPs 2-4.5, 3-7.0, and 5-8.5, to account for the high level of uncertainty in potential future emissions described by the IPCC. The range for MCMT that captures all known occurrences of resident lynx in the western U.S. (-10 to -5°C) was obtained from L. Olson (*personal communication*), and the range for the Northeast (-15 to -10°C) from A. Sirén (*personal communication*). The -15 to -10°C temperature range also encompassed the distribution of resident lynx in Minnesota (Unit 2), although snow depth was a stronger predictive variable there, perhaps related to lake effect snow from Lake Superior (N. Hostetter, *personal communication*). We used these two temperature ranges to map the projected contraction of favorable temperature (and thus habitat) conditions for lynx across the DPS range through each of the 20-year time horizons and for each emission scenario. We then calculated spatial statistics through time and by scenario for each of the SSA unit focal areas. We used the results of these projections and the contraction of prevailing temperature conditions through time to populate current and future condition category tables found in Chapters 5 and 6.

2.3 Viability Analysis

To assess the viability of the DPS, we evaluated the current and future resiliency of the lynx populations in each of the six SSA unit focal areas to inform our understanding of the current and future redundancy and representation of the DPS as a whole. This evaluation was done categorically based on the current and anticipated future state of habitat and demographic variables in the DPS populations (see tables 4 and 5, section 5.2 below) for three plausible future scenarios (see Table 9, section 6.2 below for detailed descriptions of each scenario). The categorical resiliency scores for habitat and demographic variables at the population level were averaged to produce an overall categorical resiliency condition score for each population (see section 5.1 for a detailed description of the scoring methodology). This resulted in an overall score of high, moderate, low, or not resilient/ functionally extirpated for each unit, time-period, and scenario. We used projected changes in population resiliencies over time to assess the viability of the DPS in terms of redundancy and to inform our understanding of potential future representation. The greater the number of resilient populations that persist in the DPS, the greater the ability of the DPS to withstand stochastic and catastrophic events (DPS redundancy), and to adapt to long-term changes in the environment (DPS representation). High redundancy and representation in the DPS would be demonstrated by maintenance of current population level resiliencies over time. Loss of resiliency among individual populations would reduce the overall viability of the DPS. If population level decreases in resiliency resulted in the functional extirpation of one or more extant populations, then DPS redundancy and representation would also decline, resulting in reduced viability of the DPS as a whole.

Chapter 3: Updates to Lynx Distribution and Habitat Needs

Since completion of the 2017 SSA, resident lynx populations have continued to persist in SSA Units 1, 2, 3, 4, and 6, while Unit 5 has continued to lack evidence of lynx residency or reproduction. Brief summaries of recent information regarding lynx and habitat distribution and/or abundance are provided below for each SSA unit and, in some cases, adjacent areas.

Unit 1 – High quality lynx and hare habitat in this unit continues to occur at what is believed to be historically high abundance. Recent analysis using the USFS Forest Inventory and Analysis (FIA) database (Burrill et al. 2018, entire) shows that the total amount of lynx habitat increased between 1995 and 2009 but has trended downward since then (although the most recent estimate still exceeds that from 1995). The amount of high-quality habitat increased from 1995 to 2003 and has remained relatively constant at elevated levels from 2003 to 2021 (Figure 4; Vashon and Harris 2021, p. 9).

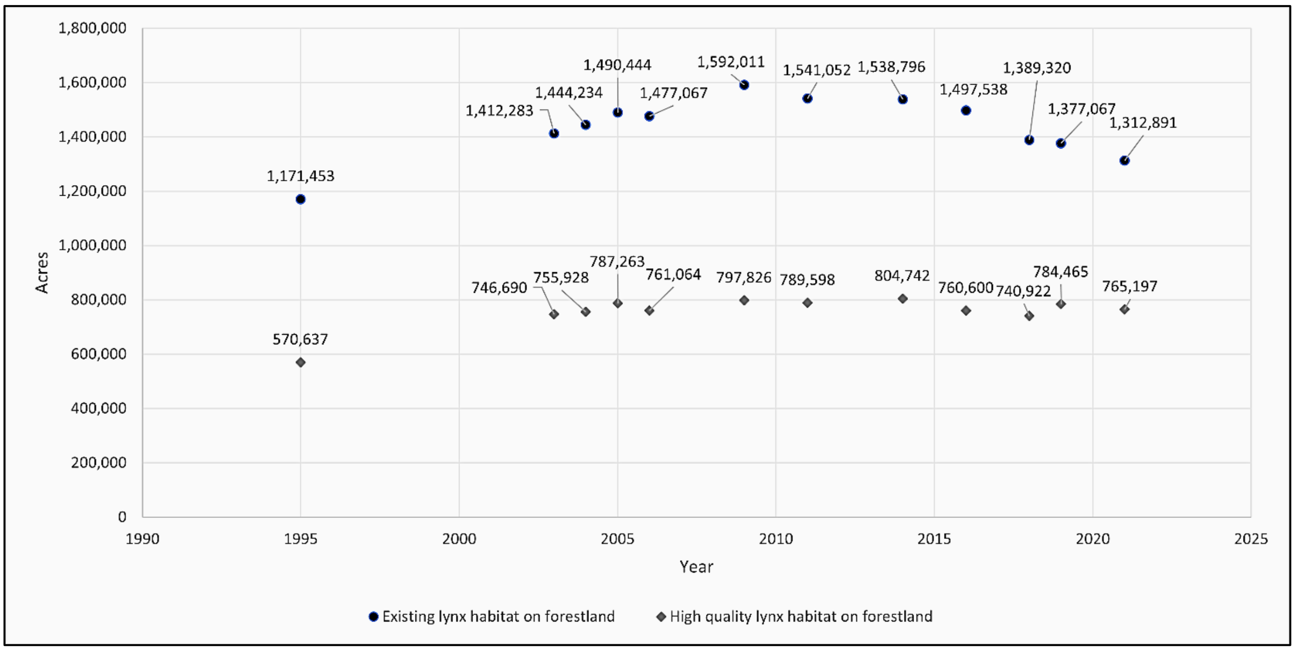

Figure 4. Trends in the amount of lynx habitat (spruce/fir sapling forest, 1 to 5 inches diameter at breast height (DBH); black circles) and high-quality foraging habitat (moderate to well stocked spruce/fir sapling forest; grey diamonds) in Maine, 1995–2021, based on annual forest inventory by the Maine Forest Service.

The Maine Department of Inland Fisheries and Wildlife (MDIF&W) recently completed a cooperative project with the University of Maine that showed an increase in Canada lynx occupancy in Maine across three survey periods (late 1990s, 2003–08, 2015–19). These surveys also demonstrated range expansion into eastern Maine after 2008 (Figure 5; Vashon and Harris 2021, p. 14). Prior to 2008, surveys were not conducted in eastern Maine because it was considered outside of the historic range of the species. However, after two winters with deep snow (2008 and 2009), MDIF&W staff began observing lynx in eastern Maine (primarily north of State Route 9) and therefore expanded winter track survey efforts from 2015–2019 into this part of the state. Results of the latest survey are not yet finalized but preliminary results indicate increased occupancy and distribution (J. Vashon, *personal communication*).

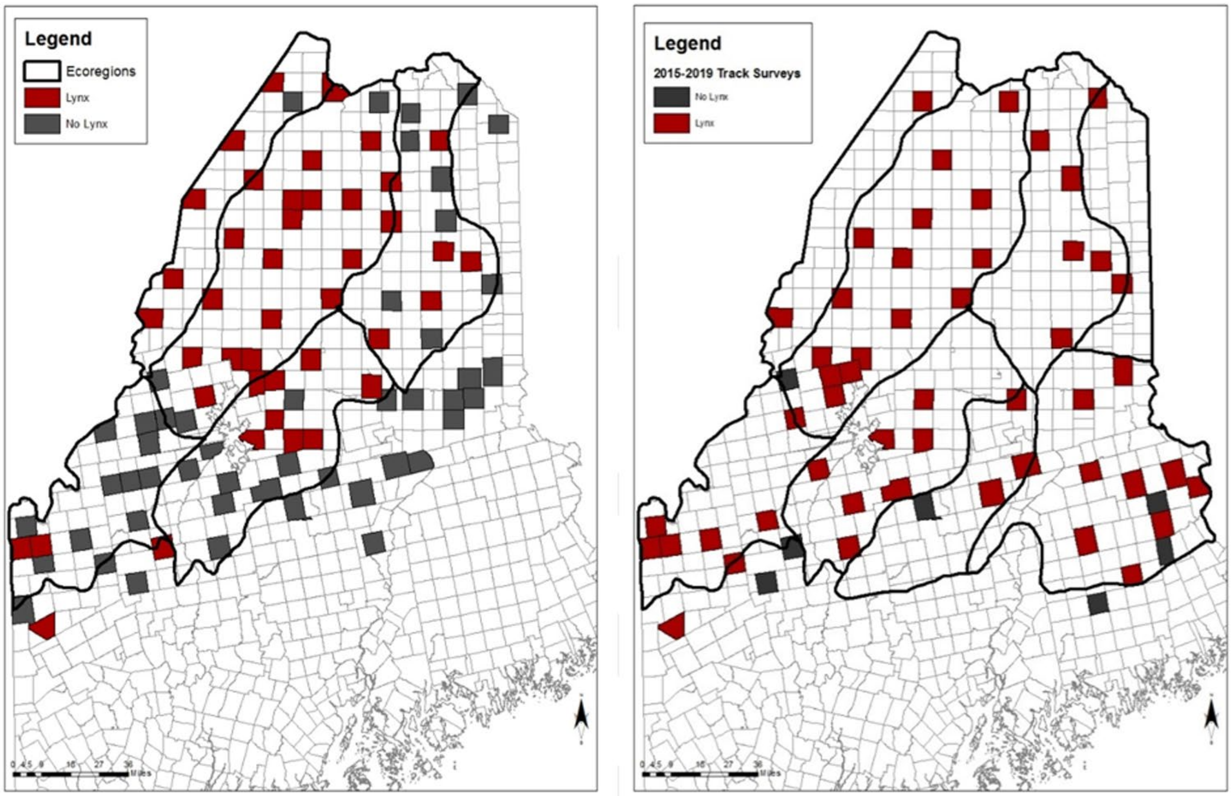

Figure 5. Results of two winter snow track surveys conducted between 2003–2007 (left) and 2015–2019 (right) to detect lynx presence and estimate occupancy in northern Maine (Survey cells where lynx were detected are in red).

Evidence of natural movement and gene flow between lynx in Maine and those in adjacent Canada, although lower than previously suspected, suggest that this SSA Unit is part of a larger, contiguous lynx population that extends into northern New Brunswick and the Gaspé Peninsula of southern Quebec (Lama 2021, pp. 32-41). South of the St. Lawrence River, extensive areas of contiguous forestland in this region provide connectivity between populations in Maine and southeastern Canada. Contemporary gene flow is evident, albeit restricted, between Maine and lynx populations north of the St. Lawrence (Lama 2021, p. 21). The recent expanding lynx population in northern Maine was likely the source of the increased lynx occurrence in northern New Hampshire and Vermont in recent years (see below).

Unit 2 – Continued snow-tracking surveys and DNA mark-recapture analysis (Barber-Meyer et al. 2018, entire; Hostetter et al. 2020, entire; Ryan et al. 2023, entire) confirm the continued presence of a resident breeding population in this unit. Estimates of population size from within a core area representing roughly half of the focal area in this unit show an increasing trend in the population of that area from a low of 43 (95% CI = 36-65) in 2016 to highs of 109 (95% CI = 96-150) in 2020 and 90 (95% CI = 71-147) in 2022 (Figure 6).

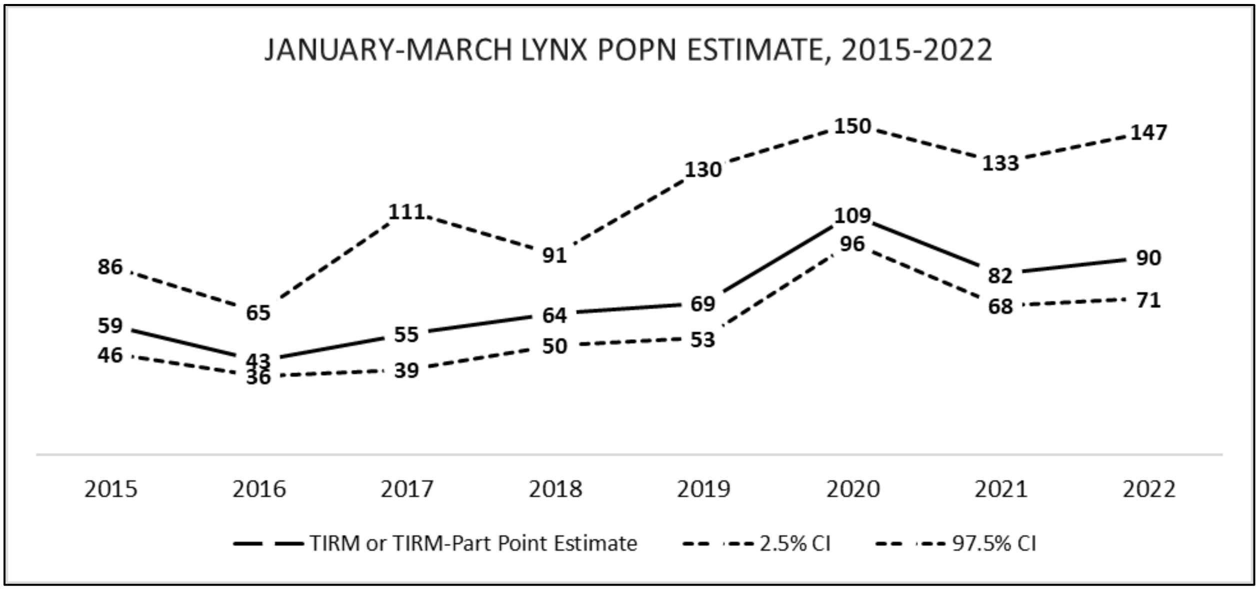

Figure 6. Lynx population point estimates and 95 percent confidence intervals generated using capture-mark-recapture analysis of genetic samples for larger core areas consistently surveyed from January-March of 2015-2022 in the Superior National Forest, Minnesota. Adapted from Barber-Meyer et al. 2018, in Ryan et al. 2022, p. 10.

Monitoring from 2004–2020 has shown that the amount of suitable snowshoe hare habitat has increased over time across the Superior National Forest. In 2004, lynx foraging habitat in 47 lynx analysis Units (LAUs) averaged 54 percent and by 2020, it had increased to 66 percent (USFS 2021, pp. 186). It is projected to decrease slightly to 63 percent by 2024 but would remain significantly higher than the 2004 Forest Plan Biological Assessment prediction of 42 percent (USFS 2021, pp. 186–188). Lynx status outside the core area is unclear, including in the Boundary Waters Canoe Area Wilderness, where there are over 4,000 km^2 (> 1,500 mi^2) with unknown or undocumented lynx/hare prevalence.

Hostetter et al. (2020, entire) assessed the effects of habitat characteristics and anthropogenic factors on Canada lynx distributional changes and occupancy dynamics in Minnesota. The study area included the majority of the Superior National Forest and designated lynx critical habitat in Minnesota. The authors used a dynamic occupancy model to evaluate lynx occupancy, persistence, colonization, and habitat covariates affecting these processes. Lynx were more likely to occupy, persist, and colonize sites with higher percent evergreen forest, greater average snowfall, and dense vegetation (LiDAR 3-5 m). The authors also found evidence of high annual variability in lynx populations at their southern range periphery (Figure 7), likely driven by environmental variation between years, connectivity to larger lynx populations in Canada, and variation in prey abundance (Hostetter et al. 2020, p. 801).

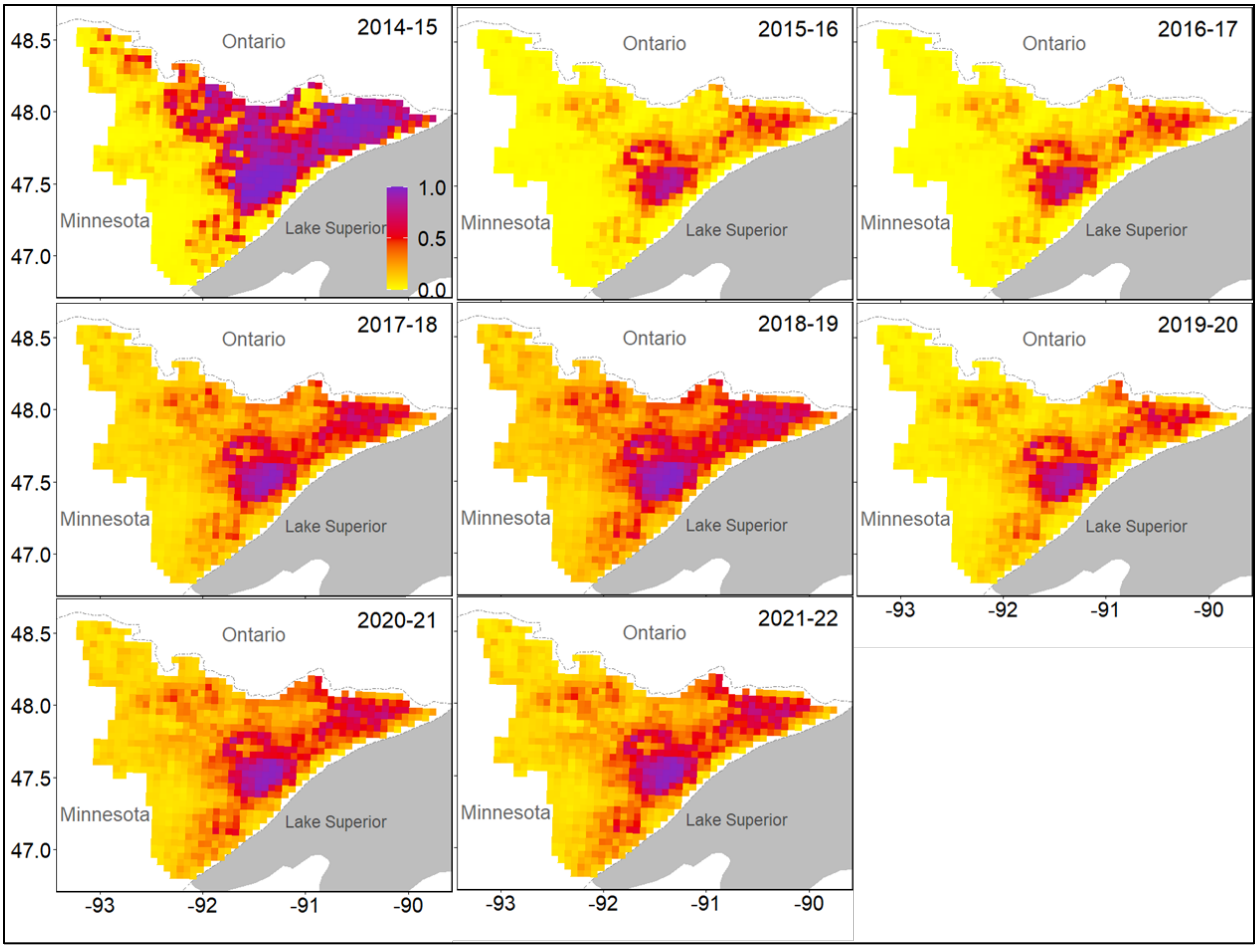

Figure 7. Median lynx winter-specific occupancy probabilities (0 – yellow [likely unoccupied] to 1 – purple [likely occupied]). Grid cells are 5×5 km and encompass Superior National Forest and designated lynx critical habitat in Minnesota (Ryan et al. 2022, p. 12).

Unit 3 – Recent empirical habitat modeling using the most extensive database of highly accurate verified lynx locations in Montana, Washington, Wyoming, and Colorado indicate that habitats capable of supporting lynx residency in this unit and throughout the West are much more limited than previously assumed (Olson et al. 2021, entire; Squires et al., in prep.; WLBT 2022, entire). While this unit has been expanded to include newly modeled high-quality habitat in northern Idaho and the Lolo Pass area on the border between Montana and Idaho and other areas of recent lynx occupancy, overall, it has just over 20,600 km^2 (7,954 mi^2) of focal area habitat thought to be capable of supporting resident lynx; about 25 percent less than the 27,000 km^2 (10,425 mi^2) evaluated in the 2017 SSA (USFWS 2017a, p. 14).

From January 1, 2017, through November 11, 2022, the Montana Natural Heritage Program reported 769 verified lynx detections or observations in western Montana, and 129 additional photos of lynx were taken within 8 wolverine (*Gulo gulo*) camera survey cells during the 2021-2022 wolverine occupancy survey (MTFWP 2023, p. 1). Montana Fish, Wildlife and Parks also developed a lynx monitoring program that it initiated in modeled high-quality lynx habitat in southwestern and western Montana in winter 2022-2023. The camera survey deploys scent pumps and visual attractants in sampled 7.5 km x 7.5 km survey cells in core lynx habitat containing > 50 percent high quality habitat as modeled by Olson et al. 2021 (entire). The intent is to survey 90 of the 180 high-quality cells in Montana every 5 years beginning in 2023-2024. The objectives are to (1) determine trends in lynx occupancy over time, (2) improve understanding of current lynx distribution in the northern GYA in southwest Montana, and (3) estimate lynx occupancy in Montana focusing on modeled core habitat (MTFWP 2023, pp. 2–4).

Recent camera trap surveys and occupancy analysis in Glacier National Park in the northeastern part of this unit suggest that lynx are more numerous and broadly distributed there than previously known (Anderson et al. 2023, pp. 10–15). The authors estimated a low average density of 1.28 lynx/100km^2 and a park-wide abundance of 52 individual lynx (95% CI = 30-92) (Anderson et al. 2023, p. 2). Similarly, snow-tracking and camera-trap surveys in the Southwestern Crown of the Continent (SWCC), which encompasses roughly the southern 30 percent of the Unit 3 focal area, during 2012-2022 documented 109 individual lynx (67 males; 42 females), 95 of which were new to the regional DNA database (Lamar and Mayernik 2023, p. *iii*). The surveys indicate an expansion of lynx occurrence in the western half of the SWCC in 2021-2022 compared to 2013-2016 (Lamar and Mayernik 2023, pp. 25–26).

Conversely, the Garnet Mountains, a small and somewhat isolated range in the southern portion of Unit 3 outside of the SWCC that has about 81 km^2 (31 mi^2) of modeled high-capability lynx habitat (0.4 percent of the unit's focal area; WLBT 2022, p. 15), were occupied by a small number (2-5) of resident lynx in 1980-1984 and again from 2002-2010 (Brainerd 1985, pp. 18–19; Squires in Lynx SSA Team 2016, p. 20 and Appendix 5). It is unclear based on verified records whether the Garnet Range was continually occupied by resident lynx from the 1980s to 2010; however, genetic analysis indicated that lynx in the Garnets exhibited minor genetic sub-structuring compared to the nearest resident population in the Seeley-Swan area to the north (Schwartz *in* Lynx SSA Team 2016, p. 13). The Garnet Range appeared to be unoccupied by lynx from 2011–2015, suggesting a minor contraction in breeding distribution in this unit. A single likely transient lynx was verified in the Garnets in 2016, and two DNA samples collected in Jan.-Feb. 2019 were also verified as lynx (J. Sparks, *personal communication*; Pilgrim et al. 2019, entire). No lynx have been detected in the Garnets since then, despite continued snow tracking surveys (L. Lamar, *personal communication*).

Recent research summarized below has improved understanding of lynx habitat use and distribution in this unit:

- The probability of female lynx producing a litter is correlated positively with connectivity of mature (50 to 200 years old) multistoried spruce-fir forest and negatively with fragmentation in female lynx core-use areas (Kosterman et al. 2018, entire; Holbrook et al. 2019, entire);
- Snowshoe hare occupancy and intensity of use are strongly correlated with high (dense) horizontal cover in Engelmann spruce-subalpine fir-lodgepole pine forest types; these habitats are patchily distributed in this unit (Holbrook et al. 2017a, entire);
- Lynx broadly select mature multistoried spruce-fir forests but, within home ranges, both males and females exhibit strongest selection, in both summer and winter, for stands of advanced regenerating forest (20 to 80 years old), which support hare densities ≥ 2.8

times higher than all other forest stand types, including mature forest (Holbrook et al. 2017b, entire; Holbrook et al. 2019, entire);

- Lynx use areas that have been silviculturally treated (thinned or harvested), but use is low for the first 10 years post-treatment, after which treatment type and the quality of surrounding untreated stands influence lynx use (Holbrook et al. 2018, entire);
- Empirical habitat modeling based on thousands of verified lynx locations indicates that abiotic variables including cold winter temperatures, high snow-water equivalents, and winter precipitation are the most important variables in delineating habitats capable of supporting resident lynx in this and other western SSA Units (Olson et al. 2021, entire), and that these habitats are less abundant and more narrowly distributed than previously thought (WLBT 2022, entire);
- Lynx occur at low density in Glacier National Park but are nonetheless more numerous and more broadly distributed there than previously known (Anderson et al. 2023, entire);
- Lynx response to wildfire and subsequent forest management differs based on the type and post-fire timing of management actions, and it is likely driven by the high hare densities supported in regenerating stands of lodgepole pine that exhibit dense horizontal cover (Olson et al. 2023, entire);
- Lynx were more broadly distributed across much of the southern portion of the Unit 3 focal area during 2021-2022 than in 2013-2016 (Lamar and Mayernik 2023, entire).

Although the number of lynx in this unit remains uncertain, resident lynx appear to remain broadly distributed throughout much of the unit, and it continues to support the largest native lynx population in the western contiguous U.S. Genetic analyses and snow and camera surveys have verified continued reproduction and recruitment among lynx populations in this unit and suggest some immigration may be occurring. The recent apparent absence of resident lynx in the Garnet Mountains may indicate extirpation of a small resident population and a minor contraction in lynx distribution in the southern part of the unit, or it may reflect natural source-sink dynamics of a naturally ephemeral peripheral population in a mainland-island metapopulation structure (USFWS 2017a, p. 143). Recent lynx detections in the Garnets indicate that dispersing lynx are able to access the area and, therefore, recolonization is possible. Recent research in Glacier National Park indicates a greater importance of this area to the unit's lynx population than was previously known.

<u>Unit 4</u> – Current lynx numbers and distribution in this unit may be reduced by 50 percent or more because of atypically large and frequent wildfires in lynx habitats over the past 20-30 years (Lewis 2016, pp. 4–6; USFWS 2017a, pp. 149–153; section 4.4 below). Thus, the number of resident lynx in this unit is likely lower than it was historically and when the DPS was listed. Based on estimates of lynx carrying capacity, this unit's designated critical habitat may have been capable of supporting roughly 50-60 resident lynx prior to large fires beginning in the early 1990s (USFWS 2017a, pp. 8, 111, 150–152). Recent habitat evaluations suggest it may have been capable of supporting about 30-35 lynx as of 2016, with the decline due to fire-driven habitat losses. Additional fires since then (see section 4.4 below) have further reduced Unit 4's carrying capacity, with current estimates of 18 to 24 females (assuming immigration and home range size of 39 km^2) or 9 to 15 females (assuming immigration and a 55 km^2 home range;

Lyons et al. 2023, p. 10). Because regeneration of burned areas should result in high-quality hare and lynx foraging habitat within 20-40 years post-burn, fire-mediated habitat loss is expected to be temporary, and large areas of burned habitat should return to good or excellent habitat in the next 5-10 years provided they do not reburn (Rohrer *in* USFWS 2019, pp. 7–8). The Washington State Wildlife Action Plan considers lynx to be highly vulnerable to climate change due to increased temperatures, reduced snowpack, earlier snowmelt, altered fire regimes and increased insect and disease outbreaks (WDFW 2015, pp. 5–18).

Recent research in Washington (King et al. 2020a, entire) has confirmed, consistent with Koehler et al. (2008, p. 1518), that resident lynx in Washington occur consistently only in the northern half (north of Lake Chelan) of the Okanogan Lynx Management Zone (LMZ). This has been the case since at least the mid-1980s (Koehler et al. 2008, p. 1518) and it may be the natural historical condition. Reliable records from the southern portion of the Okanogan (south of Lake Chelan) and the other 5 LMZs in northeastern Washington suggest that lynx occurrence was rare historically and highly correlated more recently with well-documented irruptions of lynx from Canada into the northern contiguous United States in the 1960s and 1970s (McKelvey et al. 2000, pp. 232–242; Stinson 2001, pp. 59–63). The cyclical (pulsed) nature of reliable historical occurrence records (Stinson 2001, pp. 59–62) and recent (1960–1991) trapping data (Stinson 2001, p. 63) for most northern Washington counties suggests that many records were likely of dispersing lynx associated with irruptions and not members of persistent resident breeding populations.

Recent habitat modeling (Olson et al. 2021, entire) indicates that this unit contains roughly 6,000 km^2 (2,317 mi^2) of potential high-quality habitat likely capable of supporting resident lynx (WLBT 2022, p. 30). This is a larger area than (1) the 2,400 km^2 (927 mi^2) of suitable habitat estimated in this unit by Koehler et al. (2008, pp. 1519, 1522), (2) the 5,176 km^2 (1,998 mi^2) of habitat the Service found to meet the definition of critical habitat (including Loomis State Forest lands that were ultimately excluded from critical habitat designation) (78 FR 59455), and (3) the 4,079 km^2 (1,575 mi^2) that King et al. (2020a, pp. 714, 717) predicted to be occupied by lynx. Applying a resident lynx density of 2.3 lynx/100 km^2 (Koehler 1990, p. 847) to the 6,067-km^2 (2,342-mi^2) focal area designated as Tier 1 (capable of supporting lynx residency) by the WLBT (2022, p. 30) yields a hypothetical population size of 140 lynx, assuming the entire area can support lynx home ranges. However, Koehler's density estimate was derived from telemetry data collected in the "Meadows" area, which provided the best habitat in the Okanogan Lynx Management Zone at that time (USFWS 2017a, p. 151). Because most other potential lynx habitat in this unit is lower in elevation, more highly fragmented and supports relatively low snowshoe hare density (Jensen et al. 2022, entire; Walker 2005, pp. 3, 6), we think a density of 1.5 - 2 lynx/100 km^2 is likely more reasonable and would yield an estimated population of about 90-120 resident lynx if all areas supported home ranges.

If lynx numbers track fire-driven habitat loss, the Unit 4 focal area may currently be capable of supporting 45-60 resident lynx. With several large areas approaching 20-25 years post-burn (e.g., the 323-km^2 (125-mi^2) Farewell fire in 2001 and the 706-km^2 (273-mi^2) Tripod fire in 2006), at which time regenerating forest should provide good to excellent hare and lynx habitat (dense coniferous horizontal cover), carrying capacity and lynx numbers in this focal area will likely rebound in coming years, provided these areas do not reburn. In spring 2023, preliminary data from a lynx movement study within the Tripod burn show that at least one collared male now resides entirely within the burned area, providing further support that it is beginning to provide habitat for lynx once again (C. Vanbianchi, *personal communication*). Another collared male in this study resided predominantly within the burn, except for a short period of time when he moved north into southern British Columbia before returning south to the burn area.

Unit 5 – Recent surveys and research-related trapping efforts have failed to detect lynx on the Bridger-Teton National Forest after 2010 or on the Shoshone National Forest after 2013 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20–21, 45; Hanvey *in* USFWS 2019, p. 7). However, Philbrook (*in* USFWS 2019, p. 5) reported 5 verified or "very likely" incidental records of lynx in Yellowstone National Park from 2007 to 2014. Most verified records of lynx in this unit after 2000 were lynx that had been released in Colorado and dispersed to and through this unit, which has not recently supported and does not currently appear to support resident lynx or a breeding population. Recent habitat modeling (Olson et al. 2021, entire) indicates that this unit contains much less high-quality lynx habitat than previously thought, with only 2,902 km^2 (1,120 mi^2; about 10 percent) of the 30,518-km^2 (11,783-mi^2) unit now considered as habitat capable of supporting resident lynx (WLBT 2022, p.30). Most of the high-quality habitat in this unit occurs in the southern Wyoming Range, with two smaller areas in the northern Wind River and southern Absaroka ranges (Fig. 1). Smaller patches of lower-quality habitat are sparsely distributed throughout much of the rest of the unit, including Grand Teton and Yellowstone national parks and the Caribou-Targhee and Custer-Gallatin national forests in southeastern Idaho and southern Montana (WLBT 2022, p. 30). The latter areas and most of this SSA unit lack habitat capable of supporting persistent occupancy by resident lynx populations.

Unit 6 – The historical and current numbers of resident lynx in this unit are unknown, but the 1999-2006 release by Colorado Parks and Wildlife (CPW) of 218 lynx from Canada and Alaska into the San Juan Mountains in southwestern Colorado has resulted in the establishment of resident breeding populations in the two Tier 1 focal areas in this unit (WLBT 2022, p. 30). These areas combined have over 19,000 km^2 (7,336 mi^2) of modeled high-quality habitat thought to be capable of supporting resident lynx (WLBT 2022, pp. 18-21, 30). Lynx released in Colorado had high survival but the proportion of females that produced kittens and kitten survival were low (USFWS 2017a, pp. 112-113, 164). CPW recently revised its estimate of the number of resident lynx that may occur in the Colorado population from 100–250 in 2015 (Ivan *in* Lynx SSA Team 2016, p. 47) to 75–150 currently (J. Ivan, *personal communication*). This revision does not indicate a decline in the Colorado population; rather, it is a refinement based on better, more recent information. A small portion of the southern Tier 1 area in this Unit extends into the Carson National Forest of northern New Mexico. At least 60 Colorado-released lynx dispersed into northern New Mexico during 1999-2007 but the establishment of a breeding population has not been documented (USFS 2009, p. 10). This unit is not directly connected to lynx populations in Canada, and it appears to have received few, if any, immigrant lynx during the large, documented irruptions of the 1960s and 1970s.

Beginning in 1996, two unprecedentedly large bark beetle (Mountain pine beetle (*Dendroctonus ponderosae*) and spruce beetle (*Dendroctonus rufipennis*)) epidemics have affected about 16,200 km^2 (6,255 mi^2) of spruce-fir and lodgepole pine forests in Colorado, including much of the lynx habitat in this unit. Beetle outbreaks do not appear to negatively impact snowshoe hare occupancy (Ivan et al. 2018, entire) or density (Ivan and Newkirk 2019, entire) in the first decade post-beetles, and hare numbers may yet increase in affected areas as forest regeneration progresses. However, beetle outbreaks have negatively impacted red squirrels (*Tamiasciurus hudsonicus*), an important alternate prey species for lynx in this unit. Despite substantial and widespread alteration of forest composition and structure following the beetle outbreak, lynx in the San Juan Mountains (southern focal area) did not alter their distribution (Squires et al. 2023, entire). Their general patterns of resource selection post-beetles were broadly unchanged from those documented during the reintroduction, which preceded the large beetle outbreaks. The authors attributed this consistency in population-level space use before and after beetle impacts to the maintenance of "keystone habitat elements," specifically dense horizontal forest cover and adequate hare densities (Squires et al. 2023, entire). Similarly, large-scale snow tracking and camera trap monitoring efforts in the San Juans continued to document consistent lynx occupancy and broad distribution during 2010–2011 and from 2014–2015 through 2019–2020 (Odell et al. 2021, entire), spanning the bulk of the spruce beetle outbreak in this area.

Lynx Occurrences Outside Focal Areas

Northeast – Between 2017 and 2022, there were 138 verified Canada lynx observations in New Hampshire, broken down as follows: 123 observations from camera surveys by New Hampshire Fish and Game Department, 8 tracks reported by the public, 5 tracks recorded by New Hampshire Fish and Game Department during transect surveys, and 2 direct observations by the public. All these new occurrence records were reported in Coos and Grafton counties, with the majority in Coos. Grafton County occurrences were located at higher elevations and in some of the last known areas to have lynx prior to the 1980s (e.g., Zealand Valley). Several of the camera survey photos, mostly from Pittsburg, contained more than one lynx at one time in the frame. These likely represent family groups moving together. In addition, one of the reports of tracks by the public from the town of Cambridge showed tracks of three separate lynx, which also likely indicates a family group and therefore lynx reproduction in New Hampshire (J. Kilborn, *personal communication*).

Between 2018 and 2022, there were two verified Canada lynx observations in Vermont by members of the public. The first of these happened in July 2018 in Chittenden County, which is in northwest Vermont outside of the area where lynx have previously been documented. The second sighting happened in June 2019 in Essex County, which is in the general area of previous lynx records. Eighteen other sightings were deemed plausible based on description of the animal, behavior, and location, but could not be verified due to a lack of physical evidence provided by the observers. In addition, staff from the Vermont Department of Fish and Wildlife continued efforts to monitor for lynx using a camera-based system deployed across northeast Vermont and within the Green Mountain National Forest in the southern Green Mountains. Although no lynx were detected during the past 5 years via this monitoring effort, this camera-based system is still deployed and is expected to be maintained through at least the next few years if dedicated funding can be secured (C. Bernier, *personal communication*).

Midwest – Wisconsin has had very limited evidence of lynx presence in the State. There have been 30 verified sightings since the 1800s, over half in conjunction with well-documented large irruptions of dispersing lynx in the 1960s and 1970s (Thiel 1987, entire; McKelvey et al. 2000, pp. 219–221). Between 2017 and 2022, there was one verified observation - a lynx photographed in 2018 near Herbster in Bayfield County. There has been no evidence of lynx reproduction in Wisconsin, and occasional detections are likely transient individuals passing through the state.

Ongoing surveys in Wisconsin are capable of detecting lynx (e.g., carnivore tracking programs, citizen science efforts, and Snapshot Wisconsin – an extensive volunteer trail camera project which monitors wildlife year-round including lynx habitat in northern Wisconsin).

Since 1979, there have been seven documented lynx detections in Michigan. Five of those detections were in the Upper Peninsula (one in Keweenaw County in 1979, two in Mackinac County in 2003, one in Chippewa County in 2011, one in Luce County in 2019, and one in Marquette County in 2022). There was a single female lynx occurrence in Sanilac County in 2019 in the Lower Peninsula. This animal was live-trapped and relocated to Schoolcraft County in the Upper Peninsula, and she was observed later in 2019 in Luce County. Although not previously known in the Minnesota DNA database, she was genetically similar to the Minnesota lynx population.

West – Southward lynx dispersal from Unit 3 was recently confirmed when a male lynx originally radio-collared near Lincoln, Montana in 2012 was detected and verified with DNA in the vicinity of Georgetown Lake in the northern part of the previously unoccupied Beaverhead-Deerlodge National Forest, about 80 miles southwest of his prior home range, in winter 2018-19 (Squires *in* USFWS 2019, p. 6). This male was subsequently detected by cameras and verified via DNA in the same area each winter through 2021–2022, although no other lynx were detected. Additionally, an eDNA sample collected from snow tracks on the Montana side of Lolo Pass in March 2020 were verified as lynx in an area of modeled high-quality habitat that is now included in SSA Unit 3. Hair samples collected by back-tracking confirmed that it was a male lynx new to the lynx genetic database maintained by the National Genomics Center for Wildlife and Fish Conservation in Missoula (J. Golding, *personal communication*).

Since the 2017 SSA, the Idaho Department of Fish and Game ((IDFG) has conducted multiple camera-based survey projects throughout the state capable of detecting lynx presence (IDFG 2022, pp. 3–4). Among these, the Statewide Wolf Occupancy project from 2016–2021 deployed 206 camera stations, three of which had lynx detections. The Predator-Prey Interaction project deployed 599 camera stations in 2020–2021, with lynx detected at nine stations. The Panhandle Forest Carnivore project deployed 56 camera stations in 2015–2019, detecting lynx at 29 stations. All lynx detections from these efforts were in northern Idaho, with all but one occurring north of Interstate 90 and all but three in northernmost Idaho north of Lake Pend Oreille (IDFG 2022, p. 4). Additionally, a local houndsman accidentally treed two juvenile lynx in the Selkirks in 2018 which was verified through photographs and videos (M. Kosterman, *personal communication*). Because of the consistent verified lynx detections and recently modeled high-quality habitat, SSA Unit 3 has been adjusted to include parts of the Purcell, Cabinet, and Selkirk mountain ranges in northern Idaho and northeastern Washington. However, the results described above do not confirm the permanent presence of lynx nor an established resident breeding population in northern Idaho (B. Bosworth, *personal communication*).

The Kettle Mountains of northeastern Washington are thought to have supported a small (10-23 individuals; Koehler et al. 2008, p. 1523; Lewis 2016, p. 6) lynx population as recently as the late 1970s but with very few records since then. Over two summers (2016 and 2017), lynx were detected four times at remote camera stations (King et al. 2020a, p. 712). It is unclear whether these individuals were transient or resident. Based on the Olson et al. habitat model (2021, entire), the WLBT delineated 732 km^2 of high-quality (Tier 1) habitat in the Kettle Range

(WLBT 2022, p. 30). If all or most of that area was in suitable condition supporting adequate hare density, the Kettle Mountains could hypothetically support a population of about 10-15 resident lynx at a density of 1.5–2 lynx/100 km^2. In the winter and early spring of 2022, the Confederated Tribes of the Colville Reservation and their partners initiated a 5-year project with the goal of establishing a breeding population of lynx in the Kettle Range. Their goal is to translocate 10 lynx per year for a total of 50 lynx over a 5-year period. In the first year of the project, they released nine lynx (four males and five females). Two released lynx died and two others (males) returned to southern British Columbia after release. Breeding and reproduction were verified in one female (breeding took place after release), but kitten survival has not yet been verified (one kitten was found dead). In the second year, 10 lynx were trapped and released - five males (including recapture of the two males released in 2022 that returned to Canada), and five females. As of February 2023, one lynx released in year two has died and one male lynx returned to southern British Columbia; the remainder currently occupy the Kettle Crest (R. Piccinini, *personal communication*).

Chapter 4: Updates to Factors Influencing DPS Viability

In this section, we provide updated information pertaining to the factors most likely to influence the viability of the Canada lynx DPS as described and evaluated in the 2017 SSA. These include regulatory mechanisms (the factor for which the DPS was listed under the ESA) and the first-tier anthropogenic influences considered by the Interagency Lynx Biology Team in the 2013 revised Lynx Conservation Assessment and Strategy (LCAS) to have potential population-level consequences for DPS populations – climate change, vegetation management, wildland fire management, and habitat loss/fragmentation (ILBT 2013, pp. 68–78; USFWS 2017a, pp. 51–105). We briefly discuss whether new information regarding these factors changes our assessment of lynx viability and provide additional context and interpretation in cases where it does. We also discuss several factors that do not currently exert population-level influences on DPS populations, but which could become important in the future. These include disease, lynx hybridization with bobcats (*Lynx rufus*), competition between lynx and other terrestrial predators of snowshoe hares, and incidental take of lynx.

4.1 Regulatory Mechanisms

Federal Regulations - The Service listed the Canada lynx DPS as threatened under the ESA in 2000 due solely to the inadequacy of regulatory mechanisms in Federal (U.S. Forest Service (USFS) and Bureau of Land Management (BLM)) land and resource management plans at that time (65 FR 16052, 16082; 68 FR 40096–40100). In the 2017 SSA, the Service reviewed Federal habitat management practices, which included formally amended or revised management plans or conservation agreements with the Service (USFWS 2017a, pp. 52–57). We concluded that lynx conservation measures and habitat management guidance adopted by the USFS and the BLM have substantially addressed the regulatory mechanisms that were deemed inadequate at the time the DPS was listed (USFWS 2017b, entire).

U.S. Forest Service - When the 2017 SSA was completed, only the Okanogan-Wenatchee National Forest (OWNF), which encompasses most of the SSA Unit 4 focal area, and the Colville National Forests (CNF), which includes most of the modeled high-quality habitat in the Kettle Range, in Washington (USFS Region 6 – Pacific Northwest Region) had not revised their forest plans to formally incorporate guidance from the LCAS. Since then, the CNF completed revisions to its plan in 2019, and the OWNF forest plan revision is in process. The revised CNF plan includes desired conditions, objectives, standards, and guidelines developed in accordance with the conservation measures identified in the LCAS to reduce potential impacts of forest management to lynx habitats (USFS 2019, pp. 55–69). The OWNF continues to manage for lynx habitats in accordance with the LCAS and the Conservation Agreement between the USFS and the Service (USFS and USFWS 2000, entire).

Since the 2017 SSA was completed, forest plans for other national forests within the DPS range have been revised or are currently undergoing revision. These revisions retain or improve measures to conserve and restore important lynx and hare habitats as follows:

- Region 1 – Northern Region: In western Montana and northern Idaho (SSA Unit 3), the Flathead and the Helena-Lewis and Clark national forests revised their forest plans in 2018 and 2021, respectively. In addition, the Lolo and Nez Perce-Clearwater national forests both have initiated forest plan revisions. In southwest Montana (SSA Unit 5), the Custer-Gallatin National Forest revised its forest plan in 2022.

- Region 2 – Rocky Mountain Region: In southwest Colorado (SSA Unit 6), the Rio Grande National Forest revised its forest plan in 2020 to incorporate a new standard to guide timber salvage management activities in lynx habitat affected by mountain pine beetles. Similarly, the Grand Mesa, Uncompahgre, and Gunnison National Forests in Colorado are currently undergoing forest plan revisions to incorporate salvage harvest management guidance as well.
- Region 3 – Southwestern Region: The Carson National Forest in northern New Mexico (SSA Unit 6) revised its land management plan in 2022 and included Canada lynx as an "at risk species," and considered provisions for lynx within its forest treatments.
- Region 4 – Intermountain Region: The Bridger-Teton National Forest in western Wyoming, which encompasses most of the SSA Unit 5 focal area, is expected to begin forest plan revision soon.

The Superior National Forest (SNF; Region 9 – Eastern Region) manages about 45 percent of the lands in the Unit 2 focal area in accordance with its 2004 revised Forest Plan, which includes direction based on the LCAS (Ruediger et al. 2000, entire) and the Canada Lynx Conservation Agreement (CA) between the USFS and the Service (USFS and USFWS 2000, entire). Since listing, the SNF has worked closely with the Service's Minnesota-Wisconsin Ecological Services Field Office to protect, improve, and monitor Canada lynx and their habitats (see Chapter 3 above). The SNF recently published its Forest Plan Monitoring and Evaluation Report for 2018-2019, which documents the Forest's continuing efforts to conserve and improve lynx and hare habitats and monitor the lynx population (USFS 2021, pp. 183-195). It also completed the 2023 *Summary of the Superior National Forest's Canada lynx (Lynx canadensis) DNA database and population monitoring* (Ryan et al. 2023, entire).

Bureau of Land Management - The BLM manages only about 1 percent of the lands within the SSA geographic Units, nearly all of which occur in Colorado, Montana, and Wyoming. Most resource management plans (RMPs) for these areas have been revised to include lynx conservation measures (USFWS 2017a, pp. 56–57). In Colorado, the BLM's White River Field Office (FO) completed an RMP amendment for oil and gas development in 2015, which included measures to avoid impacts to and minimize disturbances in lynx habitats (BLM 2015, pp. 2-10, 2-25, 2-38). In western Montana (Unit 3), BLM lands in the Garnet Resource Area include 405 km^2 (156 mi^2) of designated lynx critical habitat that are managed in accordance with an RMP that was revised in 2020 and continues to include the lynx conservation measures pursuant to consultation with the Service (BLM 2021, pp. II-21-26, II-35-36, III-124-126). Overall, the BLM manages 1,424 km^2 (549 mi^2) of the lands within the six geographic Units evaluated in the lynx SSA (USFWS 2017a, Table 2), over half of which are actively managed to support lynx conservation.

Since completion of the 2017 SSA, the USFS and the BLM also continue to evaluate and incorporate new science to inform lynx habitat management practices. For example, the Rio Grande and the Grand Mesa-Uncompahgre-Gunnison national forests have incorporated new vegetation standards and guidelines into their revised forest plans to guide salvage timber harvest activities in lynx habitat that has been affected by both mountain pine beetle and spruce beetle infestations. The forests coordinated with Colorado Parks and Wildlife and the Rocky Mountain Research Station to use new science to identify important areas for lynx and develop a timber salvage harvest protocol to avoid/minimize adverse impacts to important lynx and snowshoe hare habitats. Additionally, the Western Lynx Biology Team (WLBT), an interagency team consisting of USFS, USFWS, and BLM representatives, recently developed the *Spatial Framework for the Conservation of Canada Lynx Habitat in the Western U.S. and Associated Management Tiers* (WLBT 2022, entire). The framework consists of two primary parts: (1) a refined depiction of areas that contain high-quality lynx habitat in the western U.S., including a tiered approach for areas of habitat that reflects differences in ecological function; and (2) recommendations for achieving desired vegetative structural mosaics for habitat conditions within each tier. The framework is based on the WLBT's evaluation and synthesis of recently published research on Canada lynx habitat use, population demography, and habitat modeling. This spatial framework is not a regulatory document; however, it lays the foundation for improved and refined regulatory mechanisms targeting habitats of the greatest value to the conservation and recovery of lynx in the western United States.

In summary, the forest plan and resource management plan revisions described above continue to apply or improve upon the conservation measures and management standards and guidelines identified in the LCAS, interagency conservation agreements, and/or the Northern Rockies Lynx Management Direction (NRLMD; USFS 2007, entire) and Southern Rockies Lynx Amendment (SRLA; USFS 2008, entire). They demonstrate the agencies' continuing efforts to conserve lynx and hare habitats and populations on federally managed lands. Additionally, USFS and BLM continue to demonstrate their commitment to evaluate new information and develop science-based measures to achieve lynx conservation in collaboration with the Service and the lynx research community. This illustrates the agencies' continuing efforts to address and ameliorate the singular threat for which the DPS was listed. We have found no information, since the DPS was listed in 2000, that USFS or BLM timber harvest, silvicultural activities, or other management actions have diminished lynx habitats or resulted in a change in lynx analysis unit (LAU) condition from meeting to not meeting standards and guidelines developed to promote lynx habitat conservation. Nonetheless, recent research suggests that existing lynx management standards may not adequately address the lack of vegetation management and historical and recent fire suppression that have contributed to the large, high intensity fires that have impacted lynx habitat in the West, particularly in Unit, 4 and are likely to continue to do so in the future (Lyons et al. 2023, p. 3). As part of efforts to address climate change, including vegetation and wildfire management, the Bipartisan Infrastructure Law will provide $5 billion in funding for Federal wildland management efforts, including fuels reduction to prevent catastrophic wildfire.

State Regulations and Management- As summarized in the 2017 SSA, a variety of state wildlife and forestry regulations and conservation efforts, along with tribal resource management objectives and practices, influence activities in lynx habitats across the range of the DPS. Here we focus on trapping regulations and their influence on lynx conservation and incidental take. We discuss regulations or programs that address or guide timber harvest or other vegetation management in section 4.3 below.

Maine – Lynx were designated as a species of special concern in Maine in 1997, and have been fully protected from harvest (i.e., trapping and hunting) in the state since 1967 (Vashon et al. 2012, p. 31). Although incidental take was not determined to be a significant threat when the DPS was listed (65 FR 16079) and, in the revised Lynx Conservation Assessment and Strategy (LCAS; ILBT 2013, pp. 79–80), was not considered likely to have population level consequences, the Maine Department of Inland Fisheries and Wildlife (MDIF&W) has worked to address this potential source of lynx mortality. This has been accomplished through lynx related educational material in hunting and trapping courses, State trapping law summaries and social media posts, restricting trapping methods to minimize unintentional lynx capture, and active law enforcement and outreach and education divisions. The State of Maine has demonstrated a commitment to protect lynx and will continue to do so regardless of Federal status (Vashon and Harris 2021, p. 18).

Since publication of the 2017 SSA, trapping of other species in Maine has continued in compliance with a USFWS incidental take permit (TE48539B) that took effect November 17, 2014 (MDIF&W 2018–2022, entire). This permit covers the MDIF&W for the incidental capture of up to 195 lynx in traps legally set for other species over a 15-year period. The permit allows up to nine incidentally captured lynx to require treatment and/or rehabilitation for trap-related injuries before release, and up to three to be killed or rendered non-releasable as a result of capture. From 2017–2021, 49 lynx were captured in legally-set foothold traps set for other species. Of these, one lynx caught in 2017 required veterinary care and rehabilitation before release (this was the first of the nine allowed by the permit). No lynx were killed or rendered non-releasable during this time period. In 2020 and 2021, the Service released an administrative amendment to the incidental take permit to reduce the risk of SARS-CoV2 (COVID-19; see section 4.6 below) transmission to wild lynx. Among other precautions, this amendment modified the release protocol to minimize sedation and handling and suspended the requirement to have a veterinarian present in the field to evaluate captured lynx. These precautions were extended through the 2022 and 2023 trapping seasons.

Minnesota – Lynx were designated as a species of special concern in Minnesota in 2013 (MNDNR 2013, pp. 1–2). The Minnesota Department of Natural Resources (MNDNR) has identified a specific "Lynx Management Zone" (LMZ), which includes the Unit 2 focal area. The MNDNR has promulgated and enforces special trapping regulations for other furbearers in lynx habitat (MNDNR 2016a, p. 53) and modified trapping regulations within the LMZ to minimize the incidental take of lynx during the legal trapping of other furbearers. The regulations address specific trap types and sets, prohibit the use of certain baits and visual attractants, and require reporting of any incidentally trapped lynx to DNR conservation officers within 24 hours (MNDNR 2016a, pp. 53-55). In a recent court settlement agreement filed on February 21, 2023, MNDNR has committed to further strengthen protective measures for lynx in the LMZ by modifying trapping regulations for snares and foothold traps, and MNDNR will educate the public by adding the new restrictions to their website and issuing a press release (*CBD v. MNDNR*, 2023).

Montana – Lynx are designated as a species of greatest conservation need (S3; "potentially at risk") by the State of Montana (MTFWP 2015, pp. 12, 435). Lynx harvest has been prohibited by the state since 1999, and MTFWP promulgated trapping regulations and reporting requirements to minimize and track the incidental capture of lynx (MTFWP 2016, pp. 7–10). Significant changes to these regulations in 2008 reduced the reported rate of incidental lynx captures from 1.6/yr in 2000-2007 to 0.3/yr in 2008-2019 (MTFWP 2016, p. 5; B. Inman, *personal communication*). Since 2017, the incidental take of two lynx related to hunting and trapping have been reported - in 2017, a lynx was released uninjured from a trap targeting bobcats, and in 2022, a lynx was illegally shot by a big game hunter (MTFWP 2023, p. 5). The incidental take of lynx is required to be reported to MTFWP law enforcement within 24 hours and is reported to the USFWS within 3 business days. Recently, the state further strengthened protections for lynx by designating lynx protection zones and implementing additional restrictions on trapping in lynx habitat (MTFWP 2016, pp. 7–10; MTFWP 2023, pp. 5–7).

Idaho - Lynx are protected from harvest in Idaho through a closed season and, in the 2023 revision to the Idaho State Wildlife Action Plan, lynx in the Purcell Mountains of northern Idaho were designated a species of greatest conservation need (B. Bosworth, *personal communication*). IDFG provides guidance on how to reduce injury and minimize non-target catches, including lynx, in its trapper education programs mandated for trappers in general and for wolf-specific trapping. IDFG also provides guidance on reducing injury and minimizing non-target catches in "Idaho Upland Game, Turkey and Furbearer Seasons Proclamation and Rules Summary Brochure" and "Big Game Seasons Proclamation and Rules Summary Brochure." IDFG is completing a Management Plan for the Conservation of Fisher, Wolverine, and Canada Lynx in Idaho (B. Bosworth, *personal* communication). The draft plan is expected to be submitted to the Idaho Fish and Game Commission for review and, if approved, released for public comment during fall/winter 2022-2023 (IDFG 2022, p. 6). Since 2017, trappers have reported three non-target captures of lynx. During the 2019/2020 season, a trapper reported capturing a lynx in a foothold trap set for bobcat in Clearwater County. The animal was released by the trapper and reported as not injured. No photo or DNA evidence was provided to substantiate the report. During the 2020/2021 season, a single trapper reported catching two lynx in traps set for bobcat near Highway 12 in Idaho County. Both were caught in foothold traps and were reported as released unharmed. Photos were available for one of the two captures; review of the photo by IDFG staff confirmed it was a lynx.

Other than the incidents listed above, the only information we have regarding incidental hunting or trapping related take in addition to that reported in the 2017 SSA is a lynx recovered by the Washington Department of Fish and Wildlife (WADFW) that was mistaken for a bobcat and killed while raiding a chicken coop in Steven's County (WADFW 2022, p. 2) and two lynx illegally shot in northern Maine in November 2016 (*https://www.bangordailynews.com/2016/12/02/news/more-than-5000-reward-offered-in-canada-lynx-killings-in-maine/)*. We expect recent low levels of illegal shooting and lynx mortality from accidental trapping to continue but that such mortality will not pose a population-level threat to any of the DPS populations. We also anticipate continued efforts to ensure that most incidentally trapped lynx are released uninjured. Lynx remain protected in all parts of the DPS range, and we are not aware of any changes to state regulations or management since 2017 that indicate a weakening of protections or an increase in risk to lynx beyond the levels evaluated in the 2017 SSA.

<u>Tribal Management</u> – Since completion of the 2017 SSA, we have not become aware of any changes to tribal management or conservation of lynx habitats throughout the DPS range that have weakened protections for or resulted in loss or degradation of important lynx habitats.

Tribes continue to manage for the conservation and restoration of lynx habitats and populations on tribal lands. Recent examples include:

- The Leech Lake Band of Ojibwe in Minnesota continue to monitor snowshoe hare populations on the Leech Lake Reservation and conducted a pilot study to create and enhance snowshoe hare habitat through forest management activities (LLBO 2022, entire).
- In the winter and early spring of 2022, the Confederated Tribes of the Colville Reservation and their partners initiated a 5-year project with the goal of establishing a breeding population of lynx in the Kettle Range. Their goal is to translocate 10 lynx per year for a total of 50 lynx over a 5-year period (see Chapter 3 above).

Additionally, representatives from the Leech Lake Band of Ojibwe, the Sault Ste. Marie Tribe of Chippewa Indians, the 1854 Treaty Authority, and the Upper Columbia United Tribes, participated in efforts to develop plans to monitor lynx populations for at least 10 years if the DPS were to be delisted.

In summary, nearly all Federal forest plans and resource management plans throughout the DPS range have, since the DPS was listed, been revised, in coordination with the Service and the lynx research community, to include science-based measures and management practices consistent with lynx conservation, thereby greatly reducing the potential for population-scale habitat deterioration on Federal lands. These efforts have contributed significantly to addressing the singular threat for which the DPS was listed – the inadequacy, at that time, of regulatory mechanisms in USFS and BLM land and resource management plans. Additionally, Federal partners continue to incorporate the best available science into lynx habitat management practices on Federal lands, and they will need to continue doing so as climate-mediated stressors emerge or intensify and the consequences of past management practices and activities become more apparent through research and monitoring (Lyons et al. 2023, entire). State and tribal resource agencies continue to monitor and manage for the conservation of lynx and work with the Service and their partners to avoid activities that could adversely impact lynx populations. We are not aware of any changes to Federal or state regulations or to tribal resource management objectives within the range of the DPS since the 2017 SSA was completed that reduce protections for or increase risks to lynx populations. In fact, some changes to the state regulations described above further reduce the likelihood of incidental take of Canada lynx from state recreational trapping programs and reduce risk of human to lynx COVID-19 transmission (see above and section 4.6). Tribes within the DPS range also continue to manage for the conservation of lynx habitats and lynx and hare populations.

4.2 Climate Change

As summarized in the 2017 SSA (USFWS 2017a, pp. 66–83), we expect the specific effects of climate warming on lynx, hares, and their habitats in the DPS range that are occurring or can be reasonably anticipated include: (1) northward and upslope contraction of boreal spruce-fir forest types, (2) northward and upslope contraction of snow conditions believed to favor lynx over other terrestrial hare predators, (3) reduced hare populations and densities, and (4) changes in the frequency, pattern, and intensity of forest disturbance events. Other potential effects of projected warming include: (5) reduced gene flow between Canadian and DPS lynx populations, (6) changes in the periodicity and amplitude of northern hare cycles, which could result in reduced lynx immigration to the DPS from Canada, and (7) increased or novel diseases and parasites.

The Service has reviewed relevant climate publications since 2017, however we did not find that many of the publications significantly changed our understanding of climate change and associated impacts to Canada lynx, snowshoe hares and their habitats since the 2017 SSA. Many of the climate publications project continued warming, drought, snowpack loss, increased fire, forest conversion, insect outbreaks, etc. Here we briefly summarize the International Panel on Climate Change Sixth Assessment Report, regional climate updates from the Fourth National Climate Assessment, and new climate publications that are most relevant to Canada lynx, snowshoe hares, and their habitats. Climate publications reviewed but not cited in this Draft Addendum are listed in the Literature Considered but not Cited section.

In 2022, the IPCC released its Sixth Assessment Report (AR6), which represents the current scientific consensus on global and regional climate change and the best synthesis of scientific data available in this rapidly changing field. The AR6 Synthesis Report (IPCC 2023, entire) and Working Group reports (IPCC 2022, entire) largely reaffirm the conclusions of previous reports that the global climate is warming at an accelerating rate and that this warming is largely the result of human activities and the associated release of carbon dioxide and other greenhouse gases into the atmosphere. Specifically, the AR6 reports show that emissions of greenhouse gases from human activities are responsible for approximately 1.1°C of warming since 1850–1900, and finds that averaged over the next 20 years, global temperature is expected to reach or exceed 1.5° C of warming (IPCC press release, 8/9/2021).

Northeast – The 2018 Fourth National Climate Assessment states that by 2035 the Northeast is projected to be more than 2°C warmer on average than during the preindustrial era (prior to 1750; Dzaugis et al. 2018: FAQs *in* the Fourth National Climate Assessment) under both lower and higher scenarios (representative concentration pathway (RCP) 4.5 and RCP 8.5) (Dupigny-Giroux et al. 2018, pp. 671–673). The assessment states this would be the largest increase in the contiguous U.S. and would occur two decades before global average temperatures reach a similar temperature increase. Similarly, according to the 2020 update of Maine's Climate Future, the northeast is warming faster than any other region of the United States, with an average annual temperature increase of 1.6° C over the past 124 years in Maine (Fernandez et al. 2020, p. 3). From 1985 to 2020, average annual precipitation across the state of Maine increased 15 percent (5.8 inches), but the increase was primarily in the form of rain, not snow (Fernandez et al. 2020, p. 5). Over the same period, annual snowfall depth decreased 20 percent (2.3 inches), and statewide average annual snowfall is estimated to have decreased by 17 percent (Fernandez et al. 2020, p. 5, 8).

Janowiak et al. (2018, entire) evaluated key ecosystem vulnerabilities for forest ecosystems in New England and northern New York across a range of future climate scenarios (Janowiak et al. 2018, p. 1). The authors predicted reduced suitable habitat and biomass for northern and boreal tree species by 2100, with particularly large impacts on black spruce, red spruce, northern white cedar, and eastern hemlock (Janowiak et al. 2018, pp. 68–70, 90). Iverson et al. (2019, entire) modeled current and future effects of climate change on tree species of the Eastern U.S. and projected decreases in softwood species such as balsam fir, red spruce, and eastern hemlock by 2100 (Iverson et al. 2019, pp. 15–16). These findings corroborate those of other studies discussed in the SSA (USFWS 2017a, pp. 69–71). A predicted northward/upslope retreat of boreal forests is concerning, as both Canada lynx and snowshoe hare are strongly associated with these habitats in New England and elsewhere across their range, and contractions or losses of these tree communities would likely result in concomitant decreases in lynx and snowshoe hare populations (USFWS 2017a, pp. 27, 71).

Midwest – In the Midwest, the rate of warming has accelerated over recent decades. For example, from 1900 to 2010, average air temperature increased by 1.5°F, between 1950 and 2010, the average temperature increased twice as fast, and from 1980 to 2010, the average temperature increased three times as quickly as compared to the overall average from 1900 to 2010 (Pryor et al. 2014, p. 420). Additionally, warming has been most rapid during the winter months (Pryor et al. 2014, p. 420). Forests are the defining characteristic of many Midwestern landscapes and necessary for lynx survival (USFWS 2017a, p. 27), but they are already experiencing degradation due to drought and historical management (Angel et al. 2018, p. 875). Over the past 30 years, rainfall has increased in the Midwest between April and June, creating some of the most tangible changes to the landscape because of a warming climate (Angel et al. 2018, p. 880). In the past few decades, Minnesota (including SSA Unit 2) has become increasingly warmer and wetter. Over the past 125 years, Minnesota has warmed by 1.7° C, and annual precipitation has increased by an average of 3.4 inches. The top 10 combined warmest and wettest years on record have occurred during the past two decades, and even though climate conditions will vary from year to year, these increases are expected to continue through the 21st century (MNDNR 2023).

As described above in Chapter 3, Hostetter et al. (2020, entire) assessed the effects of habitat characteristics and anthropogenic factors on Canada lynx distributional changes and occupancy dynamics in Minnesota. Lynx were more likely to occupy, persist in, and colonize sites with higher percent evergreen forest, greater average snowfall, and dense vegetation (LiDAR 3-5 m). These findings further highlight the importance of snow depth and condition (USFWS 2017a, pp. 31–32, 35–36, 42–43, 71–75), as well as dense horizontal cover and conifer forest types (USFWS 2017a, pp. 27, 83–85) to lynx persistence. Projected warming is expected to reduce the extent and duration of snow conditions suitable for lynx in northeastern Minnesota significantly by the latter half of this century (Moen and Catton *in* Lynx SSA Team 2016, p. 19) and cause the northward contraction and possible loss of the boreal biome in the state with the northward expansion of deciduous forests into current lynx range (Frelich *in* Lynx SSA Team 2016, p. 14; Galatowitsch et al. 2009, pp. 2015–2016).

In recent years, wildfire impacted areas on the Superior National Forest in northeastern Minnesota, including the Pagami Creek wildfire (2011, burned 92,000 acres) and the Ham Lake wildfire (2007, burned 75,000 acres), have started to see the return of lynx to these areas as they transition into high quality snowshoe hare habitat (D. Ryan, *personal communication*).

West – The Fourth National Climate Assessment indicates that the western U.S. is likely to experience a variety of effects due to climate change. Climate models predict warming in Montana and Wyoming over the next two to three decades, coinciding with less overall snowpack and water availability (Conant et al. 2018, p. 951). In the mountains of Montana and Wyoming, the fraction of total water that falls as snow is projected to decline by 25 to 40 percent by 2100 under higher emissions scenarios (Conant et al. 2018, p. 944). Similar trends are expected in Colorado, where. snowpack in the southern Rocky Mountains has already been reduced over the past 30–65 years (Gonzalez et al. 2018, p. 1109). Average winter precipitation in the form of rainfall is expected to increase in the Pacific Northwest, as is interannual variability (May et al. 2018, p. 1042). The Pacific Northwest has warmed by about 1.1° C over the last 125 years due to increased greenhouse gasses (May et al., p. 1041). In Washington and Idaho, strong climate variability is likely to persist, owing in part to the multi-decade climate cycles associated with proximity to the Pacific Ocean, and has already contributed to increased flooding and wildfires (May et al. 2018, p. 1039). Temperatures in Montana are projected to increase by approximately 2.5–3.3° C by mid-century and by 3.1–5.4° C by the end of the century, depending on the emissions scenario. These state-level changes in Montana are larger than the average changes projected globally and nationally (Whitlock et al. 2017, pp. 158, 203).

Hostetler et al. 2021 (pp. III, 40, 57) found that from 1950 to 2018, the Greater Yellowstone Area (GYA) warmed by 1.3°C and had a 23-inch/25 percent decrease in snowfall. Their projections suggest that by 2100 (and compared to 1986–2005 values), the GYA will be about 3°C warmer and will see a 40 percent loss of snowpack. Under RCP 4.5, they projected that mean annual temperature would increase 2.8°C by the period 2061–2080 and stabilize thereafter, and that the total area of the GYA dominated by winter snowfall would decrease from 59 percent during the base period (1986–2005) to 27 percent at midcentury (2041–2060) and to 11 percent by the end of this century (2081–2099). Under RCP 8.5, they projected that mean annual temperature would increase > 5.5°C by 2100, and that the extent of snow-dominant area would decrease to 17 percent and to 1 percent for the same time periods, respectively. This climate assessment projects that the GYA will likely become even less capable of supporting resident lynx in the future than it is now and likely was historically, matching projections presented in the 2017 SSA by lynx experts for this and other DPS Units.

King et al. (2020a, p. 712) modeled future lynx occupancy probabilities in north central Washington (Unit 4) under moderate (RCP 4.5) and severe (RCP 8.5) levels of predicted future climate warming. The authors modeled future climate-driven northward contractions of lynx habitat, with their results indicating a 48–64 percent reduction by the 2050s, and a 60–90 percent reduction by the 2080s, in the area occupied by lynx in the Okanogan LMZ (King et al. 2020a, p. 714). The authors found that snowfall amount the preceding winter strongly influenced lynx summer occupancy at both broad (landscape-level) and more localized (40-km^2 grid cell) scales (King et al. 2020a, p. 712–715). King et al. 2020b (entire) also found that the distributions of lynx and other carnivores in Washington were largely dictated by abiotic factors, particularly climate. Similarly, Olson et al. (2021, entire) found that abiotic factors were strongly predictive of lynx residency in Montana, Washington, and Wyoming, where mean coldest month temperature (MCMT) was by far the strongest (most highly explanatory) covariate, followed by snow water equivalent and winter (December – February) precipitation (see section 6.1, below).

In summary, climate modeling and assessments completed since 2017 continue to document and project temperature increases and changes in precipitation pattens that are likely to adversely impact lynx habitats across the DPS range through the end of this century. Because lynx in the DPS exist at the southern periphery of the species' range, they may already be experiencing thresholds for these conditions and may be unable to adapt to projected changes (see Ch. 6).

Continuing drought and increases in the size, frequency, and intensity of wildfires, particularly in the western part of the DPS range are also predicted, with likely consequences for lynx habitats and populations. Climate warming and related impacts are likely to continue to present the greatest challenge to long-term viability of lynx populations in the DPS.

4.3 Vegetation Management

Vegetation management (timber harvest and related silvicultural activities) continues to be the most prevalent land use impact throughout the lynx DPS range, and it can have beneficial, neutral, or adverse effects on lynx and snowshoe hare habitats and populations (65 FR 16071; 68 FR 40083; ILBT 2013, p. 71). Vegetation management affects stand age, structure, composition, and arrangement on the landscape, which are important elements of lynx and hare habitat (ILBT 2013, p. 71). Timber harvest can create, restore, and maintain lynx and hare habitats, but it and related silvicultural activities (e.g., precommercial and commercial thinning, fuels management, fire suppression) can also diminish (sometimes temporarily) habitat quality, quantity, and distribution; alter natural disturbance regimes; and preclude or postpone attainment of the dense horizontal cover that provides high-quality hare and lynx habitat. The Service listed the lynx DPS under the ESA because of the potential for such activities to adversely affect lynx habitats and populations and the absence, at that time, of measures to guide them for lynx conservation on Federal lands (68 FR 40076–40101). In this section, we provide updated information pertaining to vegetation management since the 2017 SSA was completed.

Northeast – Harrison and Loman (2020, entire) analyzed data collected from 2001–2015 to test the effects of different forest management treatments on snowshoe hare densities in Maine. These authors found that although hare densities varied across years and among forest harvest treatments, they were consistently highest in regenerating conifer-dominated stands (Harrison and Loman 2020, p. 33). Specifically, conifer stands that were 16–42 years post-harvest and had been treated with herbicide to promote conifer regeneration had the highest hare densities, while partially-harvested (i.e., selection, shelterwood and overstory removal) mixed stands and mature (i.e., approximately 80 years post-germination) conifer-dominated and mixed stands had lower hare densities due to lower conifer stem densities (Harrison and Loman 2020, pp. 33–34). A large proportion of the regenerating clearcuts in Maine were salvage harvests in response to the spruce budworm outbreak of the 1970s and 1980s (USFWS 2017a, p. 7). However, since the passage of the Maine Forest Practices Act in 1989, there has been a shift away from clearcutting in favor of partial harvesting treatments, which is predicted to lead to reduced snowshoe hare and lynx densities as optimal snowshoe hare habitat declines throughout the state (USFWS 2017a, pp. 49–50; Harrison and Loman 2020, p. 34). Harrison and Loman (2020) also found strong evidence that snowshoe hare populations in Maine are cyclical, albeit with dampened amplitude and extended periodicity relative to more northern boreal forests (Harrison and Loman 2020, p. 34).

The Canada lynx population in northern Maine increased following landscape-level clearcutting and herbicide application favoring softwoods on private commercial timber lands in response to a major spruce budworm (*Choristoneura fumiferana*) outbreak in the 1970s and 1980s (USFWS 2017a, p. 7). Spruce budworm outbreaks return on an approximately 30–60-year interval, and the Maine Forest Service has used various techniques including pheromone traps, light traps, and aerial surveys to monitor the current spruce budworm population build-up in the state (Maine

Forest Service 2022, p. 1). The year 2021 was the first year of the current budworm population build-up that the Maine Forest Service found evidence of larval feeding damage using aerial surveys, and the second consecutive year that feeding damage was observed during ground surveys (Maine Forest Service 2022, p. 1). However, average spruce budworm moth capture dropped in Maine for the second year in a row in 2021 (Maine Forest Service 2022, p. 1). The discrepancy between the relatively high larval damage and low abundance of adult moths may be explained by unusual weather patterns caused by climate change in northern Maine and northwestern New Brunswick, which may have caused phenological mismatches between larval moths and their host plants (Maine Forest Service 2022, p. 14). Rising temperatures are pushing suitable climatic conditions of the spruce budworm northward, leading to conjecture that Maine may never again experience an outbreak as big as in the 1970s and 1980s (Maine Forest Service 2022, p. 14). Due to reductions in clearcuts following the Maine Forest Practices act of 1989, it is unclear what the response to a new major spruce budworm outbreak might look like; however, widespread clearcutting to salvage affected stands as was seen in the 1970s and 1980s would likely cause a temporary reduction in snowshoe hare and Canada lynx habitat (USFWS 2017a, p. 109).

Midwest and West – In the other geographic Units (2–6), the majority of Canada lynx habitat occurs on federally managed lands, predominantly USFS and BLM lands, which are managed in accordance with the forest plans and land management plans discussed in Regulatory Mechanisms (Section 4.1). The Service has previously found these plans have substantially reduced the risks of the impact of vegetation management (e.g., timber harvest and related silvicultural treatments) on lynx, snowshoe hares, and their habitats. The USFS and BLM consult with the Service programmatically or on a project-by-project basis to ensure vegetation management activities do not result in unforeseen or substantial impacts to lynx and hare habitats. Since the 2017 SSA, we are not aware of any deviations from these plans that would indicate impacts to important lynx and hare habitats beyond those previously considered or that would indicate an elevated level of risk to important lynx and hare habitats. However, recent research suggests that past vegetation management and fire suppression over the past century or more have contributed to conditions conducive to the unusually large and high-severity fires documented throughout the West in the past 2-3 decades (see 4.4 Wildland Fire Management, below), and that projected climate warming is likely to exacerbate these conditions in the absence of intentional forest management to restore or improve forest resiliency (Hessburg et al. 2021, entire; Pritchard et al. 2021, entire; Lyons et al. 2023, entire). Additionally, as part of efforts to address climate change and support resilient, climate-adapted communities, the Bipartisan Infrastructure Law (BIL) provides $5 billion for Federal wildland fire management efforts over the next 5 years. Although fuels reduction and other vegetation management activities potentially detrimental to lynx and hare habitats could occur, all projects implemented under the BIL will undergo consultation in accordance with section 7 of the ESA to ensure that adverse effects to lynx or their habitats are avoided or minimized (S. Jackson, *personal communication*; T. Olenicki, *personal communication*). On the Superior National Forest in Unit 2, projected climate warming could reduce the amount of winter timber harvest that would be feasible, as winter timber harvest is dependent on frozen ground conditions (D. Ryan, *personal communication*).

We have evaluated whether new information since 2017 changes our understanding of the impacts of vegetation management on DPS lynx populations and viability. Recent research improves our understanding of the relationship between forest management treatments and lynx occupancy and habitat use, snowshoe hare densities throughout the DPS, and the response to forest insect outbreaks in Maine and Colorado. This new information does not significantly change our previous interpretation of the observed and potential impacts of vegetation management on the population viability of Canada lynx since the 2017 SSA was completed (USFWS 2017a, pp. 83–92). However, recent studies linking past vegetation management and fire suppression with dramatic increases in the size, frequency, and intensity of wildfires in the western U.S. over the past several decades – exacerbated by climate warming – suggest that future vegetation management on Federal lands in the West should be guided by a comprehensive lynx habitat conservation strategy that considers climate warming and a wildfire risk/fuel reduction strategy designed to increase forest resiliency and reduce the likelihood of large, high-severity wildfires in important lynx habitats (WLBT 2022, p. 2).

4.4 Wildland Fire Management

As described in the 2017 SSA (USFWS 2017a, pp. 92–96), wildfire is a natural and essential component of boreal and subalpine forests that plays an important role, along with forest insects and other disturbance factors, in creating and maintaining the shifting mosaic of stand ages and forest structure across large boreal landscapes that provide snowshoe hare and lynx habitats (Agee 2000, p. 47; Ruediger et al. 2000, pp. 1-3, 2-5, 7-6; ILBT 2013, p. 75). Current Federal wildland fire management policy recognizes fire as a natural ecological process essential to the health and resilience of some forest systems, and it attempts to balance the ecological, social, and legal aspects of wildfire (USDA and USDI 2009, p. 6). However, the prior history of fire response was largely one of active suppression for most of the last century (Zimmerman and Bunnell 2000, p. 288; USDI et al. 2001, p. 1-1; USDA and USDI 2003, p. 3; 68 FR 40092; Calkin et al. 2015, pp. 1-3) which, combined with other land-use practices and climate warming, dramatically altered fire regimes in some places, particularly the western contiguous U.S., and created conditions prone to larger and more severe fires (USDI et al. 2001, p. 1-2; Hagmann et al. 2021, entire; Hessburg et al. 2021, entire). This has resulted in large increases in the amount and severity of wildfires in the western U.S., (Parks and Abatzoglou 2020, entire), including Rocky Mountain and North Cascade Mountains subalpine forests, which provide most of the lynx habitat in the West (Higuera et al. 2021, entire; Lyons et al. 2023, entire). In this section, we provide updated information pertaining to wildfires and wildland fire management since the 2017 SSA was completed, and we compare total fire extent and the amount of high-severity fire that occurred in each SSA unit focal area from 1984–1999 and 2000–2021.

Northeast – There are no known wildfires that have occurred in the SSA Unit 1 focal area since 2017, and in general, this area does not experience the same risks associated with wildland fire management as in the Midwest and West. Analysis of fire perimeter data from the interagency *Monitoring Trends in Burn Severity* (MTBS; *https://www.mtbs.gov/*) show no recorded wildfires in the SSA Unit 1 focal area from 1984 through 2021.

Midwest – Since 2017, several wildfires have occurred on the Superior National Forest in Minnesota. In 2021, the 109-km^2 (42-mi^2) Greenwood Fire burned 40 km^2 (15 mi^2) on National Forest lands, all of which was considered lynx habitat. Also in 2021, the 5.5-km^2 (2.1-mi^2) John Ek Fire and the 3.2-km^2 (1.2-mi^2) Bezhik Fire burned within the Boundary Waters Canoe Area Wilderness (BWCAW). Lynx habitat modeling has not been conducted for the BWCAW, however, both fires occurred within lynx designated critical habitat. The total area burned by these recent fires (118 km^2; 45 mi^2) represents 0.6 percent of the Unit 2 focal area. MTBS fire perimeter data indicate that wildfires burned about 97 km^2 (37 mi^2), about 0.5 percent of the Unit 2 focal area, during 1984-1999, with no high-severity fire. From 2000-2021, 712 km^2 (275 mi^2; about 2 percent of the focal area) burned, a seven-fold increase, including 2 km^2 (< 1 mi^2) that burned at high severity. When it listed the lynx DPS as threatened, the Service found historical fire suppression to be a moderate to low threat to lynx in the Great Lakes region because it locally reduced lynx habitat quality by altering natural disturbance and forest succession pathways that previously maintained the mosaic of vegetation communities that characterize lynx habitat (65 FR 16076; 68 FR 40088, 40095). The recent increase in wildfire in this area may benefit lynx by restoring some of the historical pattern of fire followed by beneficial forest succession.

Northern Rockies – Analysis of MTBS fire perimeter data indicates that during 2017-2021, fires burned 1,572 km^2 (607 mi^2), or roughly 8 percent, within the Unit 3 Focal Area. There were 12 fires larger than 20 km^2 (7.7 mi^2) in 2017, including the 685-km^2 (265-mi^2) Rice Ridge fire and the 108-km^2 (42-mi^2) Liberty fire, both in core lynx habitat in the Seeley-Swan area. Two other fires > 20 km^2 (7.7 mi^2) occurred in the focal area in 2021 – the 22.1-km^2 (8.5-mi^2) BM Hill fire and the 43.3-km^2 (16.7-mi^2) Storm Creek fire. MTBS data indicate that wildfires burned 1,040 km^2 (402 mi^2), about 5 percent of the Unit 3 focal area, during 1984-1999, 36 percent (374 km^2, 144 mi^2) of which burned at high severity. From 2000-2021, 4,851 km^2 (1,873 mi^2; about 24 percent of the focal area) burned, a nearly five-fold increase, including 1,235 km^2 (477 mi^2; 25 percent) that burned at high severity.

Northern Cascades – Several small and large fires occurred in lynx habitat in Washington from 2018-2022. Washington marked its second and third worst fire seasons on record in 2020 and 2021. However, 2022 was the lightest fire season in a decade burning only 567 km^2 (219 mi^2) statewide. In north-central Washington, the McLeod fire burned approximately 59 km^2 (23 mi^2) of lynx habitat and the Crescent Mountain fire burned approximately 76 km^2 (29 mi^2) in the Okanogan LMZ in 2018. In 2021, the Cedar Creek fire burned approximately 100 km^2 (39 mi^2) and the Cub Creek II fire burned approximately 61 km^2 (24 mi^2) of lynx habitat in the Okanogan LMZ. In the Kettle Range, the Summit Trail fire burned approximately 113 km^2 (44 mi^2) in 2021. MTBS data indicate that wildfires burned 132 km^2 (51 mi^2), just over 2 percent of the Unit 4 focal area, during 1984-1999, 24 percent (32 km^2, 12 mi^2) of which burned at high severity. From 2000-2021, 2,794 km^2 (1,079 mi^2; about 46 percent of the focal area) burned, a more than 21-fold increase, including 945 km^2 (365 mi^2; 34 percent) that burned at high severity. Although carrying capacity and the lynx population in the Unit 4 focal area have declined as a result of the recent large fires (Lyons et al. 2016, entire; Lyons et al. 2023, entire), there is evidence of continued occupancy, including resident reproducing lynx.

King et al. (2020a, entire) assessed lynx occupancy of burns less than 10 years old and burns between 10–20 years old in Washington. Their results indicate that lynx avoid both age ranges, providing support for the existing assumption that recent, severe burns provide little value to lynx until several decades of regeneration have increased habitat quality for hare and lynx (Koehler et al. 2008, entire). Vanbianchi et al. (2018, entire) used GPS collar data to model lynx habitat use and found that lynx used burns sooner and more often than previously thought, often utilizing fire skips (unburned patches of forest within burn perimeters) or densely regenerating areas within the burn (Vanbianchi et al. 2017a, pp. 2387–2390). Habitat use within burns was rare 1–6 years post-fire and was much higher 17–19 years post-fire. However, even within recent burns, lynx used fire skips and surviving residual trees within the perimeter of the burned areas (Vanbianchi et al. 2018, entire). They primarily used areas within 550 meters from the burn perimeter, but distances as far as 5 km were also recorded (Vanbianchi et al. 2017a, p. 2390). More recent work has also confirmed collared lynx regularly used the Tripod burn 17 years post fire (C. Vanbianchi, *personal communication*). These findings provide evidence that while lynx are unlikely to use recent, severely burned areas, they are able to use residual forest structure as movement corridors and foraging habitat even within new burn scars.

In 2022, the Washington Department of Natural Resources and the USFS Pacific Northwest Region released a Memorandum of Understanding outlining the Central Washington Initiative. The two agencies will collaborate to restore and reduce fire risk to 350,000 acres (> 1,400 km^2; 540 mi^2) over the next 10 years in Chelan, Okanogan, Kittitas, and Yakima counties. The USFS has received an increase in funding from several appropriation bills, including the Bipartisan Infrastructure Law, to increase forest resiliency and reduce the risk of catastrophic wildfires. Some of these restoration activities overlap with Unit 4 in Okanogan County and they may also include other areas with lynx occupancy and habitat in Washington.

Atypically large wildfires are a major contributor to lynx habitat loss in Washington. Many of the previous large fires (e.g., the 2006 Tripod fire, which burned 706 km^2 (273-mi^2) in the Loomis State Forest and the Okanogan-Wenatchee National Forest, and 2001 Farewell fire, which burned 323-km^2 (125-mi^2)) are beginning to regenerate to habitat conditions (dense horizontal cover) favorable to hare and lynx (Vanbianchi et al. 2017a, entire). As habitat regenerates to high quality forage for lynx, the risk of reburning also increases (Prichard et al. 2021, pp. 17-18), and intense fires occurring in rapid succession may weaken fire resistance and delay or preclude postfire recovery (Coop et al. 2020, p. 662). Increasing forest resiliency in these historic burns and preventing future catastrophic fires may increase available lynx habitat and carrying capacity in some areas of the range.

Greater Yellowstone Area - Analysis of MTBS fire perimeter data indicates that during 2017-2021, fires burned 125 km^2 (48 mi^2), or roughly 4 percent, within the Unit 5 Focal Area. Over 90 percent of that total (113 km^2; 44 mi^2) burned in the 2018 Roosevelt fire. MTBS data indicate that wildfires burned only 7 km^2 (3 mi^2), about 0.2 percent of the Unit 5 focal area, during 1984-1999, 1 km^2 (0.4 mi^2) of which burned at high severity. From 2000-2021, 324 km^2 (125 mi^2; about 11 percent of the focal area) burned, a 46-fold increase, including 95 km^2 (37 mi^2; 29 percent) that burned at high severity.

Southern Rockies - In the Southern Rocky Mountains, the 416 fire in 2018 in the San Juan Mountains burned 45 km^2 (17 mi^2) and the Williams Fork fire in 2020 burned 38 km^2 (15 mi^2); both fires overlapped focal area habitat in Unit 6. MTBS data indicate that no documented wildfires burned within the Unit 6 focal area during 1984-1999. From 2000-2021, 573 km^2 (221 mi^2; about 3 percent of the focal area) burned within the Unit 6 focal area, including 113 km^2 (44 mi^2; almost 20 percent) that burned at high severity.

In summary, large wildfires in lynx habitat have continued since 2017, especially in the West, continuing the trend of larger and more severe fires since the turn of this century. We anticipate large wildfires will continue in the Midwest and West, with some occurring in lynx habitat. Wildfires can have positive, negative, or neutral affects to Canada lynx and snowshoe hare habitats and populations (USFWS 2017a, pp. 92-96). For example, there is now evidence from

Washington (Unit 4) that lynx will use burned areas sooner and more often than previously thought, often utilizing fire skips or densely regenerating areas within burned areas (Vanbianchi et al. 2018, entire) which demonstrates that lynx, at least in some parts of the DPS range, may be more adaptive in their responses to wildfires than was previously believed. However, large, high severity fires in the West are occurring at a frequency exceeding historical patterns (Parks and Abatzoglou 2020, entire; Hagmann et al. 2021, entire; Higuera et al. 2021, entire), and subsequent reburns may limit seed sources, increase forest regeneration time, and facilitate forest conversion to non-forest vegetation (Coop et al. 2020, entire; Prichard et al. 2021, entire; Lyons et al. 2023, p. 15).

We expect that wildfires will continue and potentially increase in Canada lynx and snowshoe hare habitats in the DPS. We anticipate an increased pressure on land managers now and into the future to manage forests for wildfire resiliency. Projected climate warming, anticipated wildfires, and the need for wildland fire management are likely to pose an increasing risk to Canada lynx in the DPS and a growing challenge to land managers to address that risk. Wildland fire management aimed at mitigating or preventing large scale impacts to Canada lynx and snowshoe hare habitats will need to be increasingly prioritized to mitigate this increasing threat to important Canada lynx and snowshoe hare habitats.

4.5 Habitat Loss and Fragmentation

As described in the 2017 SSA, habitat loss for lynx is, generally, the conversion of boreal forest to another land use or vegetative cover. Fragmentation, which may involve permanent or temporary habitat loss, has been variously defined to describe a reduction of total area, increased isolation of patches, and reduced connectedness among patches of natural vegetation (Rolstad 1991; ILBT 2013, p. 76). The largest potential sources of habitat loss and fragmentation are climate change, wildland fire, and vegetation management, discussed above in sections 4.2–4.4. Other sources of habitat loss and fragmentation include energy development, recreation (e.g., ski resorts), urban development and other sources of commercial development.

Northeast – Farrell et al. (2018) investigated the landscape variables that characterize lynx and bobcat habitat in northern New England, then projected those variables 30 years into the future to determine how future development pressure would affect connectivity across this region (Farrell et al. 2018, p. 7/25–10/25). This study found that lynx, unlike bobcats, were closely associated only with natural habitats and that areas where lynx occur were always near cover (Farrell et al. 2018, p. 15/25). This study concluded that overall lynx connectivity is expected to remain stable, with some areas experiencing connective habitat decreases (e.g., eastern Maine) and other areas experiencing increases (e.g., northern Maine; Farrell et al. 2018, p. 13/25).

Across the DPS, the Service isn't aware of any large-scale developments that have resulted in significant permanent loss or fragmentation of Canada lynx or snowshoe hare habitats since 2017. Additionally, some recent studies indicate that lynx are adaptable, at least to some extent, to habitat fragmentation related to recreation (Olson et al. 2018, entire; Squires et al. 2019, entire), forest insect damage (Squires et al. 2020, entire; Squires et al. 2023, entire), and silvicultural treatments after fires and other disturbances (Holbrook et al. 2018, entire; Olson et al. 2023, entire). However, there are probably thresholds to lynx tolerance to recreation, and the species might be vulnerable to high levels of recreation that are present in some areas of the range, such as the Southern Rockies (J. Ivan, *personal communication*). Although not a new source of habitat loss and fragmentation, and as described above, several studies since 2017 provide further evidence that long-term fire suppression and climate change will continue to affect forest regeneration and succession, and in some cases resulting in forest conversion to nonforest vegetation (Coop et al. 2020, entire; Prichard et al. 2021, entire; Lyons et al. 2023, pp. 15). High severity fires, short-interval fires, warmer and drier postfire climate, and lack of tree seed sources may result in longer term or permanent habitat loss and fragmentation when they occur in lynx habitat (Coop et al. 2020, entire; Lyons et al. 2023, pp. 15). Uncertainty around future precipitation, human activity pre-and post-fire, and ecosystem response prevent reliable predictions of where forest conversion is most likely to occur (Coop et al. 2020, pp. 666-667).

As we concluded in the 2017 SSA, we find no evidence that habitat loss and fragmentation from anthropogenic activities (e.g., energy development, recreation, urban development and other sources of commercial development) have had population-level negative consequences for resident lynx in the DPS range or resulted in extirpation of lynx from areas that previously supported persistent resident populations. However, recent and projected increases in wildfire size, frequency, and intensity and its potential to permanently convert lynx habitat to non-habitat in some places, could result in future loss and fragmentation of lynx habitats at biologically meaningful scales.

<u>4.6 Other Factors</u>

Other factors that may influence individual lynx but are not thought to exert population-level consequences include disease, predation, competition, and incidental take. Here we summarize new information on these factors since 2017.

Disease - Within the DPS range, lynx deaths attributable to disease have been documented only in Maine and among lynx released in Colorado. In Maine between 1999 and 2011, 17 radio-collared lynx died as a result of heavy lungworm loads (Vashon et al. 2012, p. 19). In Colorado from 1999 to 2007, 7 lynx died of plague (Devineau et al. 2010, p. 528). Although not currently considered a population-level influence among DPS populations, a warming climate could increase the range of disease vectors for both lynx and hares, thus potentially leading to increased or novel diseases and parasites (USFWS 2017a, p. 81).

Beginning in 2018, the foreign animal disease Rabbit Hemorrhagic Disease Virus Serotype 2 (RHDV2), a highly contagious and fatal disease that affects both domestic and wild lagomorphs (rabbits, hares, and pikas), was detected in domestic and feral rabbits in the contiguous U.S. It was first detected in wild rabbit populations in the U.S. in March 2020 and has since been confirmed in the western U.S. among wild populations of Eastern, Desert, and Mountain cottontails and Brush and Riparian brush rabbits (*Sylvilagus* spp.); Pygmy rabbits (*Brachylagus idahoensis*); and Black-tailed and Antelope jackrabbits (*Lepus* spp.) (*https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nwdp/nwdp-rabbit-hdv*). Because the virus thus far has not been detected among snowshoe hares in the contiguous U.S. or in areas occupied by lynx, it is not currently a threat to lynx populations in the DPS. However, RHDV2 has been detected in wild cottontails in southwestern Colorado in counties peripheral to the core of the state's lynx population (https://ag.colorado.gov/animals/livestock-health/rabbit-hemorrhagic-disease-virus-rhdv2) and in western Wyoming (*https://usda-*

aphis.maps.arcgis.com/apps/webappviewer/index.html?id=37791da88ef04cd08404a5794aaf0be3). If it were to spread to hare populations in areas occupied by lynx, it could substantially reduce hare numbers, potentially affecting lynx survival and productivity and, thus, lynx population resiliency.

In southern Spain, virulent diseases affecting European rabbits (*Oryctolagus cuniculus*) have affected endangered Iberian lynx (*Lynx pardinus*) populations (Ferreras et al. 2010, p. 516; Rodriguez and Calzada 2015, p. 5). In 2011-2013, a variant of RHDV reduced European rabbit populations by 70–80 percent in areas occupied by Iberian lynx, and the rabbit decline was accompanied by a sharp decline in lynx productivity in 2012-13 and a doubling of the number of lynx killed by vehicles (Delibes-Mateos et al. 2014, entire). Nonetheless, in response to concerted conservation and recovery actions, the Iberian lynx population has increased from a low of about 100 individuals in 2002 to over 1,100 in 2020 (Fernandez 2022, entire). Canada lynx are as reliant on snowshoe hares as Iberian lynx are on European rabbits, and because the RHDV2 virus is highly contagious and fatal, outbreaks of the virus among snowshoe hares in areas occupied by Canada lynx in the DPS range could result in impacts to DPS lynx populations. Because of the potential consequences of this emerging contagion, the Service is working with partners to monitor the spread and evaluate the effects of RHDV2 on snowshoe hares and lynx in the contiguous U.S.

Hendrikse et al. (2019) discovered a novel gammaherpesvirus in Canada lynx, which they named Lynx canadensis gammaherpesvirus 1 (LcaGHV1) (Hendrikse et al. 2019, p. 1/15). These viruses have previously been discovered in other felines, but this is the first finding of a gammaherpesvirus in lynx (Hendrikse et al. 2019, p.2/15). The prevalence of this virus was estimated to be 17 percent in Newfoundland lynx populations and 36 percent in Maine lynx populations (Hendrikse et al. 2019, p. 11/15). The study did not find any significant relationship between infection status and lynx health (Hendrikse et al. 2019, p. 13/15).

In 2020, the spread of the SARS-CoV-2 (COVID-19) virus among humans spurred concern regarding the potential for humans to transmit the virus to wildlife populations (Gryseels et al. 2020, OIE and IUCN 2020, Olival et al. 2020), including in North America (AFWA 2020). Documented transmissions of COVID-19 from humans to domestic cats and to large cats in zoos (USDA 2020, ZAHP 2020) suggested that transmission to wild cats was possible. Thus, it is also possible that Canada lynx (*Lynx canadensis*) captured and handled for research purposes (e.g., for radio-telemetry studies) or when incidentally trapped could be exposed to the virus. Because of the possibility of human-to-lynx virus transmission, the USFWS worked with state agency representatives and members of the lynx research community from within the DPS range to identify and implement measures to reduce or eliminate that risk. We jointly developed and revised trapping and handling protocols and recommendations to reduce the potential for human-to-lynx COVID transmission during incidental and targeted (research) trapping efforts. To the best of our knowledge, thus far there have been no documented cases of the virus being transmitted from humans to wild cat populations (Delahay et al. 2021, OIE 2021, USDA 2021, AFWA 2020, OIE and IUCN 2020). Given the continued prevalence of COVID-19 among the U.S. population, however, the risk remains, and continued vigilance and monitoring are needed. The potential consequences of establishment of a COVID-19 reservoir among wild lynx populations to DPS populations and the viability of the DPS are uncertain.

Over the past several years, highly pathogenic avian influenza (HPAI) H5N1 has re-emerged globally, including in the U.S., predominantly affecting domestic and wild birds. It has also been detected in many mammals, including Eurasian lynx in Europe and bobcats in the U.S. (Charostad et al. 2023, entire; Harvey et al. 2023, p. 7). Thus far, to our knowledge, HPAI H5N1 has not been detected among captive or wild Canada lynx in Canada or the U.S.

Competition and Predation - The Maine Department of Inland Fisheries and Wildlife conducted a telemetry study to assess the status of lynx populations in northern Maine from 1999–2011 which resulted in the first documented predation of lynx by fishers (McLellan et al. 2018, pp. 1777, 1779). As part of this telemetry study, the authors investigated lynx deaths resulting from predation and used intercanine width measurements and characteristics of snow tracks to identify predators when possible (McLellan et al. 2018, p. 1777). Of 85 lynx equipped with radio collars during the study, 18 were killed by predators (McLellan et al. 2018, p. 1778). Fishers were confirmed as the predators of 14 lynx and were suspected but not confirmed to be the predators of two additional lynx (McLellan et al. 2018, p. 1778). The species of predator was undetermined for the remaining two deaths (McLellan et al. 2018, p. 1778). All but one lynx killed by fishers were adults, and most were found to have been healthy prior to predation (McClellan et al. 2018, p. 1780–1781). The spatial and temporal distribution of these lynx mortalities ruled out learned behavior by a small number of fishers, and instead suggested that fishers are opportunistic predators of lynx (McLellan et al. 2018, p. 1781). The authors found no indication that fishers are competitively excluding lynx from habitats or limiting range or number of lynx in Maine, but suggest continued monitoring of lynx and fishers to balance the management and conservation of both species (McLellan et al. 2018, p. 1782).

Sirén et al. (2021, entire) and Sirén et al. (2022, entire) used models to evaluate abiotic and biotic factors influencing the distribution of Canada lynx and of some of its competitors (i.e., coyotes (*Canis latrans*), bobcats, and fishers (*Pekania pennanti*)) in the Northeastern United States. Lynx occupancy was found to be positively correlated with snow depth, and negatively correlated with forest biomass (the opposite relationship was found for bobcat; Sirén et al. 2022, pp. 761-762). Further, competition from coyotes, bobcats, and fishers was found to limit Canada lynx occupancy along its southern range boundary (Sirén et al. 2021, p. 1768; Sirén et al. 2022, p. 762). However, the occupancy of these lynx competitors was mediated by snow depth, leading to an indirect positive effect of snow depth on Canada lynx (Sirén et al. 2022, p. 762). Sirén et al. (2021) also found that dietary overlap between lynx and bobcat likely leads to competitive exclusion limiting lynx occupancy, with the competitively superior bobcat preventing lynx from accessing prey resources such as red squirrels (Sirén et al. 2021, p. 1768).

Scully et al. (2018, entire) examined lynx habitat selection and spatial association with snowshoe hare, bobcat, and cougar across the summer and snow seasons in Washington. Lynx distribution was associated with high hare abundance, high elevation, low temperatures, and low moisture (Scully et al. 2018, p. 765). Lynx, bobcat, and cougar were more likely to overlap during off-snow seasons (Scully et al. 2018, pp. 765–766). Lynx decreased their use of an area when bobcats were present (Scully et al. 2018, p. 765). Similarly, King et al. (2020b, p. 338) found negative associations between the spatial occurrence of lynx and two competitor species (bobcat and cougar). Although competition between lynx and coyotes is not well understood, coyotes were detected at 56 percent of high elevation wolverine survey stations (Lewis et al. 2020, p. 12). These stations were located in subalpine forest at elevations deemed suitable for wolverine but sub-optimal for coyotes and may indicate that coyotes could interact with lynx more frequently than expected. These findings further highlight the importance of snow to lynx persistence (e.g., USFWS 2017a, p. 186), and elucidate mechanisms by which decreased snowfall caused by climate change may enable northward expansion of lynx competitors, further constricting the lynx range (e.g., USFWS 2017a, p. 191).

In summary, the studies described above improve our understanding of the potential effects of disease, predation, and competition on lynx in the DPS. Although these factors do not currently appear to exert population-level influences on DPS populations, their impacts could increase in the future. For example, if RHDV2 were to spread to hare populations in lynx focal areas, it could dramatically reduce hare abundance, with subsequent declines in lynx survival, reproduction, populations size, and resiliency. Likewise, climate warming is expected to diminish the snow conditions that currently favor lynx over competitors and predators, allowing both greater access to habitats from which they are currently excluded, at least seasonally.

Chapter 5: Current Conditions

5.1 Lynx Ecological Requirements

Individual lynx require large landscapes with hare densities that allow them to (1) survive to independence, (2) establish and maintain home ranges, (3) breed successfully, and (4) contribute genes to future generations (USFWS 2017a, p. 36). These landscapes also must provide conditions that allow lynx to compete sufficiently for hares and minimize the likelihood of predation and other sources of lynx mortality. At the southern periphery of lynx distribution, some places, including within the range of the DPS, seem to be at minimum thresholds to meet these requirements or do so inconsistently.

Lynx populations need large (hundreds to thousands of square kilometers) boreal forest landscapes with hare densities capable of supporting (1) multiple lynx home ranges, (2) reproduction and recruitment most years, and (3) at least some survival even during years when hare numbers are low (USFWS 2017a, p. 38). These areas must also have snow conditions (consistency, depth, and duration) that allow lynx to outcompete other terrestrial hare predators. To persist, lynx populations must exhibit recruitment and immigration rates that exceed mortality and emigration rates on average over the long-term.

For more information on ecological requirements of individual lynx and lynx populations, see the 2017 SSA report (USFWS 2017a, pp. 32–38).

5.2 Resiliency

Resiliency describes the ability of populations to withstand stochastic events. To evaluate the current resiliency of DPS lynx populations, we identified habitat and demographic variables indicative of each focal area's capacity to provide the resources needed by individual lynx to breed, feed, and shelter and to support resilient populations over time. Habitat variables included the amount of habitat in each unit known or modeled to be capable of supporting resident lynx over time, snowshoe hare density, and we explored several climate variables including snow season duration, annual snowfall, and temperature ranges. Demographic variables included estimated lynx population size, adult survival rate, the percentage of females with kittens, kitten survival rate, and relative connectivity of focal areas to lynx populations and habitats in Canada.

With input from recognized lynx experts, we narrowed the list of variables to consider in this assessment to those that can be measured or evaluated broadly across the large geographical areas encompassed by the focal areas and projected into the future. Based on the scientific literature, expert input, and our understanding of lynx ecology and population dynamics on the periphery of the species' range, we established thresholds to define resiliency conditions for each variable. Larger populations occupying larger areas of high-quality habitat with higher proportions of the focal area in favorable climate (temperature) conditions and that are better connected to the core of the species' Canadian range were assumed to have higher resiliency (greater ability to withstand stochastic events) than smaller populations occupying smaller, less climatically favorable, and less well-connected habitat areas. Populations estimated at fewer than 25 individuals or occupying habitat areas too small to support that many are considered "not resilient/functionally extirpated" because populations that small are unlikely to persist over time. Resiliency categories and associated variable scores are shown in Table 4.

Table 4. Resiliency categories and variables evaluated to assess current and future resiliency of Canada lynx populations in the contiguous United States distinct population segment.

Resiliency Category	**Habitat Variables**		**Demographic Variables**	
	Habitat Amount (km^2)[1]	Percentage of Unit Focal Area in Appropriate Climate Condition[2]	Estimated Lynx Population Size	Connectivity to Species' Core Range[3]
High	≥ 20,000	75 - 100	400 – 1,000	Directly Connected and Highly Permeable
Moderate	5,000 – 19,999	50 – 74	100 – 399	Indirectly Connected and Moderately Permeable
Low	1,250 – 4,999	25 – 49	25 – 99	Poorly Connected and Marginally Permeable
Not Resilient/ Functionally Extirpated	< 1,250	< 25	<25	

[1]The focal area within each SSA unit known to contain the abiotic and biotic features necessary to support a resident breeding lynx population or modeled as having a high capability of doing so.
[2]The proportion of each SSA unit focal area that is (or is projected to remain) within the appropriate temperature (mean temperature of the coldest month) range. In Units 1 and 2, -15ºC to -10ºC; in Units 3-6, -10ºC to -5ºC.
[3]Canada lynx core range represents areas north of the U.S.-Canada border.

We then evaluated lynx populations in each SSA unit in terms of those resiliency variables and categories to determine the current resiliency of each population. We scored each variable for each population based on the resiliency category it exhibits as follows: High = 3; Moderate = 2; Low = 1; Not Resilient/Functionally Extirpated = 0. Then we calculated the mean of the four variable scores to designate the overall unit resiliency, with Units scoring 2.5–3 considered to be highly resilient; those scoring 1.75–2.25 to be moderately resilient; those scoring 0.75–1.5 to have low resiliency; and those scoring 0–0.5 to be functionally extirpated. Additionally, if the estimated population size was in the Not Resilient/ Functionally Extirpated category, the overall unit resiliency was also designated as functionally extirpated.

Resiliency scores for each unit are presented in Table 5 and illustrated in Figure 8, below, showing three Units with current high resiliency, two with moderate resiliency, and one that is functionally extirpated (the GYA, but note that it is uncertain whether this unit historically supported a small persistent population or if lynx residency was and is naturally ephemeral).

Table 5. Current resiliency metrics and categorical scores of Canada lynx populations in SSA unit focal areas in the contiguous United States distinct population segment.

SSA Unit	Habitat Variables		Demographic Variables		Overall Unit Resiliency
	Minimum Habitat Amount (km^2)[1]	Percentage of Unit Focal Area in Appropriate Climate Condition[2]	Estimated Lynx Population Size[3]	Connectivity to Species' Core Range[4]	
1 Northeast	28,913	91	750 – 1,000	High	**High**
2 Midwest	21,119	100	100 – 200	High	**High**
3 Northern Rockies	20,606	100	200 – 300	High	**High**
4 Northern Cascades	6,067	87	30-35	High	**Moderate**
5 GYA	2,902	100	0-10	Moderate	**Functionally Extirpated**
6 Southern Rockies	19,411	89	75-150	Low	**Moderate**

[1]The focal area within each SSA unit known to contain the abiotic and biotic features necessary to support a resident breeding lynx population or modeled as having a high capability of doing so. In Units 1 and 2, this area is defined by designated critical habitat and other areas that meet the definition of critical habitat (i.e., areas excluded from critical habitat in accordance with section 4(b)(2) of the ESA); in Units 3-6, this area is defined as high-quality habitat modeled by Olson et al. 2021 and Squires et al. *in prep.* and designated as Tier 1 areas by the Western Lynx Biology Team 2022.
[2]The proportion of each SSA unit focal area that is (or is projected to remain) within the appropriate temperature (mean temperature of the coldest month) range. In Units 1 and 2, -15°C to -10°C; in Units 3-6, -10°C to -5°C.
[3]Estimates of current population size are based on expert opinion or published estimates of carrying capacity.
[4]Canada lynx core range represents areas north of the U.S.-Canada border.

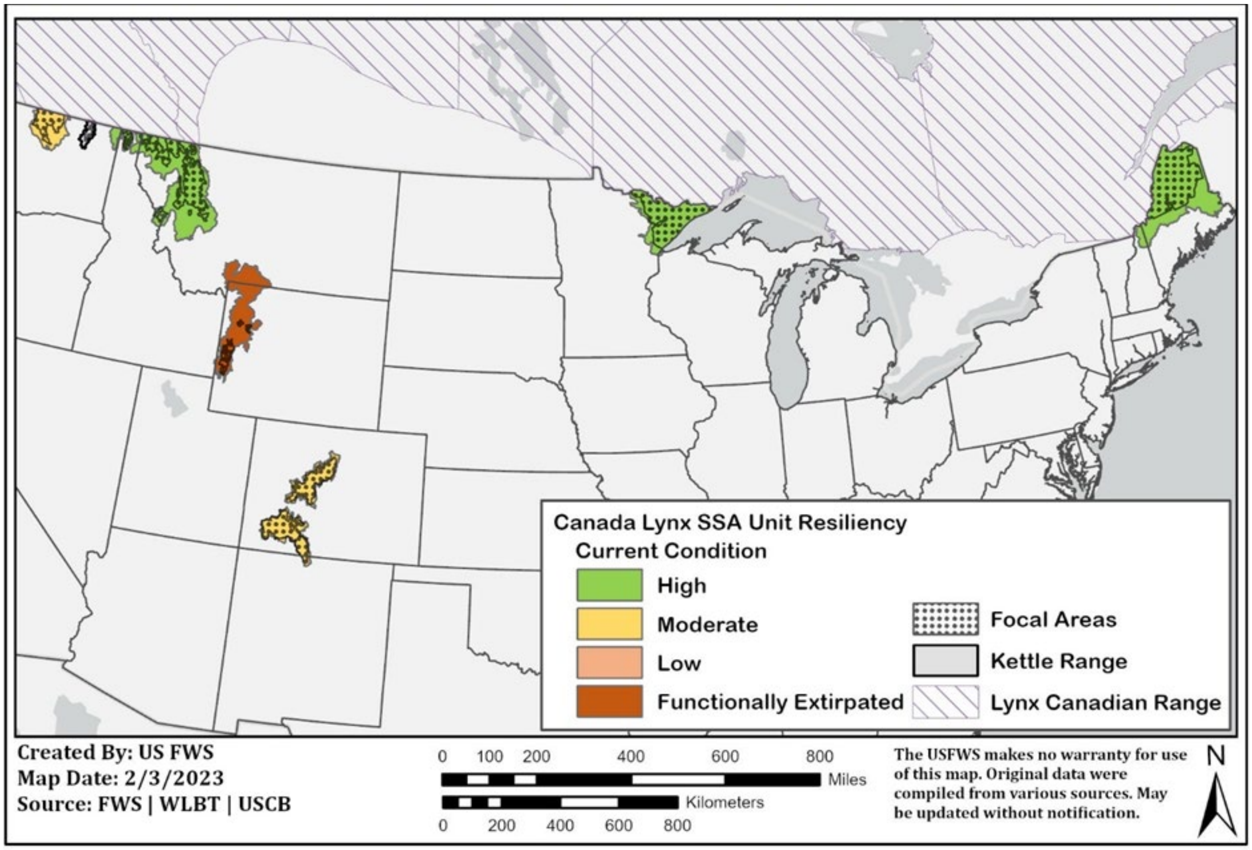

Figure 8. Current resiliency of Canada lynx populations in SSA unit focal areas in the contiguous United States distinct population segment.

Several DPS populations have recently demonstrated an ability to withstand stochastic events. For example, the population in Maine responded first to a temporary anthropogenically influenced decrease in habitat immediately following widespread clear-cutting of budworm impacted forests in the 1970s-80s, and then to the dramatic increase in the amount and distribution of high-quality foraging as those forests regenerated into excellent hare habitat in the decades after timber harvest. The population responded to the latter by increasing its size, density, and distribution to what are believed to be historically high levels (Vashon et al. 2012, pp. 14–15, 50–60, 87–91; Vashon and Harris 2021, pp 8–15).

The population in northeastern Minnesota has demonstrated resiliency by persisting despite very high trapping harvest in some years during the 1930s through the early 1970s (McKelvey et al. 2000, pp. 221–223, 241). Although some or most of the lynx harvest in peak years was clearly associated with large irruptions of dispersing lynx from Canada into the Great Lakes region, largely unregulated trapping also likely depressed the local breeding population. Other DPS populations (Maine, western Montana and northern Idaho, and northern Washington) also have demonstrated resiliency to sometimes high levels of largely unregulated trapping harvest in the 1800s through the 1950s-70s (Hoving et al. 2003, pp. 363, 372–374; McKelvey et al. 2000, pp. 224–228).

More recently, the lynx population in Washington has demonstrated resiliency by persisting despite large-scale wildfire impacts to habitats (Vanbianchi et al. 2017a, entire; Vanbianchi et al.

2017b, entire; Vanbianchi et al. 2018, entire). In northwestern Montana, lynx have demonstrated resiliency to wildfire and to a variety of silviculture applications (Holbrook et al. 2018, entire; Olson et al. 2023, entire). In Colorado, lynx have demonstrated resiliency to large-scale forest insect impacts to habitat (Squires et al. 2020, entire; Squires et al. 2023, entire; Ivan et al. 2023, p. 8) and to human recreation (Olson et al. 2018, entire; Squires et al. 2019, entire).

In summary, based on our assessment, three of four historically persistent DPS populations (those in Units 1–4) currently exhibit a high level of resiliency (Units 1–3) and the other (Unit 4) exhibits moderate resiliency. The Unit 4 population is thought currently to be reduced to about half of its historical size because large wildfires have impacted roughly half of the lynx habitat in the past 20–25 years. Because of its relatively small focal area size and low estimated lynx density, even at full habitat capability and with a hypothetical population of 90–120 resident lynx (see Chapter 3), this population would at best be marginally capable of demonstrating high resiliency according to our criteria, and it is uncertain to what extent it may have done so historically. Regardless, its current resiliency is likely lower than its typical historical condition. This unit faces a nearly annual threat of substantial habitat loss and fragmentation from large wildfires which could result in further declines in resiliency given the small population size. Unit 5 lacks a resident population and is scored as "not resilient/functionally extirpated." It is uncertain whether Unit 5 historically supported a resident population or if lynx occupancy is and was naturally ephemeral. If the latter, its historical resiliency would have matched its current condition, at least some of the time. Like the GYA, the historical presence of a persistent resident lynx population in the Southern Rockies (Unit 6) is not strongly supported by an evaluation of the available reliable information. However, the State of Colorado's Lynx Reintroduction Program (*https://cpw.state.co.us/lynxresearch*) has resulted in the establishment of resident populations in two large focal areas in west central and southwestern Colorado. This unit's moderate resiliency score is limited by its low level of connectivity to the core of the species range, but it may represent an increase in resiliency from the typical historical condition. Overall, the current resiliency of populations in Units 1 and 6 likely represents an increase from historical conditions, that in Unit 4 a decrease, with the remaining Units (2, 3, and 5) exhibiting resiliency typical of historical conditions.

5.3 Representation

Representation describes a species' ability to adapt to long-term changes in the environment. Maintaining a species across its full breadth of ecological variation can reduce extinction risk from known and unknown threats in two ways. First, ecological variation can correlate with species-wide evolutionary potential when a species has evolved local adaptations. Second, different ecological settings (niches) can be differentially exposed or affected by various stressors such that a species has greater resistance (ability to remain essentially unchanged when subject to disturbance) or resilience (ability to recovery from disturbance) within certain ecological settings (Forester et al. 2022, pp. 511–512).

We evaluated the lynx's ability to respond to environmental change in two ways. First, we examined core attributes of the lynx's adaptive capacity in relation to standardized categories (Thurman et al. 2020, entire) to characterize the likelihood that lynx in the contiguous U.S. will be able to adapt to changing conditions. Second, we evaluated the current distribution of resident lynx across the DPS range to understand whether the timing, extent, and magnitude of environmental changes may vary across the range and whether lynx in different ecological contexts may have dissimilar responses to these changes.

Adaptive Capacity – Whether and to what extent lynx can adapt to direct and indirect effects of projected climate warming and related impacts to habitats, prey populations, and the forest disturbance regimes that maintain the mosaic of vegetation conditions to which they are adapted will determine how vulnerable the DPS is to these changes. To better understand how vulnerable lynx in the DPS may be, we evaluated their adaptive capacity relative to 12 core attributes defined by Thurman et al. (2020, entire) (Table 6).

Table 6. Core attributes of adaptive capacity, an explanation of each attribute, the score we assessed for the lynx DPS in the contiguous U.S. for each attribute, and the justification for why lynx fit the score categories as defined by Thurman et al. (2020).

Category: Attribute	Explanation	DPS Adaptive Capacity Score	Justification
Distribution: ***Extent of occurrence***	The area that encompasses all known, inferred, or projected sites of present occurrence	High	Very broad distribution, current DPS range 100,000 – 200,000 km^2 – approx. 6 million km^2 in Canada and Alaska.
Distribution: ***Habitat specialization***	Habitat specificity, or the degree to which a species can use multiple habitats vs. being confined to specific or narrow subset of habitats	Low	Highly specialized - snowy boreal forest obligate; not specialized in dispersal habitat.
Distribution: ***Commensalism with humans***	Degree of tolerance of human interaction and infrastructure	Moderate	Some tolerance of humans and related disturbances (timber management, recreation); generally low overlap between lynx and high human density, though not necessarily avoidance. Evidence of avoidance of off-trail motorized winter recreation (snow machine, Squires et al. 2019, pp11-15).
Movement: ***Dispersal distance***	The distance an individual can move from an existing population's location	High	Among the largest of any N. American mammal; 500 to >1,000 km documented.
Evolutionary Potential: ***Genetic diversity***	The diversity of genotypes within a species	Moderate	Naturally low genetic diversity due to dispersal capability; nearly panmictic.

Category: Attribute	Explanation	DPS Adaptive Capacity Score	Justification
Evolutionary Potential: ***Population size***	The number of individuals in the population (DPS)	Moderately Low	Experts' estimates of population sizes in 6 SSA focal areas provide a range of roughly 1,200 – 1,800 resident lynx in the DPS. Only 1 DPS population likely exceeds 300 individuals; 3 populations are thought to be between 100 and 300; 1 about 30-60; and 1 zero to 10. Most DPS populations are connected to Canadian populations. Across the species' entire distribution, lynx numbers likely range from a minimum of 100,000 during cyclic lows to perhaps a million during highs.
Ecological Role: ***Diet breadth***	The ability to use a range of food resources	Low	Highly specialized and dependent on snowshoe hares. Alternate prey (e.g., red squirrels and grouse) important when hare abundance is low and at the range edge (Szumski et al. 2023, entire), but alternate prey alone cannot sustain persistent breeding populations.
Abiotic Niche: ***Climate niche breadth***	Niche specialization or the range of abiotic conditions to which a species is adapted	Low	Highly specialized to cold, snowy environments
Abiotic Niche: ***Physiological tolerances***	The degree to which a species is restricted to a narrow range of abiotic conditions and the degree of tolerance of physiological stressors	Moderate (?)	Adapted to cold, snowy environments. DPS populations occur in narrow winter temp. bands (-15 to -10^{o}C MCMT in Northeast and Midwest; -10 to -5^{o}C in West); likely intolerant of warmer temps on southern range periphery. Much colder in core of species' range; DPS populations have roughly 4-5 months of snow-dominated conditions; core of the range 6-7 months.

Category: Attribute	Explanation	DPS Adaptive Capacity Score	Justification
Life History: *Reproductive phenology*	The timing of reproductive events within a species life cycle	Low	Reproduction tied closely to hare abundance - females may produce kittens as 1-year-old's and annually when hares are abundant; during hare lows, reproduction may cease completely. Timing of reproduction likely related to photoperiod (Lama 2021, p. 65), potentially limiting phenological shift in a warming climate.
Life History: *Fecundity*	Number of offspring produced on average	Moderate (Low?)	In the DPS, litter size averages 2.3-3.3; up to 6. Kitten survival highly variable (0.12 – 0.89). In core of species' range, litters of 4-5 when hares peak; 0 at hare cycle low. Dramatic population declines and rebounds following hare population cycle. Females may not breed every year depending on hare availability
Demography: *Life span*	Average period between birth and death of an individual	Moderate	Average generation time estimated at 3 years (Prentice et al. 2019, p. 6). Survival (thus life span) variable, driven by hare abundance. With sufficient hares, lifespan in wild probably 5-10 years; up to 16 years documented in wild.

Several lynx attributes – especially their broad geographical distribution, exceptional dispersal capability, and ability to quickly increase survival, productivity, and population size in response to cyclic rebounds or other increases in prey (i.e., hare) abundance (note that within the DPS range, hare populations are non- or weakly cyclic) – suggest potential adaptive capacity to changing conditions. However, we assume that those attributes are counteracted by others that limit the lynx's adaptive capacity, particularly in the DPS range, including very high degrees of habitat and prey specialization, naturally low genetic diversity, small population sizes, and their high degree of specialization for a cold, snowy climate.

Lynx in the DPS are widely distributed and capable of long-distance dispersal, but dispersal capability is of limited adaptive benefit if there are no or few additional areas within the DPS range that provide suitable and vacant habitat. Recent modeling described above indicates relatively small areas of potentially suitable habitat in the southern portion of the GYA (the Unit 5 focal area) and in the Kettle Range of northeastern Washington. There is uncertainty regarding the historical capability of either area to support a persistent resident population, but at lynx densities typical for the western part of the DPS range (1–2 lynx/100 km^2), the modeled high-quality habitat in the GYA and Kettle Range could hypothetically support populations of about

29-58 and 7-15 resident lynx, respectively. From 2004-2010, several lynx released into southwest Colorado dispersed to the southern GYA and settled into the modeled habitat of the SSA focal area for varying amounts of time but did not establish a resident population. The Kettle Range is the site of an ongoing lynx reintroduction effort (see Chapter 3 above). Establishment of resident populations in either or both areas would increase representation (and redundancy) within the DPS.

Overall, our evaluation of historical and current distribution of resident lynx in the DPS range does not indicate broad scale range contraction or the loss of breeding populations from large geographical areas that historically supported them (USFWS 2017a, pp. 39-51). Although some small populations may have become extirpated recently (note, however, that source-sink dynamics in a metapopulation structure at the periphery of the species range suggest that some populations may be naturally ephemeral), resident lynx in the DPS currently remain broadly distributed across the range of ecological settings that seems to have supported them historically. Therefore, while lynx are physiologically and behaviorally capable of shifting in space, lynx within the DPS are limited in their ability to do so by the lack of additional large and vacant high quality habitats for them to move into.

Adaptive capacity of lynx in the DPS is also constrained by high levels of habitat and diet specialization which limit their ability to adapt in place. Despite differences in forest community types and topographic/elevation settings, lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation types and structure, snow conditions, and the abundance of a single prey species. As snowy boreal forests with abundant hares recede northward and to higher elevations in response to continued climate warming, lynx are unlikely to be able to adapt to the temperate forests and different prey and competitor assemblages that are expected to replace them. Although there are projected differences in the timing at which favorable temperatures will recede from DPS populations areas, all populations are expected to respond similarly. That is, no populations are thought to be more resistant to or better able to cope with the expected impacts of a warming climate, despite differences in when those impacts may occur. There is no known adaptive genetic differentiation between lynx populations in the DPS, but these populations occur at the species' southern range boundary, where the conditions for evolutionary responses to changing ecosystems conditions (if any are possible) are most likely to be found.

In summary, there are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historical conditions. However, given the limited opportunity for lynx to shift in space within the range of the DPS and the low likelihood that they will be able to adjust to novel climate and habitat conditions, the current degree of representation in the DPS likely limits the capacity of DPS populations to adapt to expected changes.

5.4 Redundancy

Currently, there are multiple high to moderate resiliency populations occupying large areas and broadly distributed across a wide geographic extent that generally aligns with our understanding of the historic distribution of resident lynx populations within the DPS range. The large sizes and broad geographic distributions of the areas currently occupied by resident lynx populations indicate historical and current redundancy in the DPS sufficient to preclude the possibility of extirpation from catastrophic events (wildfire, disease, etc.). The degree of current redundancy contributes to viability and limits the risk to the DPS, especially given the low frequency and limited magnitude of events that could possibly cause widespread lynx mortality and impacts at the population scale.

5.5 Summary of Current Viability

Three of four historically persistent DPS populations (in Units 1-3) currently exhibit a high level of resiliency (with Unit 1 likely more resilient now than historically) and the other (in Unit 4) exhibits moderate resiliency that is likely reduced, perhaps temporarily, from its historical condition. Unit 5 (GYA) does not support a resident population and it is uncertain whether it did so historically; we scored it "not resilient/functionally extirpated" and note that this may be its typical historical condition. Unit 6 (Southern Rockies) currently supports a moderately resilient population, likely representing an increase in resiliency from its typical historical condition. The broad distribution of highly to moderately resilient populations in geographically large and discrete focal areas provides redundancy that precludes catastrophic extirpation of the DPS, limiting risk and supporting current viability. However, DPS viability is constrained by the lynx's limited adaptive capacity to respond to projected climate and habitat changes and the absence of vacant areas of suitable habitat in the DPS range to which they might move.

Chapter 6: Future Conditions

6.1 Climate Vulnerability Assessment

In the 2005 Recovery Outline for the lynx DPS, the Service identified that climate warming was likely to negatively affect the cold climatic conditions that maintain the boreal and subalpine ecosystems to which lynx are highly adapted (USFWS 2005, p. 11). We anticipated a warming-induced northward and upslope contraction of these systems, potentially resulting in a substantial decrease or possible future elimination of lynx habitats in the contiguous United States (USFWS 2005, p. 14). In 2013, the Interagency Lynx Biology Team (ILBT) included climate change among four First Tier anthropogenic influences - those with the potential to have population-level consequences - likely to impact lynx in the DPS range (ILBT 2013, pp. 68–71). The ILBT recognized several other likely or possible effects of climate change on lynx and snowshoe hares, including changes in the dynamics of snowshoe hare and lynx population cycles, reduced habitats and population sizes, changes in other demographic rates, and changes in predator-prey relationships (ILBT 2013, pp. 43, 53, 55, 62-63, 66, 68–71). The ILBT also recognized climate-driven changes in natural disturbance regimes, especially the increasing size, frequency, and intensity of wildland fires and forest insect outbreaks related to warming and drying climate conditions, were likely to negatively impact lynx but that there remained substantial uncertainty about the mechanisms, magnitude, and timing of such impacts (ILBT 2013, pp. 66, 76, 98).

To inform the 2017 SSA, we sought expert input on the "timing, extent, magnitude, and severity of potential threats associated with climate change" on the current and future viability of lynx and hare populations and habitats in the DPS range (Lynx SSA Team 2016, pp. 6, 10, 14–17, 19, 21–23, 36–48). Experts considered the direct and indirect effects of climate change that posed the greatest challenge to future long-term viability of lynx populations in the contiguous United States. Anticipated effects included potential "climate-driven increases in the size, frequency, and intensity of fire and insect outbreaks; decreases in snow amount, duration and quality, potentially leading to increased competition with bobcats and other hare predators; and the projected warming-induced northward and upslope migration of boreal and subalpine forests that would result in the loss and further fragmentation and isolation of lynx and hare habitats" (Lynx SSA Team 2016, p. 58). Again, however, experts expressed great uncertainty about the timing, extent, and magnitude of these potential impacts and recognized that they would likely vary depending on future greenhouse gas emissions scenarios.

In the 2017 SSA, we recognized that the lynx, as a boreal forest- and snow-adapted habitat and prey specialist, is probably broadly exposed and highly sensitive to the projected impacts of continued climate warming and has limited capacity to adapt to it. We concluded that lynx populations in the DPS are vulnerable (i.e., predisposed to be adversely affected) to the projected impacts of continued warming and related impacts, particularly increased wildfire and forest insect activity (USFWS 2017a, pp. 4–8, 20). We found that projected warming is likely to reduce the amount and quality of lynx habitats, lynx numbers, and the resiliency of lynx populations in the DPS, and we expect all DPS populations to become smaller and more fragmented in the future due largely to climate-driven losses in habitat quality and quantity (USFWS 2017a, pp. 10, 67–83).

Given the significant challenge that climate warming is expected to present to the long-term resiliency of DPS lynx populations and, therefore, to the viability of the DPS as a whole, a more rigorous evaluation of the potential impacts of continued warming is warranted to reduce the degree of uncertainty surrounding future condition. Therefore, a major part of this addendum to the lynx SSA is a structured climate vulnerability assessment intended to present a range of plausible warming scenarios and their potential consequences for lynx habitat suitability and population resiliency based on recent advances in climate and lynx habitat modeling.

The methods of the climate vulnerability assessment presented in this report are based on the results of an ensemble species distribution model (SDM) for lynx in the Northern Rocky Mountains and the Pacific Northwest (Olson et al. 2021, entire) and projecting the strongest covariate from that ensemble forward in time across all areas currently occupied by lynx in the contiguous U.S. The Olson et al. model used lynx telemetry location data from three geographically distinct lynx populations in Washington (n=17 lynx; 21,518 locations), Montana (n=66 lynx; 164,612 locations) and Wyoming (n=10 lynx; 757 locations) from 1996 to 2015 (Olson et al. 2021, p. 3). Ensemble SDMs were built for each population and all populations combined, with the combined population SDM performing as well as, or better than, each of the individual population SDMs (Olson et al 2020, pp. 6-8). Sixteen climate, topographic, vegetation, and anthropogenic covariates were included in the SDMs (Olson et al. 2021, p. 11; Figure 9). By far, the strongest (most highly explanatory) covariate was mean temperature of the coldest month (Mean Coldest Month Temperature; MCMT), followed by snow water equivalent and winter (December – February) precipitation. It is highly probable these three covariates are proxies for snow amount, duration, density, and consistency that give lynx a sufficiently long seasonal competitive advantage in hunting their primary prey species, snowshoe hares, over other terrestrial hare predators (e.g., bobcats and coyotes). These variables also likely influence hare populations and density, and by extension lynx are indirectly reliant on the environmental conditions that favor hares (Olson et al. 2021, p. 11; Squires et al. 2010, pp. 1656–1657).

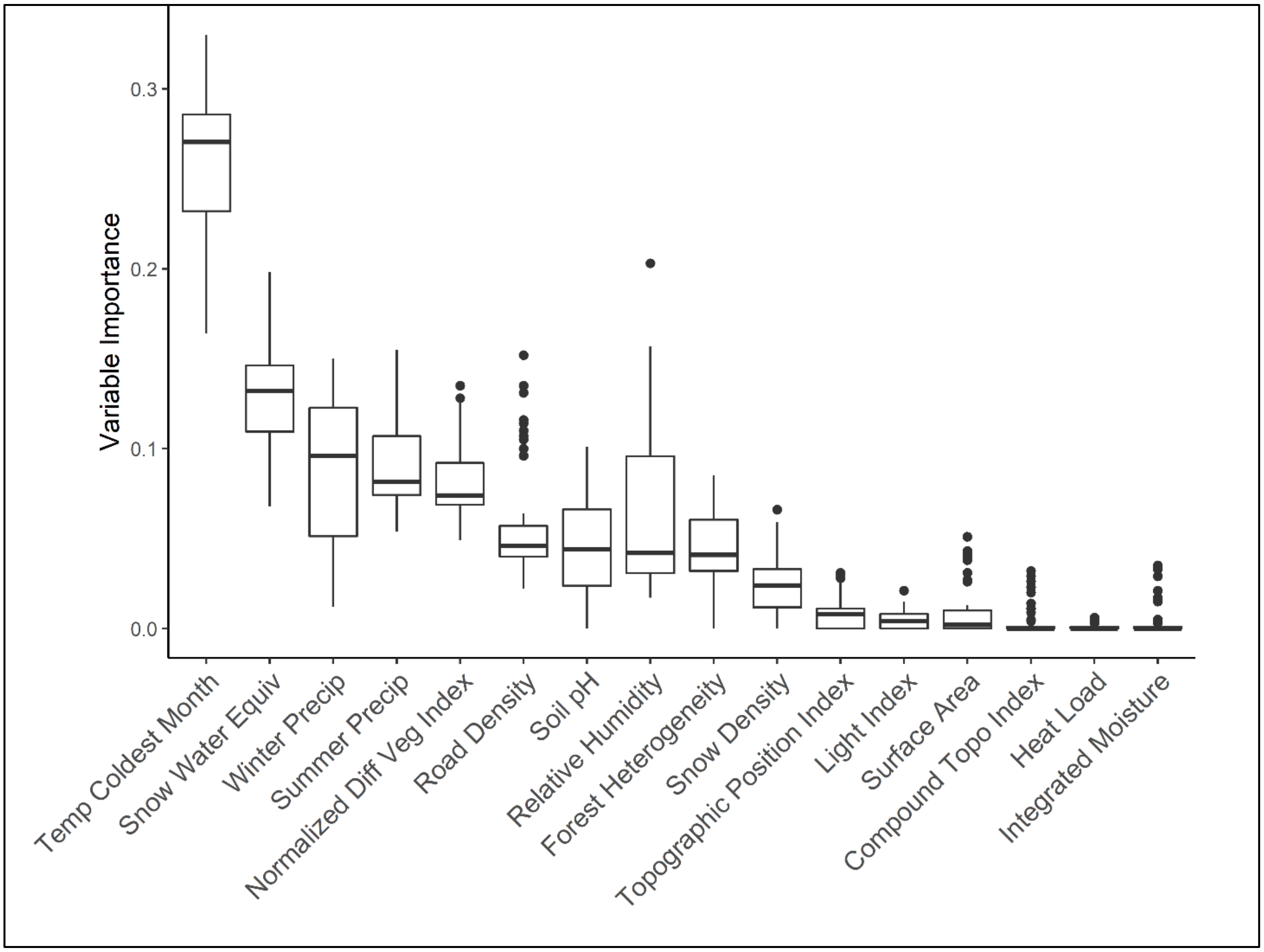

Figure 9. Estimated variable importance of each covariate to the best-performing species distribution model for Canada lynx in the Northern Rockies and North Cascades, western contiguous U.S. (Olson et al. 2021, Fig. 7, p. 11; used with lead author's permission).

L. Olson (*personal communication*) provided the range of values for MCMT for all independent lynx occurrences (n=30,676) within their study area (Northern Rocky Mountains and Pacific Northwest) and > 99 percent (n=30,548) of the records were found to occur in areas where MCMT was -10 to -5° C. Historical data (2001–2020) for MCMT were obtained from AdaptWest (AdaptWest Project 2022, entire; Mahony et al. 2022, entire; Wang et al. 2016, entire) and plotted with lynx current range, critical habitat and WLBT tier 1 polygons (WLBT 2022, p. 30) in the Pacific Northwest, Rocky Mountains, Minnesota, and Maine to assess current lynx distribution within the -10 to -5° C range. All occupied areas in the West (WA, ID, MT, WY, and CO) fell within this temperature range, but areas occupied by lynx in Minnesota and Maine were colder (-15 to -10° C) (Figure 12).

An independent analysis of lynx occupancy in Maine reported MCMT as having the highest predictive performance (as a single variable), with snow duration having the second highest performance (A. Sirén, *personal communication*). The range of values for MCMT for lynx occurrences in this area was -10 to -13°C. The interpretation of this was that MCMT and snow duration have opposite effects on lynx occupancy (A. Sirén, *personal communication*).

Increasing temperatures and longer snow durations have negative and positive effects on lynx occupancy, respectively. This is logical as one would expect colder areas receiving snow to have longer snow seasons, which coincides with lynx being found in parts of the study region that experience the coldest temperatures and longest duration of snow, such as northern Maine.

In northeast Minnesota, lynx occupancy was positively related to percent evergreen, average snowfall, and dense vegetation (Hostetter et al. 2020, pp. 800–803). An independent analysis of lynx occupancy that included MCMT as a covariate appeared to be less predictive of lynx occupancy than average snowfall in this area (D. Ryan, *personal communication*), and MCMT and average snowfall were weakly correlated (r = 0.12) (N. Hostetter, *personal communication*). We believe this is likely due to lake effect snow which occurs when cold air moves over the relatively warm waters of the Great Lakes, resulting in heavier rates of snow in some areas adjacent to the lakes. At the broader scale (e.g., Great Lakes region), the -15 to -10° C temperature envelope captured where resident breeding lynx occur in northeast Minnesota, and the median temperature of coldest month across the study area was -14° C (range -18 to -8° C) (Figure 10). In summary, the -15 to -10° C temperature envelope captured where resident breeding lynx occur in Minnesota at the broad scale, but there are likely additional factors (e.g., lake effect snow, boreal forest biome, and average snowfall) that better explain lynx occupancy at the finer scale.

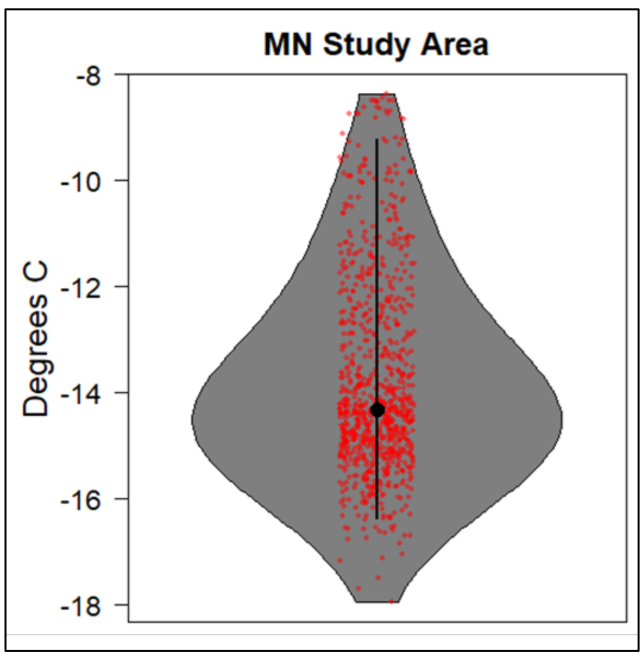

Figure 10. Mean temperature of coldest month during 2011-2020 (https://climatena.ca/) across 884 5x5 km grid cells encompassing SSA Unit 2 (Minnesota). Red points denote grid cell specific values, black point is median (error bars = 95% quantiles).

The Rocky Mountain Research Station provided preliminary SDM results using the same future projections of MCMT used in this analysis (ClimateNA) for SSP2-4.5 and 5-8.5, plus the full suite of additional co-variates identified in Figure 9 for lynx Units 3, 4, and 5 in Montana, Idaho, Washington, and Wyoming. These results were compared spatially to the results in Figure 12 to assess whether additional co-variates (not included in this SSA analysis) had a significant impact on predicted future probabilities of lynx habitat suitability. The results from both analyses were highly similar, which is not surprising given the variable importance of MCMT (Figure 9) compared to the additional covariates. This comparison provided further support for using MCMT to assess the potential for future lynx habitat suitability at broad scales and reinforces the assessment of Olson et al. (2021, entire) that MCMT has, by far, the most significant influence on SDM predicted probabilities.

The temperature range differences described above between the Northern Rocky Mountains, Pacific Northwest, Minnesota, and Maine are likely due to higher humidities and precipitation differences in Minnesota and Maine, requiring colder temperatures to create the same favorable snow conditions for snowshoe hares and a competitive advantage for lynx over other predators for hares. Roebber et al. (2003, entire) determined that temperature had the greatest effect on snow density, but second order effects of precipitation and humidity also have an effect. If a region is wetter (higher total precipitation amount and/or higher humidities or dew point temperature), snow will be denser for a given air temperature. By extension lower temperatures would be needed in these areas to produce snow conditions (i.e., deep, unconsolidated snowy) more conducive to lynx maintaining their competitive advantage over competitors.

Ensemble (a combination of 13 Global Climate Models) future projections of MCMT were obtained from AdaptWest (AdaptWest Project 2022, entire; Mahoney et al. 2022, entire; Wang et al. 2016, entire) for years 2021-2040, 2041-2060, 2061-2080 and 2081-2100 for three different emission pathways (SSPs) from the IPCC Sixth Assessment Report. The SSPs included were SSP2-4.5, SSP3-7.0 and SSP5-8.5 (Table 7 and Figure 11). The SSP5-8.5 pathway was included in this analysis to provide an upper-bounding scenario for MCMT and represents the highest-temperature scenario modeled. SSP5-8.5 has been identified as a plausible upper-bounding scenario for the end of century (OSTP 2023, p.11)

Table 7. Climate (SSP) scenarios used to evaluate a range of potential future climate conditions for Canada lynx populations in the contiguous United States distinct population segment (summarized from Arias et al. 2021, p. 54).

SSP Scenario Label	Description of SSP Scenario
SSP2-4.5	Intermediate greenhouse gas emissions with CO_2 emissions remaining at current levels to mid-century. Socioeconomic factors follow historic trends. Warming of ~2.7°C (2.1-3.5°C) by 2100.
SSP3-7.0	High greenhouse gas emissions scenario with no additional climate policy and high non-CO_2 (aerosol) emissions. CO_2 emissions roughly double from current levels by 2100. Warming of ~3.6°C (2.8-4.6°C) by 2100.
SSP5-8.5	Very high greenhouse gas emissions scenario with no additional climate policy. CO_2 emissions roughly double from current levels by 2050. Warming of ~4.4°C (3.3-5.7°C) by 2100.

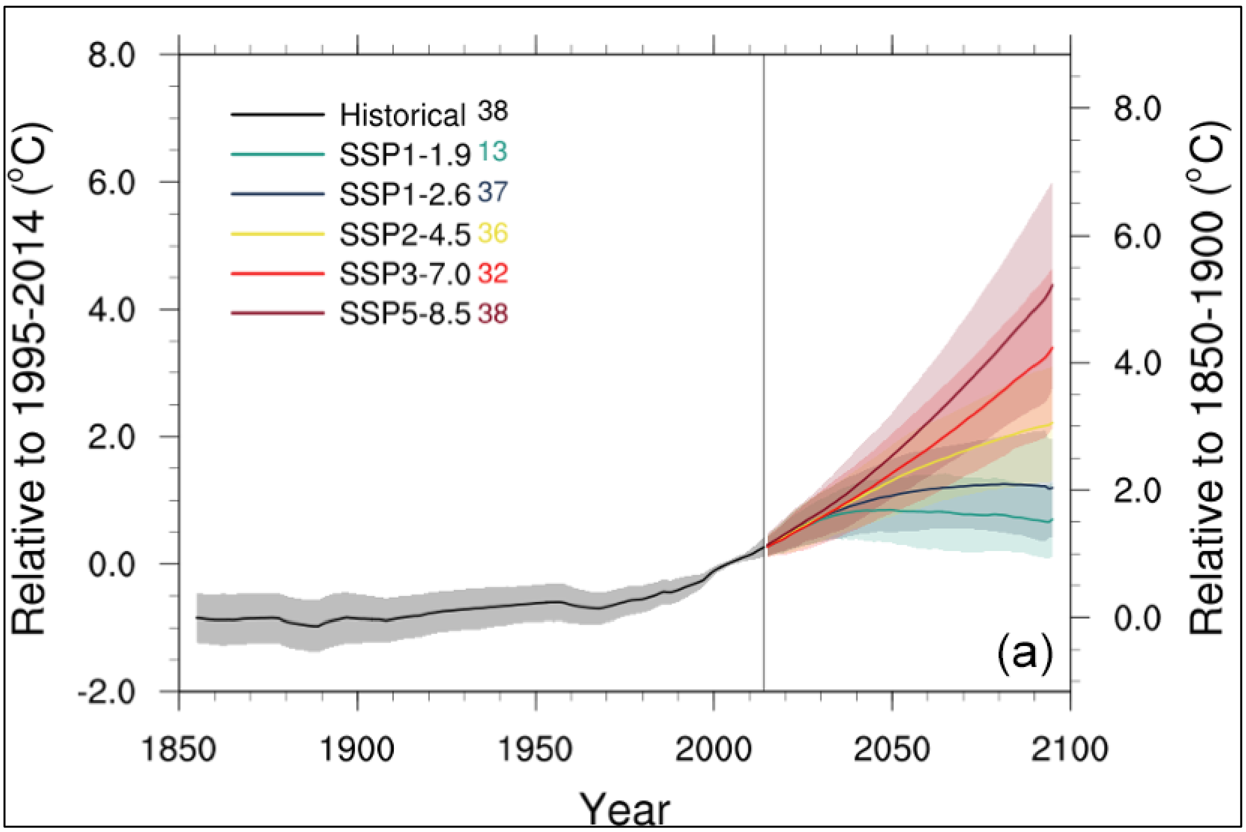

Figure 11. Global average temperatures time series (11-year running averages) of changes from current baselines (1995-2014, left axis) and pre-industrial baseline (1850-1900, right axis, obtained by adding a 0.84°C offset) for SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7, and SSP5-8.5 (Tebaldi et al. 2021).

We used the temperature ranges for MCMT described above that currently prevail in lynx population areas (-15 to -10° C in SSA Units 1 and 2; -10 to -5° C in Units 3–6) to map the potential contraction of favorable conditions for lynx focal areas for the twenty-year time horizons (through the end of this century) for the three climate scenarios. Figure 12 shows this contraction in favorable conditions for mid-century (2041-2060) and for end-of-century (2081-2100) for the three SSPs we modeled (2-4.5, 3-7.0, and 5-8.5). Full future time series maps by 20-year intervals are found in Appendix 1.

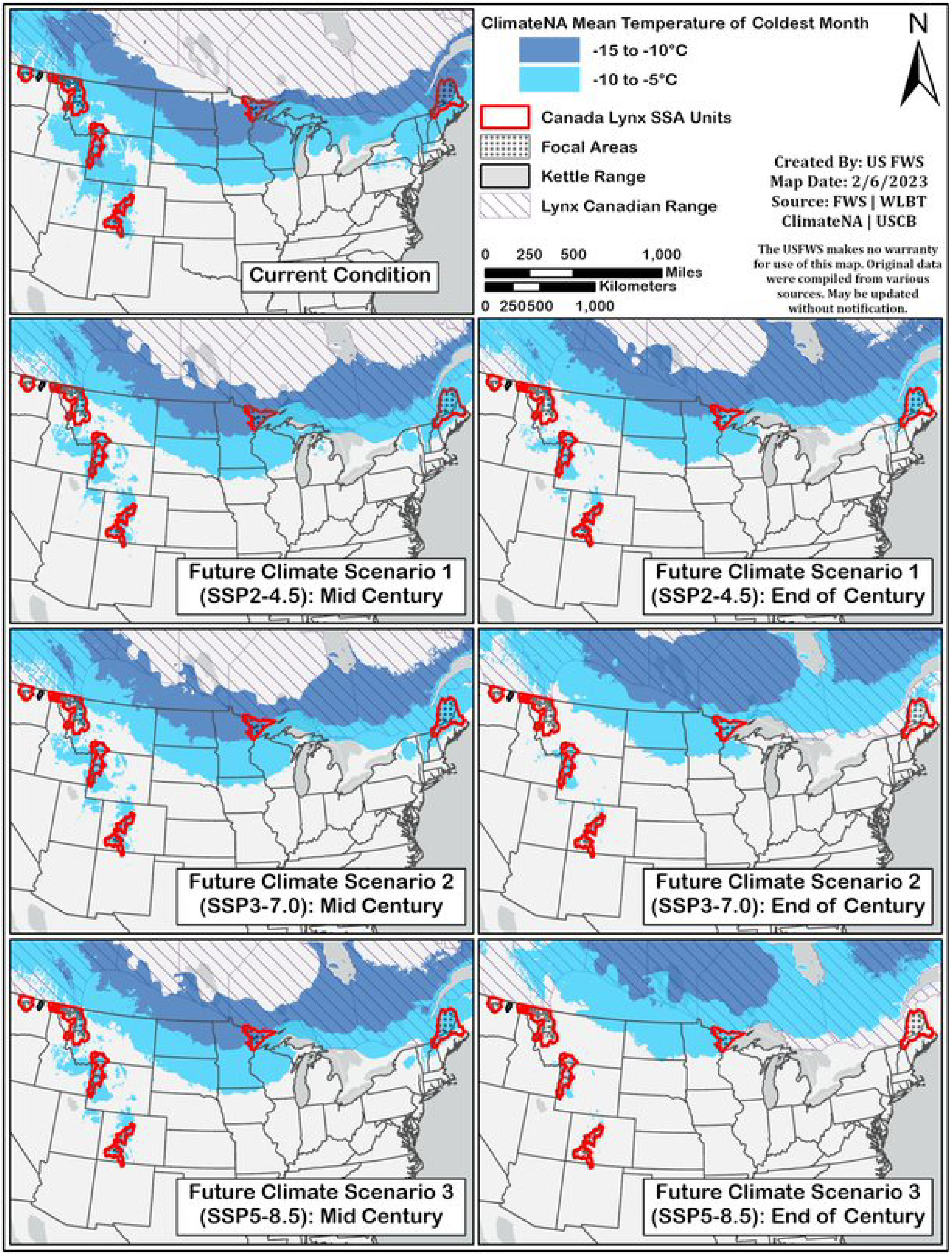

Figure 12. Modeled current and future (mid-century and end-of-century) favorable temperature conditions for Canada lynx populations in SSA Units and focal areas under three future climate scenarios.

Figures 13–15 show the projected timing and magnitude of loss of favorable conditions in SSA unit focal areas over time with projected warming under each climate scenario. As expected, the speed and magnitude of losses increase with increasing projected greenhouse gas emissions.

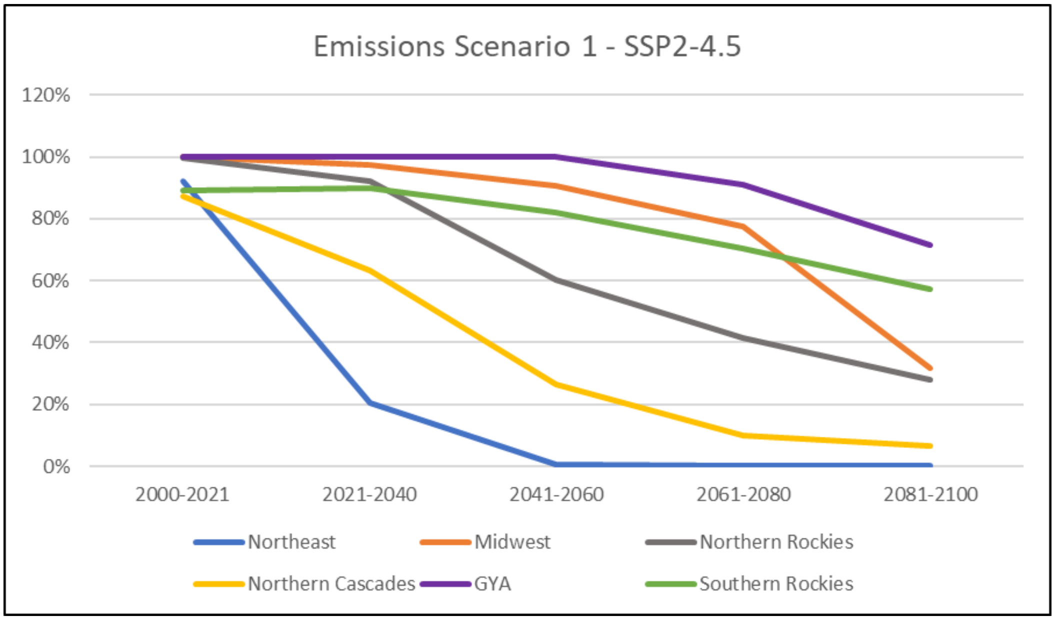

Figure 13. Projected proportions of Canada lynx species status assessment unit focal areas that remain in favorable temperature envelopes under emissions scenario 1 (SSP2-4.5) using an ensemble of 13 global circulation models.

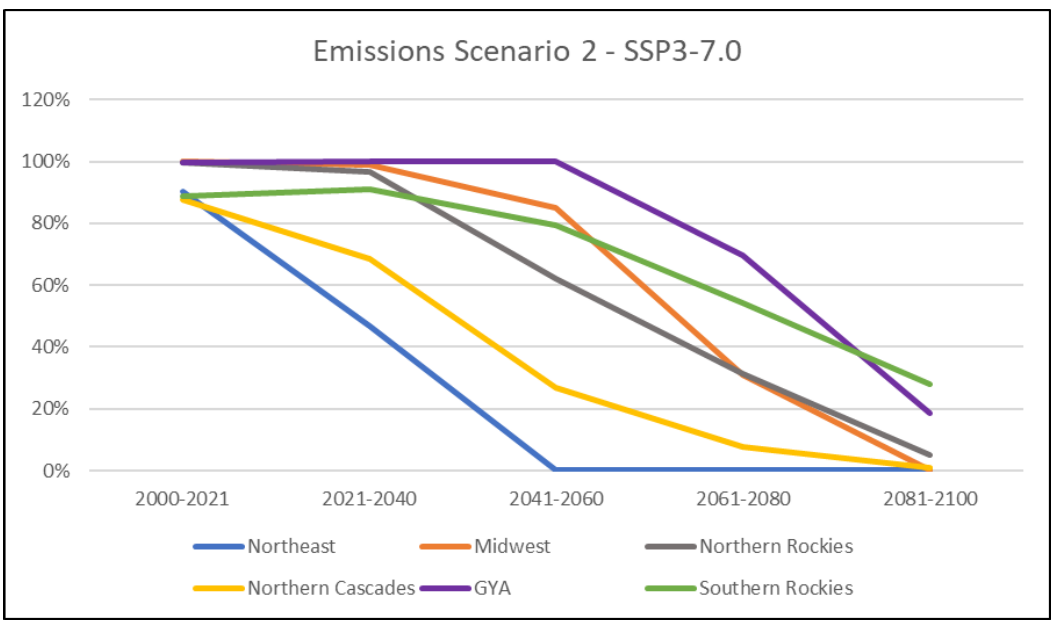

Figure 14. Projected proportions of Canada lynx species status assessment unit focal areas that remain in favorable temperature envelopes under emission scenario 2 (SSP3-7) using an ensemble of 13 global circulation models.

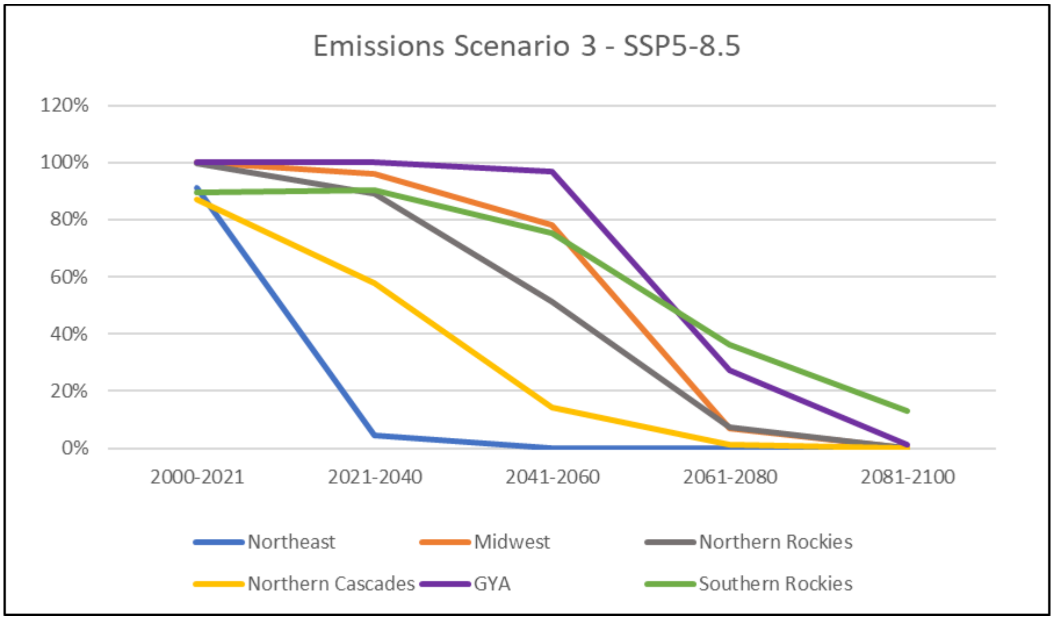

Figure 15. Projected proportions of Canada lynx species status assessment unit focal areas that remain in favorable temperature envelopes under emissions scenario 3 (SSP5-8.5) using an ensemble of 13 global circulation models.

Table 8 shows the percentage of the focal area in each unit that retains favorable climatic conditions through the end of century for the three SSPs included in the analysis. The Northeast unit shows an 80 percent decrease (20 percent retained) in favorable condition area by the first timestep (2021-2040) under scenario 1 and a 99 percent decrease (1 percent retained) in favorable condition area by the second time-step (2041-2060). This is concerning as the available information suggests that the Northeast unit currently supports the largest lynx population in the contiguous U.S., likely two to three times larger than any other DPS populations, based on expert opinions, documented lynx densities, and estimates of home range sizes throughout the DPS (Squires and Laurion 2000, pp. 343-344; Squires et al. 2004, p. 13; Vashon et al. 2012, pp. 14-17; Vashon, Moen and Catton, Squires, Maletzke, and Ivan *in* Lynx SSA Team 2016, pp. 18-23; Holbrook et al. 2017b, p. 5; Anderson et al. 2023, pp. 12-15). Similar trends in decreasing favorability, albeit not as drastic, are predicted in all population Units. The GYA (Unit 5) and the Southern Rockies (Unit 6) population Units have the least amount of decrease in favorable conditions by end of century in SSP2-4.5, a 29 percent decrease (71 percent retained) and 43 percent decrease (57 percent retained), respectively. These two areas are predicted to be the least impacted by climate warming across all population Units and SSPs, but there is uncertainty, based on evaluation of historical data, regarding the capability of these two Units to support persistent lynx populations. The GYA does not currently support a lynx population and is categorized as not resilient/functionally extirpated. The Southern Rockies unit is categorized currently to be moderately resilient but is only populated due to reintroduction efforts by the State of Colorado. Consequently, the two population Units with the highest potential for retaining temperatures and snow conditions favorable for lynx at the end of this century also have the least evidence of historical occupancy, which calls into question the future potential of these areas to support resident breeding populations.

Table 8. Current and projected future percentages of SSA unit focal areas retaining favorable climate conditions for Canada lynx under three climate scenarios and associated resiliency category scores for this variable (Green = High [75-100%]; Yellow = Moderate [50-74%]; Pink = Low [25-49%]; Orange = Not Resilient/Functionally Extirpated [< 25%]).

SSA Unit	Percentage of Unit Focal Area in Favorable Climate Condition												
	Current	Future Scenario 1 – SSP2-4.5				Future Scenario 2 – SSP3-7.0				Future Scenario 3 – SSP5-8.5			
		2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100
1	91	20	1	0	0	47	0	0	0	4	0	0	0
2	100	97	91	77	32	99	85	31	0	96	78	7	0
3	100	92	60	41	28	97	62	31	5	89	51	7	0
4	87	63	26	10	7	69	27	8	1	58	14	1	0
5	100	100	100	91	71	100	100	70	19	100	97	27	1
6	89	90	82	71	57	91	80	54	28	90	75	36	13

Because DPS lynx populations exist at the southern periphery of the species' continental range, many of the areas they occupy likely already approach upper thermal thresholds for temperature and snow conditions which can support persistent lynx breeding populations. Recent modeling showing a strong correlation between resident lynx occupancy and winter temperature and snow conditions across the DPS range supports this hypothesis and suggests that warming will likely reduce the duration of the lynx's seasonal competitive advantage over other terrestrial predators of snowshoe hares. Other recent research showing warming-mediated northward contraction of snowshoe hare distribution (Diefenbach et al. 2016, entire; Sultaire et al. 2016a, entire; Sultaire et al. 2016b, pp. 900-904; Burt et al. 2017, entire) suggests the likelihood of future declines in the lynx's primary prey in lynx focal areas. Therefore, despite potential lag times between warming temperatures and changes to the boreal and subalpine spruce-fir-pine vegetative communities that currently support lynx populations, the loss of favorable temperatures is expected to result in reduced capacity of focal areas to support persistent breeding populations of lynx in the DPS range. However, uncertainty remains about whether, and if so, for how long, spruce-fir forests may retain snow conditions that exclude generalist hare predators (e.g., bobcats and coyotes) during winter and whether the future duration of that seasonal exclusion will remain sufficient to support persistent lynx presence. Nonetheless, even with recent documented climate warming, we have seen recent southward expansion of lynx distribution in Maine and New Hampshire, along the boundary of assumed favorable and unfavorable temperature regimes. This may suggest that high-quality habitat can moderate, delay, or offset expected effects of warming, or that lynx possess unexpected adaptive capacity, perhaps behavioral adaptations, that allow them to survive in marginal climatic conditions.

In summary, our analysis of a range of plausible future climate scenarios indicates that by mid-century, climate suitability is projected to decrease dramatically in Units 1 and 4, potentially precluding their ability to continue to support lynx populations into the latter half of this century. By the end of the century, our models project that lynx could be functionally extirpated (see definition in section 5.2) from these Units. Units 2, 3, 5 and 6 are projected generally to retain favorable climate conditions through mid-century but are projected to experience substantial decreases by the end of the century. Lynx may be functionally extirpated from all or most of these Units by 2100, with the possibility of low- to moderate-resiliency populations only under the least impactful climate scenario.

6.2 Future Scenarios

The future condition assessment is based on three future scenarios. The scenarios provide a form of an if-then assessment: If a specified future scenario occurs, then what do we expect the species' (or, in this case, the DPS's) condition to be in terms of resiliency, redundancy, representation, and overall viability? Specified scenarios are used to inform and bound our understanding of what can happen to a species in the future. In this case we evaluated the expected condition for three future scenarios that bound our understanding of what the plausible future conditions could be (Scenarios 1 and 3) and provide an intermediate view of another plausible future (Scenario 2). These scenarios vary in terms of the magnitude and severity of effects to the DPS's condition of important influencing factors.

As we did in the 2017 SSA, we focus on the factor for which the DPS was listed under the ESA (the inadequacy of regulatory mechanisms in Federal land management plans when the DPS was listed) and on the anthropogenic influences identified by the ILBT in the revised LCAS as having the potential to exert population-level impacts on lynx and lynx habitats (ILBT 2013, pp. 68–78). Those anthropogenic influences - climate change, vegetation management, wildland fire management, and habitat loss and fragmentation - are considered the most influential factors in the future viability of the lynx DPS. We also considered other factors currently not thought to exert population-level influence on DPS populations, but which could potentially do so in the future. These include disease, hybridization, competition, and incidental take. Here we provide a brief description of the state of influences in each scenario. The full description of each scenario is provided below (Table 9).

Scenario 1 provides an upper plausible limit to the future condition of the DPS. That is, Scenario 1 is expected to result – within the range of plausible scenarios – in the least expected risk to the DPS (see sections 6.3 and 6.4 below for detailed assessments of the future resiliency of each DPS population and the viability of the DPS in terms of the 3Rs). This scenario is characterized by intermediate greenhouse gas emissions, an increase in regulatory protections, minimal loss and fragmentation of habitats, improved connectivity to populations in Canada, and maintenance of the current magnitude of influence from diseases, hybridization, competition, and incidental mortality.

Scenario 3 provides a lower plausible limit to future condition of the species. That is, Scenario 3 is expected to result – within the range of plausible scenarios – in the most expected risk to the DPS. This scenario is characterized by very high greenhouse gas emissions, a decrease in regulatory protections, substantial loss and fragmentation of habitat, substantial decrease in connectivity to populations in Canada, and a substantial increase in the magnitude of influence from diseases, hybridization, competition, and incidental mortality.

Scenario 2 provides another look at the expected future condition of the species given a scenario that is within the bounds of scenarios 1 and 3 and results in an intermediate degree of risk to the DPS. This scenario is characterized by high greenhouse gas emissions, maintained regulatory protections, moderate loss and fragmentation of habitat, marginal decrease in connectivity to populations in Canada, and a moderate increase in the magnitude of influence from diseases, hybridization, competition, and incidental mortality.

Table 9. Summary and full descriptions of three plausible future scenarios used to evaluate potential future resiliency conditions of Canada lynx populations in the Contiguous U.S. distinct population segment.

Factors Influencing Resiliency	**Plausible Future Scenarios**		
	Scenario 1 Lower Impacts	Scenario 2 Moderate Impacts	Scenario 3 Higher Impacts
Summary	• **Intermediate** greenhouse gas emissions resulting in **least reduction** to lynx habitats and provision of needs (SSP2-4.5). • **Increase** in regulatory protections. • **Minimal (least)** habitat loss/ fragmentation; most impacts are **temporary**. • **Maintained or improved** connectivity to populations/ habitats in Canada. • Other factors **remain unchanged** and do not diminish resiliency (may affect individuals, but not populations): ○ **No increase** in or novel diseases ○ **No increase** in hybridization ○ **No increase** in competition ○ **No increase** in Incidental mortality or injury	• **High** greenhouse gas emissions resulting in **moderate reduction** to lynx habitats and p**rovision of** needs (SSP3-7.0). • Regulatory protections **maintained** at current levels. • **Moderate** habitat loss/ fragmentation; impacts may be **temporary or permanent**. • **Marginal decrease** in connectivity to populations/ habitats in Canada. • Other factors: **Moderate increase** in threats with population level resiliency impacts: ○ **Moderate increase** in impact of current and novel diseases ○ **Moderate increase** in hybridization ○ **Moderate increase** in competition ○ **Moderate increase** in anthropogenic sources of mortality and injury	• **Very-high** greenhouse gas emissions resulting in **substantial (and faster) reduction** to lynx habitat and provision of needs (SSP5-8.5). • **Decrease** in regulatory protections. • **Substantial (most)** habitat loss/ fragmentation; many impacts are **permanent**. • **Substantial decrease** in connectivity to populations/ habitats in Canada. • Other factors: **Substantial increase** in threats with DPS wide resiliency impacts: ○ **Substantial increase** in impact of current and novel diseases ○ **Substantial increase** in hybridization ○ **Substantial increase** in competition ○ **Substantial increase** in anthropogenic sources of mortality and injury.
Climate Warming	**SSP 2-4.5**: Intermediate greenhouse gas emissions with CO_2 emissions remaining at current levels to mid-century. Socioeconomic factors follow historic trends. <u>Warming of about 2.7°C (2.1 - 3.5°C) by 2100</u>. Emissions increase at lower end of plausible projections; slower gradual northward and upslope contraction of lynx habitats (snowy boreal spruce-fir forest types) as "climate envelope" shifts; hare populations and landscape-level densities remain highly capable of supporting extant lynx populations in the DPS; lower trajectory of increases in the size, frequency, and intensity of destructive wildfires and forest insect outbreaks; lower likelihood of increased competition from other terrestrial hare predators (esp. bobcats and coyotes).	**SSP 3-7.0**: High greenhouse gas emissions scenario with no additional climate policy and high non-CO_2 (aerosol) emissions. CO_2 emissions roughly double from current levels by 2100. <u>Warming of about 3.6°C (2.8-4.6°C) by 2100</u>. Emissions track recent trends and middle-of-the-road projections; moderate gradual northward and upslope contraction of lynx habitats (snowy boreal spruce-fir forest types) as "climate envelope" shifts; hare populations and landscape-level densities remain moderately capable of supporting extant lynx populations; moderate trajectory of increases in the size, frequency, and intensity of destructive wildfires and forest insect outbreaks; moderate likelihood of increased competition from other terrestrial hare predators (esp. bobcats and coyotes).	**SSP 5-8.5**: Very high greenhouse gas emissions scenario with no additional climate policy. CO_2 emissions roughly double from current levels by 2050. <u>Warming of about 4.4°C (3.3-5.7°C) by 2100</u>. Emissions increase at higher end of projections; faster gradual northward and upslope contraction of lynx habitats (snowy boreal spruce-fir forest types) as "climate envelope" shifts; hare populations and landscape-level densities become marginally capable or incapable of supporting extant lynx populations; higher trajectory of increases in the size, frequency, and intensity of destructive wildfires and forest insect outbreaks; higher likelihood of increased competition from other terrestrial hare predators (esp. bobcats and coyotes).

Regulatory Mechanisms	Federal – USFS and BLM mgmt. plans strengthen regulatory protections and increase priority on science-based conservation of lynx/ hare habitats and populations. Lynx conservation objectives strongly influence vegetation mgmt. (timber harvest, silviculture, fuels mgmt.), wildland fire policy and response, access (roadbuilding and maintenance), and motorized recreation mgmt. State – SWAPs (ME, NH, MN, MT, ID, WA, WY, CO, NM) increase focus on/ commitment to lynx habitat and population conservation. Lynx trapping prohibitions remain in place regardless of ESA listing status; regulations and guidance to avoid incidental/ accidental take of lynx during legal trapping/ hunting of other species are strengthened. State forest management agencies adopt, and encourage private timber operators to adopt, forestry practices with a greater focus on conservation of lynx and hare habitats. Tribal – Tribal wildlife management policies and programs increase focus on efforts to conserve lynx and hare habitats and populations.	Federal – USFS and BLM mgmt. plans maintain current regulatory protections and priority on science-based conservation of lynx/ hare habitats and populations. Lynx conservation objectives moderately influence vegetation mgmt. (timber harvest, silviculture, fuels mgmt.), wildland fire policy and response, access (roadbuilding and maintenance), and motorized recreation mgmt. State – SWAPs (ME, NH, MN, MT, ID, WA, WY, CO, NM) continue current focus on/ commitment to lynx habitat and population conservation. Lynx trapping prohibitions remain in place; regulations and guidance to avoid incidental/accidental take of lynx during legal trapping/ hunting of other species remain in place. State forest management agencies adopt, and encourage private timber operators to adopt, forestry practices with a continued focus on conservation of lynx and hare habitats. Tribal – Tribal wildlife management policies and programs maintain current focus on efforts to conserve lynx and hare habitats and populations.	Federal – USFS and BLM mgmt. plans reduce regulatory protections and priority on conservation of lynx/ hare habitats and populations. Lynx conservation objectives minimally influence vegetation mgmt. (timber harvest, silviculture, fuels mgmt.), wildland fire policy and response, access (roadbuilding and maintenance), and motorized recreation mgmt. State – SWAPs (ME, NH, MN, MT, ID, WA, WY, CO, NM) decrease focus on/ commitment to lynx habitat/ population conservation. Lynx trapping prohibitions and regulations to avoid incidental take during legal trapping/ hunting of other species are rescinded. State forest management agencies adopt, and encourage private timber operators to adopt, forestry practices with a reduced focus on conservation of lynx and hare habitats. Tribal – Tribal wildlife management policies and programs decrease focus on efforts to conserve lynx and hare habitats and populations.
Vegetation Management	As guided by federal, state, and tribal regulatory mechanisms described above, timber harvest (volume and spatio-temporal extent), silviculture, and fuels mgmt. on federal, state, tribal and private commercial timber lands are strongly influenced by increased lynx habitat and population conservation objectives. These activities are undertaken and implemented in a manner intended, based on best available science, to increase and/or restore (within the historical natural range of variation) the amount and distribution of high-quality habitat capable of supporting reproductively successful resident lynx populations.	As guided by federal, state, and tribal regulatory mechanisms described above, timber harvest (volume and spatio-temporal extent), silviculture, and fuels mgmt. on federal, state, tribal and private commercial timber lands are moderately influenced by lynx habitat and population conservation objectives. These activities are undertaken and implemented in a manner intended, based on best available science, to maintain an amount and distribution of high-quality habitat capable of supporting extant reproductively successful resident lynx populations.	As guided by federal, state, and tribal regulatory mechanisms described above, timber harvest (volume and spatio-temporal extent), silviculture, and fuels mgmt. on federal, state, tribal and private commercial timber lands are minimally influenced by lynx habitat and population conservation objectives. These activities are undertaken and implemented with little or no consideration of maintaining, increasing, or restoring the amount and distribution of high-quality habitat capable of supporting reproductively successful resident lynx populations.

Wildland Fire Management	As guided by federal, state, and tribal regulatory mechanisms described above, wildland fire policy and response and fuels mgmt./ reduction practices are strongly influenced by lynx habitat and population conservation considerations. Adverse impacts of these activities in important lynx habitats are minimized. Proactive forest resiliency efforts are developed and implemented to (1) reduce the likelihood of catastrophic wildfire in important lynx habitats and (2) restore or maintain spatio-temporal mosaics of mature multi-storied and dense advanced regenerating forest stands to provide year-round high-quality hare and lynx foraging habitats.	As guided by federal, state, and tribal regulatory mechanisms described above, wildland fire policy and response and fuels mgmt./ reduction practices are moderately influenced by lynx habitat and population conservation considerations. Adverse impacts of these activities in important lynx habitats are considered. Forest mgmt. and fire response policies and guidance consider opportunities to (1) reduce the likelihood of catastrophic wildfire in important lynx habitats and (2) restore or maintain spatio-temporal mosaics of mature multi-storied and dense advanced regenerating forest stands to provide year-round high-quality hare and lynx foraging habitats.	As guided by federal, state, and tribal regulatory mechanisms described above, wildland fire policy and response and fuels mgmt./ reduction practices are minimally influenced by lynx habitat and population conservation considerations. Adverse impacts of these activities in important lynx habitats are not considered. Forest mgmt. and fire response policies and guidance do not consider opportunities to (1) reduce the likelihood of catastrophic wildfire in important lynx habitats or (2) restore or maintain spatio-temporal mosaics of mature multi-storied and dense advanced regenerating forest stands to provide year-round high-quality hare and lynx foraging habitats.
Habitat Loss, Fragmentation, and Connectivity	Permanent loss and fragmentation of high-quality lynx/hare habitats from anthropogenic activities (transportation, energy, recreation development/ infrastructure; commercial/ real estate development/building) are minimal. Temporary habitat degradation and fragmentation from anthropogenic (timber harvest, silviculture, forest and fuels management, wildfire response) and natural factors (wildfire, forest insect outbreaks, wind and ice storms) approximate the natural range of variability in historical disturbance regimes and maintain a mosaic of forest stand ages and structures capable of providing relatively high landscape-level hare densities and, therefore, very likely to sustain extant lynx populations in the DPS. Connectivity between DPS and Canadian habitats is maintained or improved; cross-border landscapes are highly permeable to dispersing lynx.	Permanent loss and fragmentation of high-quality lynx/hare habitats from anthropogenic activities (transportation, energy, recreation development/ infrastructure; commercial/ real estate development/building) are moderate. Temporary habitat degradation and fragmentation from anthropogenic (timber harvest, silviculture, forest and fuels management, wildfire response) and natural factors (wildfire, forest insect outbreaks, wind and ice storms) may exceed the natural range of variability in historical disturbance regimes but maintain a mosaic of forest stand ages and structures capable of providing moderately high landscape-level hare densities and, therefore, moderately likely to sustain extant lynx populations in the DPS. Connectivity between DPS and Canadian habitats is maintained or decreases marginally; cross-border landscapes remain largely to moderately permeable to dispersing lynx.	Permanent loss and fragmentation of high-quality lynx/hare habitats from anthropogenic activities (transportation, energy, recreation development/ infrastructure; commercial/ real estate development/building) are substantial. Temporary habitat degradation and fragmentation from anthropogenic (timber harvest, silviculture, forest and fuels management, wildfire response) and natural factors (wildfire, forest insect outbreaks, wind and ice storms) exceed the natural range of variability in historical disturbance regimes and fail to maintain a mosaic of forest stand ages and structures capable of providing landscape-level hare densities necessary to sustain extant lynx populations in the DPS. Connectivity between DPS and Canadian habitats decreases substantially; cross-border landscapes become marginally permeable or impermeable to dispersing lynx.

Other Factors (Disease, Hybridization, Competition, Incidental Take)	Diseases among lynx in the DPS (Lungworm [Maine], Plague [Colorado], Toxoplasma gondii, Gammaherpesvirus 1 [LcaGHV1]) remain at levels that may affect individual lynx but do not reduce resiliency of DPS populations. COVID-19 remains undetected in DPS lynx populations. Rabbit Hemorrhagic Disease [RHDV2]) remains undetected in wild snowshoe hare populations within the range of DPS lynx populations. Rates of hybridization between lynx and bobcats in Maine and Minnesota **remain low**; hybridization remains undetected in western DPS populations. Hybridization does not diminish resiliency of any DPS populations. Competition between resident lynx and other terrestrial predators of hares (esp. bobcats and coyotes) remains at current (if unknown) levels, preserving the lynx's seasonal competitive advantage in DPS population areas and supporting the continued resiliency and persistence of extant resident breeding populations. Incidental lynx mortality and injury related to hunting and trapping of other species and vehicle collisions remain at levels that may affect individual lynx but do not reduce resiliency of DPS populations.	Diseases among lynx in the DPS (Lungworm [Maine], Plague [Colorado], Toxoplasma gondii, Gammaherpesvirus 1 [LcaGHV1]) increase to levels that may moderately reduce resiliency of one or more DPS populations. COVID-19 is detected in one or more DPS lynx populations. Rabbit Hemorrhagic Disease [RHDV2]) is detected in one or more wild snowshoe hare populations within the range of DPS lynx populations, resulting in moderate hare population declines. Rates of hybridization between lynx and bobcats in Maine and Minnesota increase **moderately**; hybridization is detected at low levels in one or more western DPS populations. Hybridization moderately diminishes resiliency of one or more DPS populations. Competition between resident lynx and other terrestrial predators of hares (esp. bobcats and coyotes) increases moderately from current levels, reducing the lynx's seasonal competitive advantage in one or more DPS population areas and moderately reducing the resiliency and likelihood of persistence of one or more extant resident breeding populations. Incidental lynx mortality and injury related to hunting and trapping of other species and vehicle collisions increase moderately to levels that may reduce resiliency of one or more DPS populations.	Diseases among lynx in the DPS (Lungworm [Maine], Plague [Colorado], Toxoplasma gondii, Gammaherpesvirus 1 [LcaGHV1], COVID-19) increase to levels that substantially reduce resiliency of one or more DPS populations. COVID-19 is detected in all DPS lynx populations. Rabbit Hemorrhagic Disease [RHDV2]) is detected in all wild snowshoe hare populations within the range of DPS lynx populations, resulting in substantial hare population declines. Rates of hybridization between lynx and bobcats in Maine and Minnesota increase **substantially**; hybridization is detected at moderate levels in all western DPS populations. Hybridization substantially diminishes resiliency of one or more DPS populations. Competition between resident lynx and other terrestrial predators of hares (esp. bobcats and coyotes) increases substantially from current levels, reducing the lynx's seasonal competitive advantage in all DPS population areas and substantially reducing the resiliency and likelihood of persistence of all extant resident breeding populations. Incidental lynx mortality and injury related to hunting and trapping of other species and vehicle collisions increase substantially to levels that reduce resiliency of one or more DPS populations.

6.3 Future Resiliency

We used the same resiliency variables and categories described above for current resiliency (section 5.2, Table 4) to inform our understanding of the possible future resiliency of DPS populations and, thus, the future viability of the DPS in terms of redundancy, and representation. We projected the resiliency of each DPS population under each of the three future scenarios described above (Table 9) at four future time periods (2021-2040; 2041-2060; 2061-2080; and 2081-2100). As with the assessment of current resiliency, the condition for each of the four variables was scored and combined as follows: High = 3; Moderate = 2; Low = 1; Not Resilient/Functionally Extirpated = 0. Then we calculated the mean of the four variable scores to designate the overall unit resiliency, with Units scoring 2.5-3 considered to be highly resilient; those scoring 1.75-2.25 to be moderately resilient; those scoring 0.75-1.5 to have low resiliency; and those scoring 0-0.5 to be not resilient/functionally extirpated. Additionally, if the estimated population size was "Not Resilient/Functionally Extirpated", the overall unit resiliency also received that categorical designation. The outcomes of the future resiliency assessment are summarized in Table 10 and mapped by scenario at mid- and end-of-century in Figure 16.

Resiliency scores and maps for each DPS population under each future scenario and timestep are in Appendix 2.

Table 90. Current and plausible future resiliency of Canada lynx populations in six SSA Units in the contiguous United States under three future scenarios (Green = High resiliency; Yellow = Moderate; Pink = Low; Brown = Not resilient/functionally extirpated).

Unit	Current Resiliency	Future Scenario 1				Future Scenario 2				Future Scenario 3			
		2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100
1	High												
2	High												
3	High												
4	Moderate												
5	Extirpated												
6	Moderate												

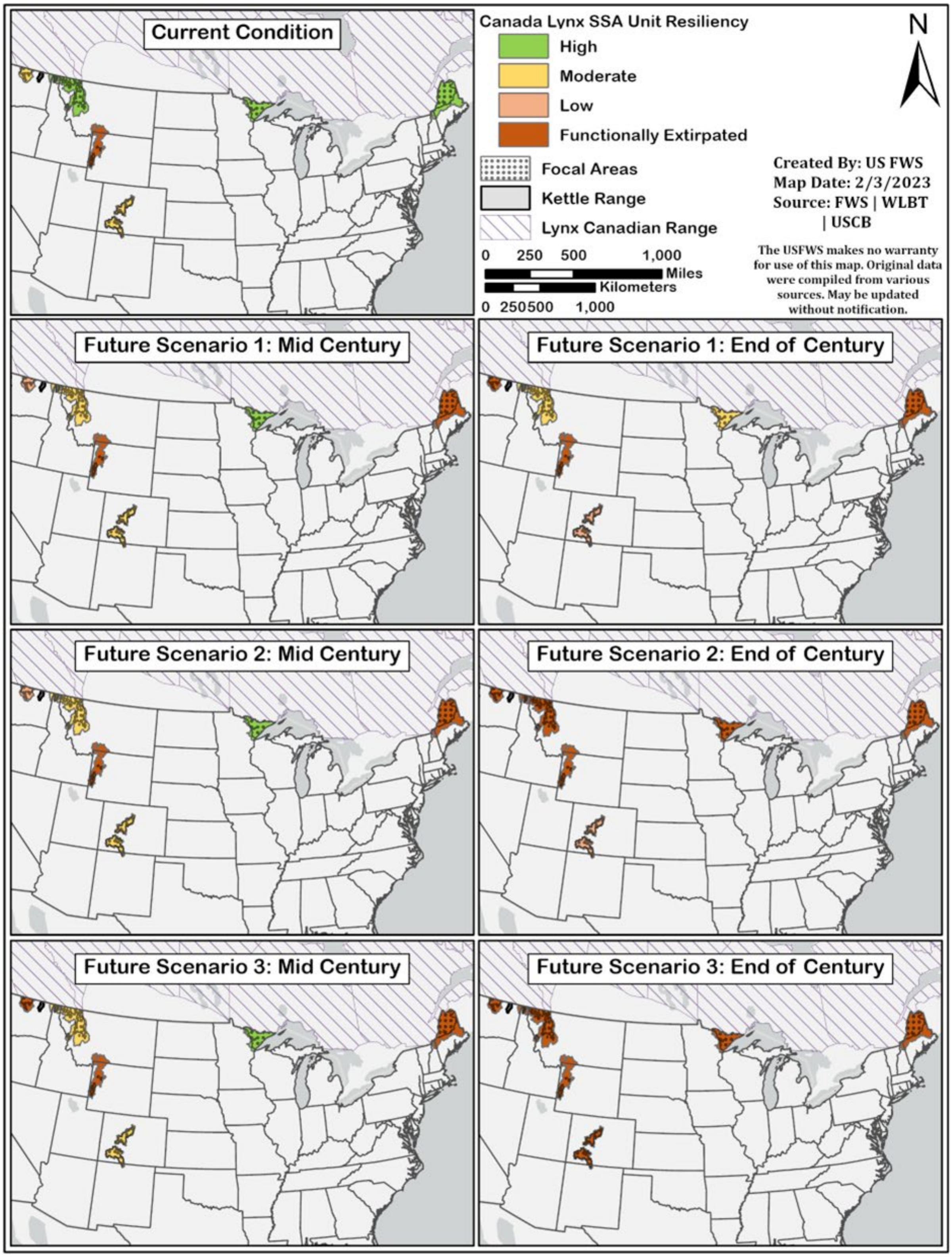

Figure 16. Current and projected (mid-century and end-of-century) resiliency of Canada lynx populations in the contiguous United States under three future scenarios.

As illustrated above in the climate vulnerability assessment (section 6.1), we expect continued climate warming will result in substantial loss of the temperature conditions that currently prevail in the focal areas that support resident breeding lynx populations in the DPS. This warming will likely result in reduced habitat quantity and quality – first as the loss of snow conditions favorable for lynx and snowshoe hares then, after a lag time of uncertain duration, as the loss of the spruce-fir-pine forest types that support lynx and hare populations. Favorable snow and forest conditions are both expected to contract northward and to higher elevations but over different time intervals, with both representing decreases in the amount of high-quality habitat capable of sustaining resident lynx over time. As high-quality habitat recedes northward, connectivity between DPS populations and the core of the species' range will also decrease. As habitat amount and quality and population connectivity decline, we expect DPS lynx populations will also decline and suffer reduced resiliency. Therefore, as summarized in Table 11, we expect the loss of highly and moderately resilient DPS populations and a trend toward low resiliency and functional extirpation through the end of this century.

Table 11. Projected numbers of Canada lynx populations in each future resiliency condition in each 20-year time period through the end of this century. Uncertainty across scenarios is expressed by the range of values in each cell.

Time Period	**Number of DPS Populations in Each Resiliency Condition**			
	High	Moderate	Low	Not Resilient/ Functionally Extirpated
Current	3	2	0	1
2021-2040	2	2-3	0-1	1
2041-2060	1	2	0-1	2-3
2061-2080	0-1	0-3	0-2	3-4
2081-2100	0	0-2	0-1	3-6

The timing of decreases in resiliency varies across DPS populations, with resiliency declining soonest in the Northeast and Northern Cascades and slower declines in the Midwest and Northern and Southern Rockies. Table 12 summarizes expected future resiliency for lynx populations in each SSA Unit focal area.

Table 1210. Summary of expected future resiliency of Canada lynx populations in the contiguous Unites States distinct population segment.

DPS Population	Expected Future Resiliency Condition
1-Northeast	Regardless of scenario, not resilient/functionally extirpated by mid-century.
2-Midwest	Regardless of scenario, remains highly resilient at mid-century; declines to moderately resilient at end-of-century under scenario 1 and to not resilient/ functionally extirpated under scenarios 2 and 3.
3-Northern Rockies	Regardless of scenario, declines from highly resilient to moderately resilient at mid-century; declines to moderately resilient at end-of-century under scenario 1 and to not resilient/functionally extirpated under scenarios 2 and 3.
4-Northern Cascades	Declines from moderate to low resiliency at mid-century under scenarios 1 and 2, not resilient/functionally extirpated under scenario 3; regardless of scenario, reduced to not resilient/functionally extirpated by end-of-century.
5- GYA	Regardless of scenario, remains not resilient/functionally extirpated at mid-century and end-of-century.
6-Southern Rockies	Regardless of scenario, remains moderately resilient at mid-century; at end-of-century, declines to low resiliency under scenarios 1 and 2, to not resilient/ functionally extirpated under scenario 3

In summary, the resiliency of lynx populations in all Units is expected to decline in the future, with a better case (Scenario 1) expectation of one unit with high resiliency, two with moderate resiliency, one with low resiliency, and two functionally extirpated by mid-century. At the end of this century under Scenario 1, the DPS could retain two moderately resilient populations, one with low resiliency, and three that are functionally extirpated. Under the highest impact scenario (3), the DPS is projected to have one highly resilient population, two with moderate resiliency, and three that are functionally extirpated at mid-century. At the end of this century under Scenario 3, populations in all six Units are projected to be functionally extirpated.

6.4 Future Redundancy

With the loss of population resiliency and trend toward functional extirpation described above, we expect redundancy to decline along with the current degree of risk reduction it provides to the DPS. By mid-century, we expect the functional loss of one or two of the current five populations - a 20–40 percent loss of redundancy. At the end of this century, we project the loss of three to five populations, representing a 60–100 percent loss of redundancy. Even if some populations persist, they are likely to be smaller and to occupy smaller geographical areas, making them more vulnerable to catastrophic events and reducing their contribution to DPS viability.

6.5 Future Representation

As with future redundancy, we expect diminished future representation as DPS populations are lost to (extirpated) or reduced by climate warming and associated impacts. With decreased resiliency and smaller expected populations, the potential for evolutionary adaptation to changing ecosystem conditions is expected to decline as well. As described above in section 5.2, lynx likely have very limited capacity to adapt *in situ* to projected changes in habitats, and few or no vacant suitable areas in the DPS range to which they might move. Our assessment indicates that populations are likely to be lost first on the eastern and western extremes of the DPS's current broad distribution. Although lynx across the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation types and structure, snow conditions, and the abundance of a single prey species, subtle differences in forest communities and local conditions may infer contributions to current representation that would be lost with range contraction. Additionally, while there is no known adaptive genetic differentiation between DPS populations, genetic bottlenecks are limited by dispersal between populations. With expected future habitat loss and fragmentation, smaller lynx populations, and reduced connectivity to the core of the species' range, the risk of genetic isolation, inbreeding depression, and genetic drift also increases. In summary, given the limited ability for lynx to shift in space within the range of the DPS or adapt to changing conditions, and the impact of fragmentation and reduced abundance, the degree of representation is expected to decline and exacerbate the risks to the DPS resulting from declining resiliency and redundancy.

6.6 Summary of Future Viability

Our assessment above suggests gradual but substantial, and in some places rapid, deterioration of the climate and habitat conditions that currently support resident lynx populations in the DPS. Given the species' strong association with cold, snowy, boreal habitats and its expected limited capacity to adapt to projected changes, we expect projected warming will result in decreased resiliency of DPS populations leading ultimately to loss of redundancy and representation and, therefore, loss of DPS viability. We expect the resiliency of all DPS populations to decline in the future, with functional extirpation of at least one current population possible by mid-century and several to all extant populations functionally extirpated by the end of this century. Even under the least impactful climate and future conditions scenarios, our assessment indicates there may be no highly resilient populations remaining at the end of the century. With the expected loss of some DPS populations, redundancy and representation within the DPS are also expected to decline, reducing the DPS's viability. We expect DPS viability to be substantially diminished by mid-century, and our analysis suggest little chance that a viable DPS will persist through the end of the century. These results are contingent upon the uncertainties and assumptions of our analysis, discussed above in section 1.3.

Chapter 7: Synthesis

Lynx populations in the DPS occur at the southern limits of the species' distribution, where boreal forests become transitional, and habitats become naturally marginal relative to the core of the species' range in Canada and Alaska. DPS populations are generally smaller and more isolated and, thus, more at risk of stochastic demographic and genetic impacts and vulnerable to declines in habitat quality and prey abundance. Further, several centuries of timber harvest and fire suppression have altered the natural patterns of forest disturbance and regeneration with which lynx evolved. The net effects of these changes on DPS populations are uncertain, with evidence that timber harvest and subsequent forest regeneration has benefitted lynx in Maine and concern that fire suppression in the west has created unnaturally large and contiguous blocks of dense mature forest that may have benefitted lynx, but which are now at increased risk of catastrophic fire in a warming climate (Parks and Abatzoglou 2020, entire; Hagmann et al. 2021, entire; Higuera et al. 2021, entire; Lyons et al. 2023, entire).

Nonetheless, our evaluation of the available reliable information does not indicate large-scale declines in lynx numbers or substantial contraction in the distribution of resident breeding populations in the DPS from historical to recent times (USFWS 2021, *unpublished report*). There are currently more resident lynx populations and individuals in the contiguous U.S. than were known or suspected at the time the DPS was listed in 2000 and, in some places, more lynx than likely occurred historically under natural patterns of forest disturbance and lynx dispersal. Although we continue to lack statistically robust estimates of populations sizes for all SSA Units, it seems clear that lynx are more abundant in the Northeast (Unit 1) now than historically due to the abundance and broad distribution of high-quality regenerating forest stands after large-scale timber harvest in the 1970s–80s following an extensive forest insect outbreak. It was unclear when the DPS was listed whether a resident population occurred in the Midwest (Unit 2), but research and monitoring have documented a persistent breeding population in the Arrowhead Region of northeastern Minnesota. In Colorado, where verified occurrence records do not strongly support the historical presence of a resident population for at least the past century, the releases of Canadian and Alaskan lynx have resulted in the establishment of a resident breeding population. Available information does not suggest that resident lynx were substantially more numerous or more broadly distributed historically in Unit 3 than they are now. Verified records for Unit 5 are ambiguous as to whether this unit historically supported a small resident population or if lynx residency and reproduction were and are naturally ephemeral there. Among DPS populations, only that in Washington (Unit 4) has likely declined since listing – the result of large wildfires in lynx habitat that have reduced carrying capacity in the Northern Cascades (Lyons et al. 2023, entire), perhaps temporarily.

In this addendum and the 2017 SSA report, we explored the potential impacts to DPS lynx populations of regulatory mechanisms, climate change, vegetation management, wildland fire management, and habitat loss/ fragmentation - the stressors with the greatest potential to have population-level consequences within the DPS. We also considered several factors that do not currently exert population-level influences on DPS populations, but which could become important in the future (disease, competition between lynx and other terrestrial predators of snowshoe hares, and incidental take of lynx). The stressor of greatest concern for the long-term resiliency of lynx populations within the DPS and thus the viability of the DPS, is continued climate warming and its potential detrimental effects to the cold temperatures, snow conditions, and forest structural characteristics to which lynx are clearly adapted and which are necessary to support populations into the future.

Of the five SSA Units with current breeding populations, three currently have high resiliency and two have moderate resiliency according to our analysis (Table 13). The low frequency and limited magnitude of widespread mortality events relative to the size and distribution of these resilient Units provide redundancy to the DPS that limits risk and increases viability. In terms of representation, lynx currently occupy 5 diverse ecosystems across the DPS range; however, lynx appear to be limited in their adaptive capacity by high levels of habitat and diet specialization. Relative to a fully viable DPS with highly resilient and redundant Units that provide representation promoting a capacity to adapt, the current state of the DPS indicates that half of the geographically diverse Units are at a high level of resiliency, two are at a moderate level of resiliency, and that overall DPS viability is constrained by the species' limited capacity to adapt to expected changes in climate and habitat conditions.

Table 113. Current and plausible future resiliency of Canada lynx populations in six SSA Units in the contiguous United States under three future scenarios (Green = High resiliency; Yellow = Moderate; Pink = Low; Brown = Not resilient/functionally extirpated).

Unit	Current Resiliency	Future Scenario 1				Future Scenario 2				Future Scenario 3			
		2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100	2021-2040	2041-2060	2061-2080	2081-2100
1	High												
2	High												
3	High												
4	Moderate												
5	Extirpated												
6	Moderate												

Characterizing the future viability of the lynx DPS is complicated by uncertainty around the magnitude and rate of climate change, the resulting effects of those changes on the ecosystems important to lynx, the interplay of those changes with other potential stressors affecting lynx, and a multitude of other interrelated variables that are beyond our ability to precisely predict. Given that, we attempted to project lynx viability into the future under three plausible future scenarios that capture upper and lower bounds of a range of potential impacts over four timesteps out to 2100. By doing this, we have attempted to capture a sufficient risk profile for lynx that allows us to characterize the future viability of the DPS. In all plausible future scenarios considered and across all timesteps, we project at least some reduction in the resiliency of lynx populations compared to the current condition (Table 14). The projected reduction in population resiliency becomes more severe and ubiquitous across the DPS range with increasing impacts within the scenarios and increasing time into the future. Along with reduced population resiliency, and in some cases projected extirpation, we expect a resulting reduction in redundancy and representation within the lynx DPS and a commensurate reduction in DPS viability.

Table 14. Summary of current and future viability in terms of resiliency, redundancy, and representation for the six lynx SSA Units in the Canada lynx distinct population segment.

VIABILITY: CURRENT AND FUTURE 3Rs							
Conservation Principle	***Current Condition***	***Future Scenario 1 Lower Impacts***		***Future Scenario 2 Moderate Impacts***		***Future Scenario 3 Higher Impacts***	
		2041-2060	***2081-2100***	***2041-2060***	***2081-2100***	***2041-2060***	***2081-2100***
Resiliency	3 High 2 Moderate 1 Extirpated	1 High 2 Moderate 1 Low 2 Extirpated	2 Moderate 1 Low 3 Extirpated	1 High 2 Moderate 1 Low 2 Extirpated	1 Low 5 Extirpated	1 High 2 Moderate 3 Extirpated	6 Extirpated
Redundancy	5 ecosystems, as distributed	4 ecosystems, as distributed	3 ecosystems, as distributed	4 ecosystems, as distributed	Very low redundancy	3 ecosystems, as distributed	None
Representation	Ecological diversity across 5 ecosystems	Ecological diversity across 4 ecosystems	Ecological diversity across 3 ecosystems	Ecological diversity across 4 ecosystems	Very low ecological diversity	Ecological diversity across 3 ecosystems	None

Clearly, the potential loss of resiliency among DPS populations, driven largely by projected climate warming and its anticipated effects to the amount, quality, and carrying-capacity of habitat for resident lynx, paints a discouraging picture of potential DPS viability even under the lowest impact scenario in our assessment. Loss of resiliency among DPS populations in this century seems likely to result in substantial loss of redundancy and representation across the entire DPS. If our assumptions regarding warming, its direct and indirect effects to lynx habitats and populations, and the species' limited capacity to adapt to those changes are reasonable, the viability of the DPS is projected to decrease across all scenarios through the latter half of this century.

The Canada lynx, as a species (rather than just the DPS), remains widespread and abundant over most of its range and has been designated a "species of least concern" in accordance with the IUCN Red List of Threatened Species (Vashon 2015, entire). Overall, even in a warming climate, the species is not considered to be at risk of extinction, despite uncertainty about how climate change might affect northern lynx and hare populations and cycles and those of other hare predators. In fact, some climate researchers predict a net expansion of the species' distribution in a warming climate, with projected gains on the northern edge of the range exceeding projected losses on the southern periphery (Deb et al. 2020, pp. 444-448). Regardless, these authors and the lynx experts we consulted agree, as does our assessment in this addendum, that substantial climate-mediated northward contraction of lynx range and extirpations of populations on the southern edge of the species range, which includes the entire DPS range, are expected through the end of this century.

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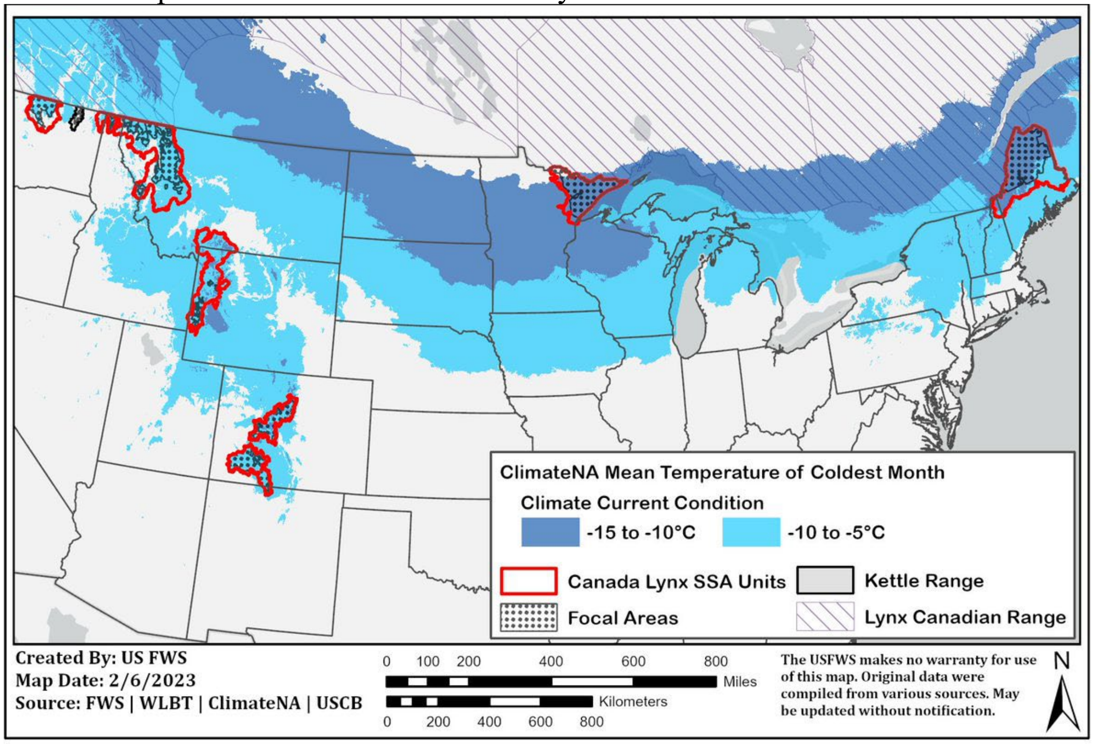
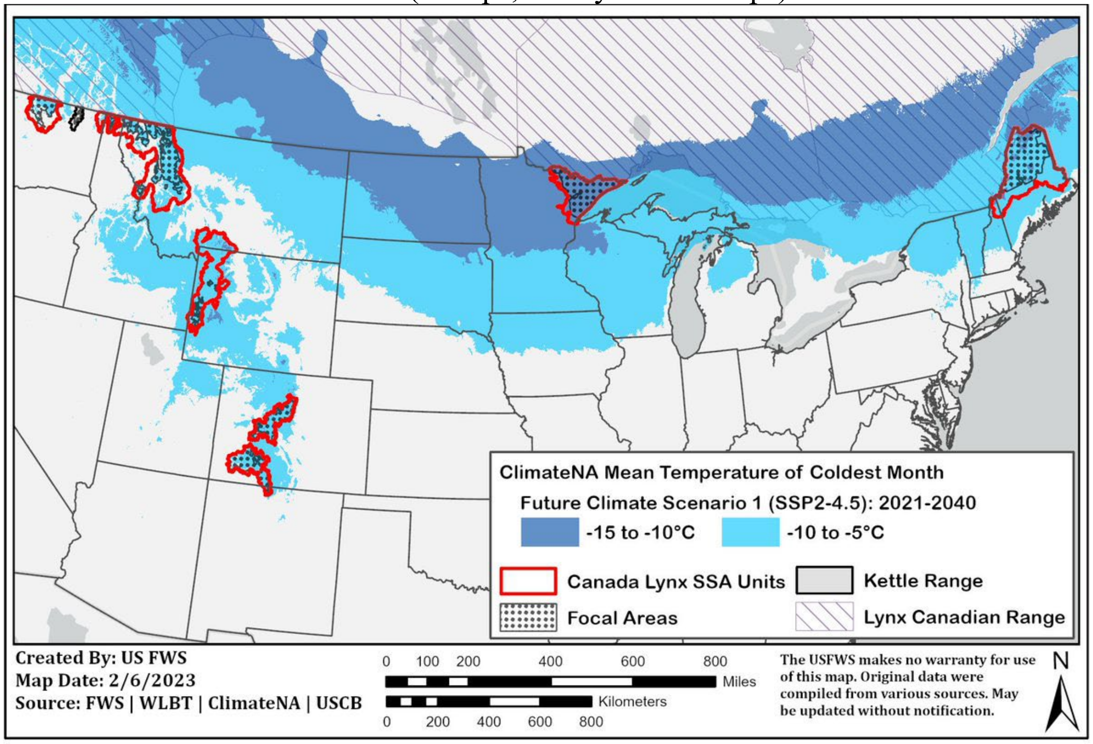
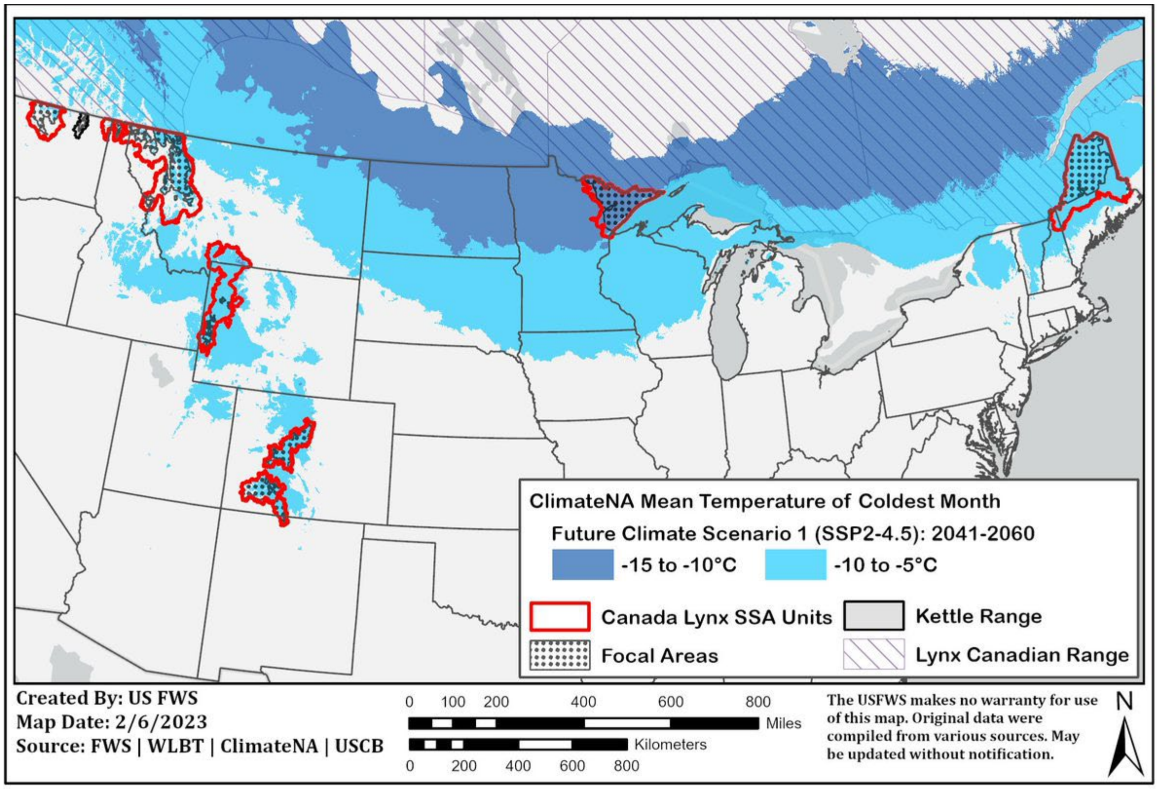
Appendix 1 - Temperature Envelope Maps for Three Climate Scenarios and Four 20-year Timesteps through 2100

Current temperature conditions in Canada lynx SSA Units and Focal Areas.



Climate Scenario 1 – SSP2-4.5 (4 maps; 4 20-year timesteps).




ClimateNA Mean Temperature of Coldest Month
Future Climate Scenario 1 (SSP2-4.5): 2041-2060
-15 to -10°C
-10 to -5°C
Canada Lynx SSA Units
Kettle Range
Focal Areas
Lynx Canadian Range
Created By: US FWS
Map Date: 2/6/2023
Source: FWS | WLBT | ClimateNA | USCB
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Miles
Kilometers
0 200 400 600 800
The USFWS makes no warranty for use of this map. Original data were compiled from various sources. May be updated without notification.
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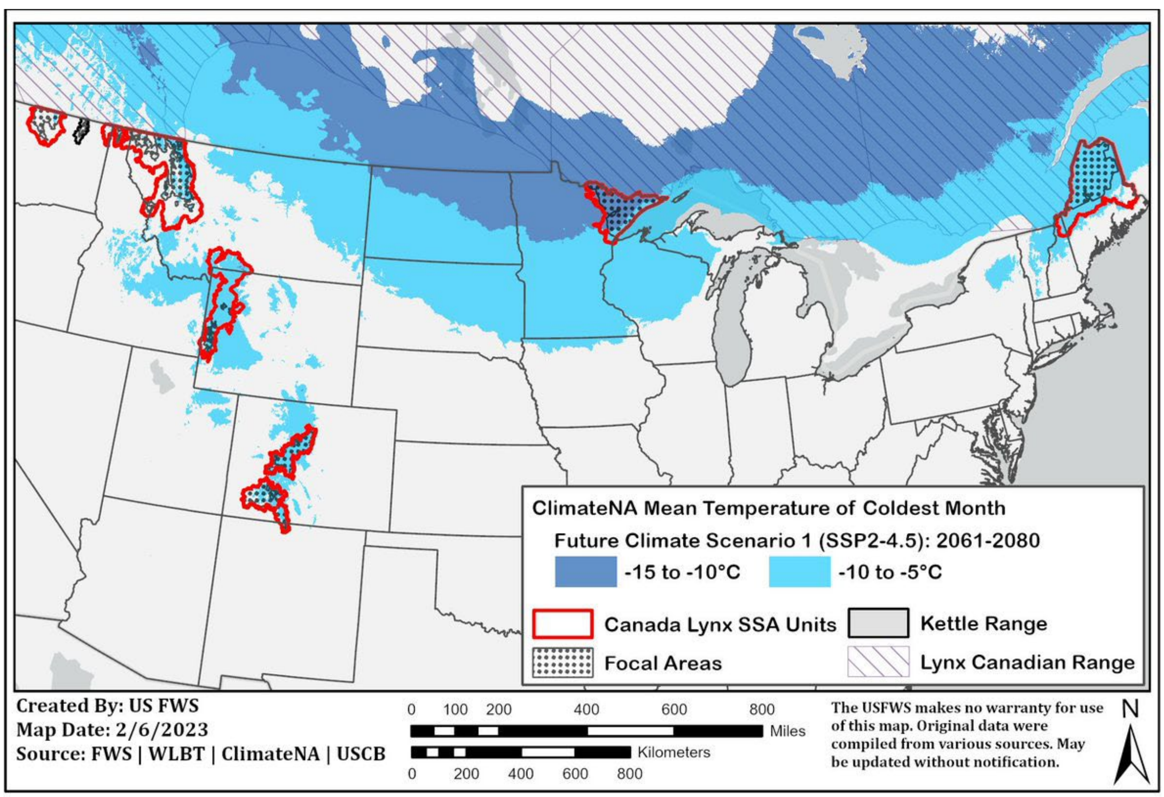
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Future Climate Scenario 1 (SSP2-4.5): 2061-2080
-15 to -10°C
-10 to -5°C
Canada Lynx SSA Units
Kettle Range
Focal Areas
Lynx Canadian Range
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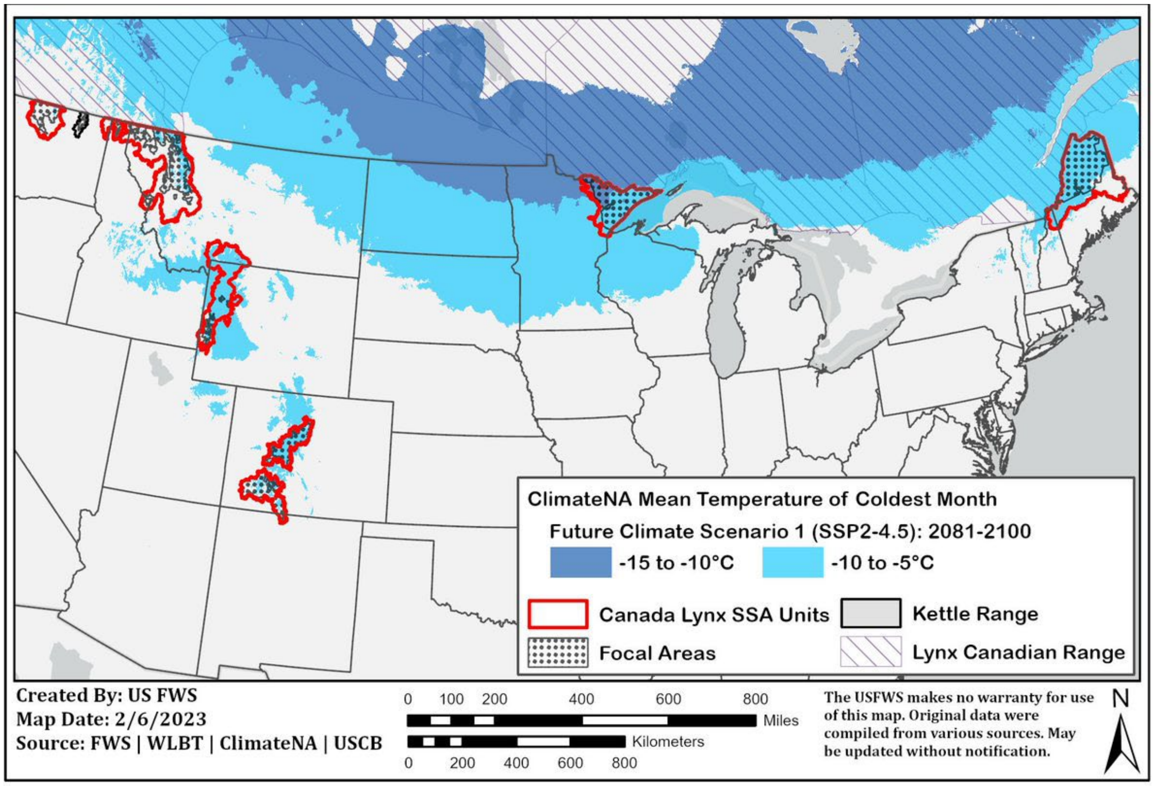

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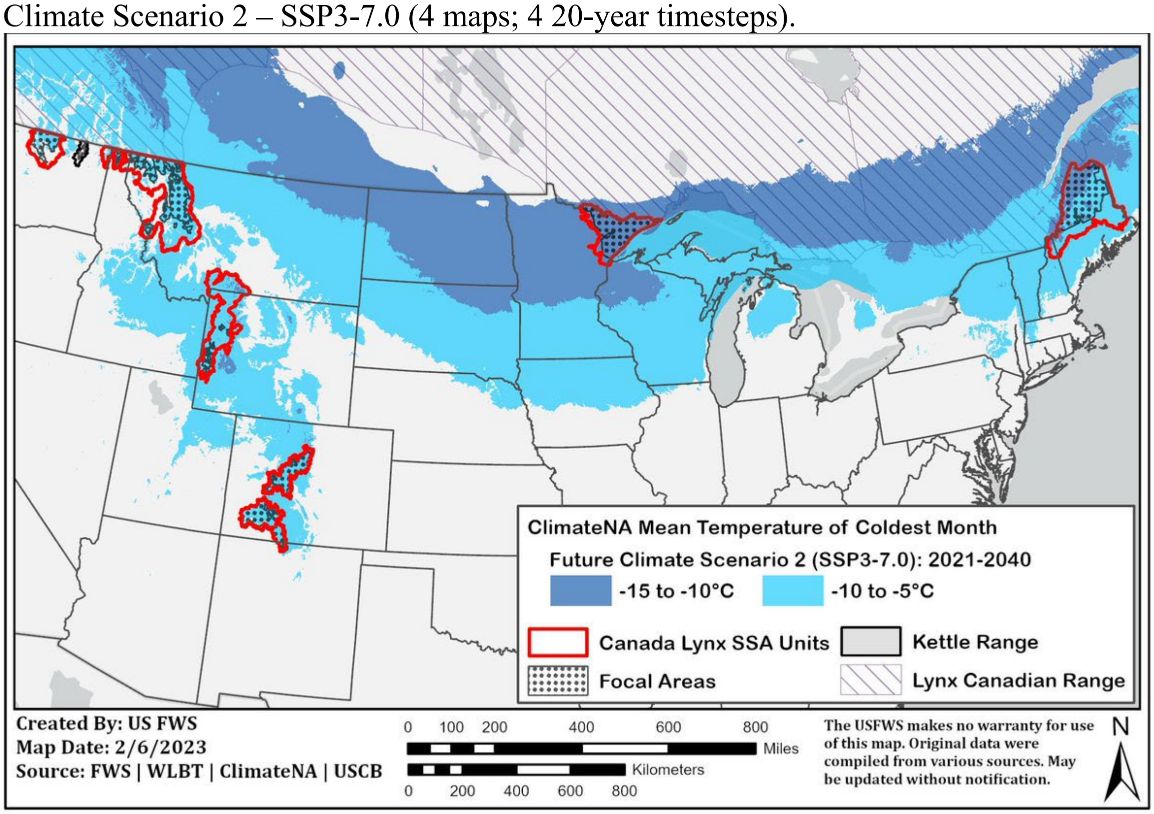

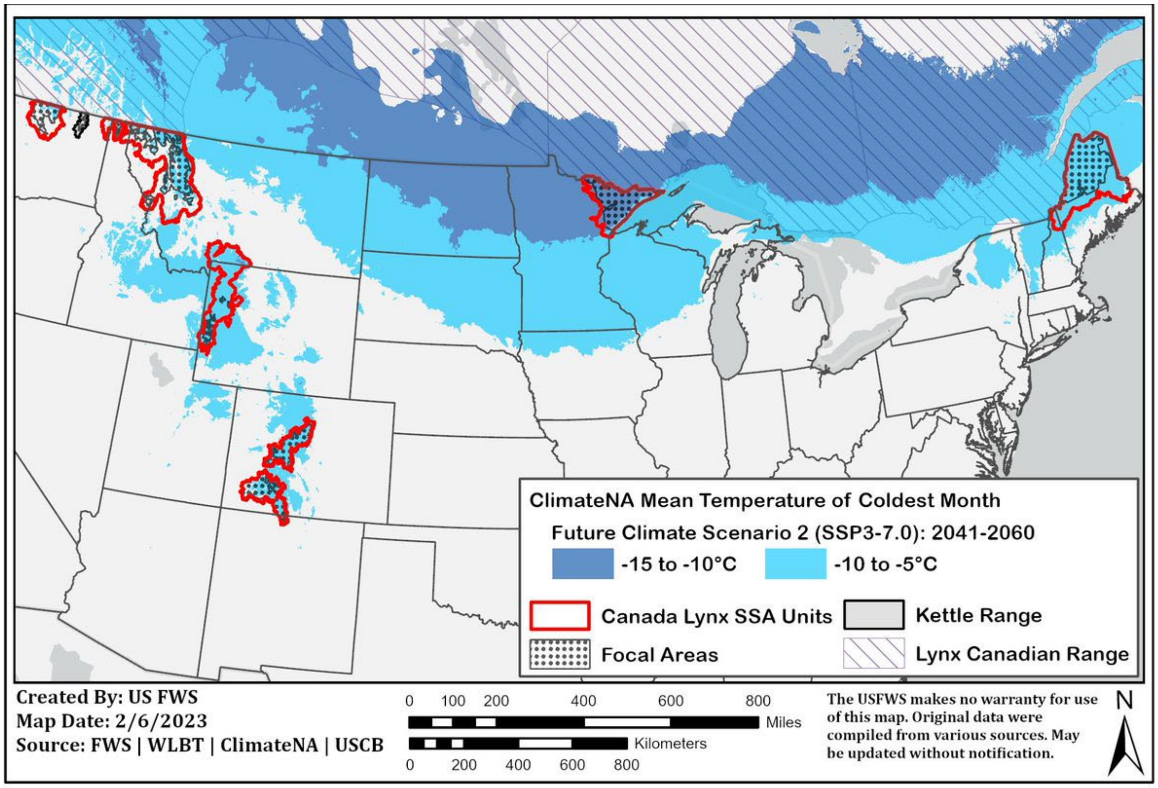
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Future Climate Scenario 2 (SSP3-7.0): 2041-2060
-15 to -10°C
-10 to -5°C
Canada Lynx SSA Units
Kettle Range
Focal Areas
Lynx Canadian Range
Created By: US FWS
Map Date: 2/6/2023
Source: FWS | WLBT | ClimateNA | USCB
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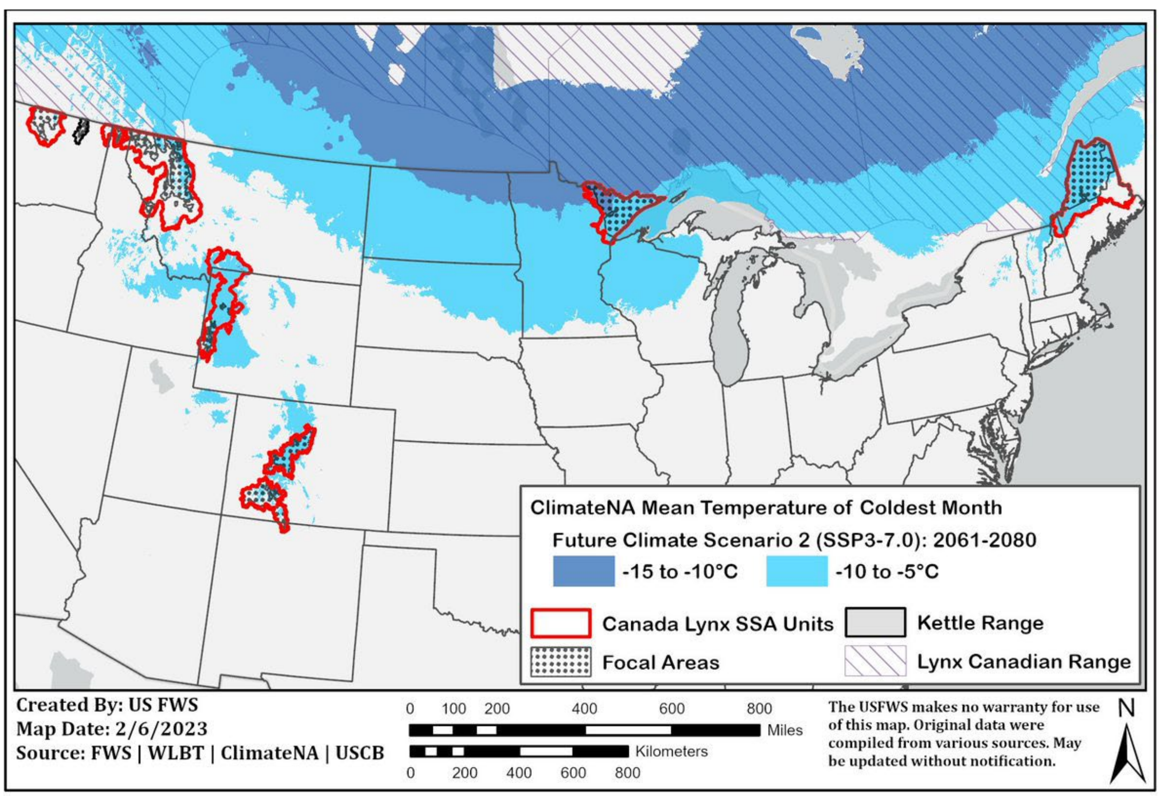
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Future Climate Scenario 2 (SSP3-7.0): 2061-2080
-15 to -10°C
-10 to -5°C
Canada Lynx SSA Units
Kettle Range
Focal Areas
Lynx Canadian Range
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The USFWS makes no warranty for use of this map. Original data were compiled from various sources. May be updated without notification.
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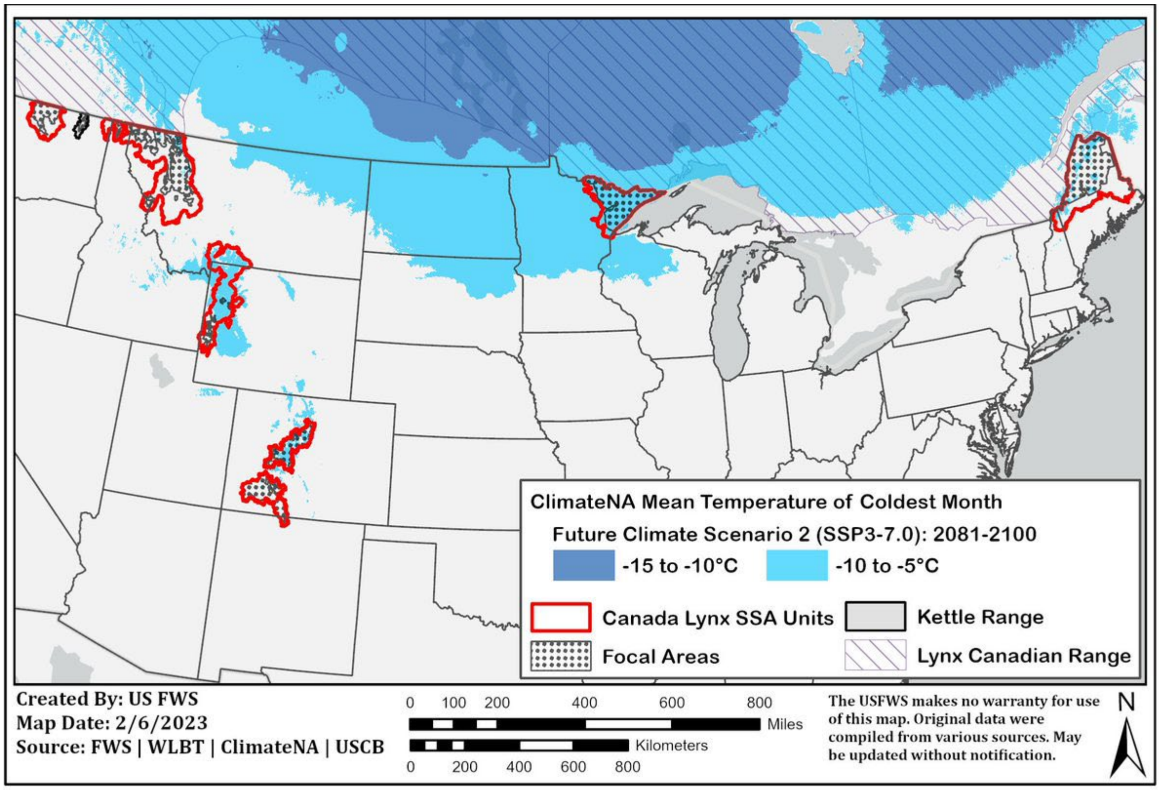
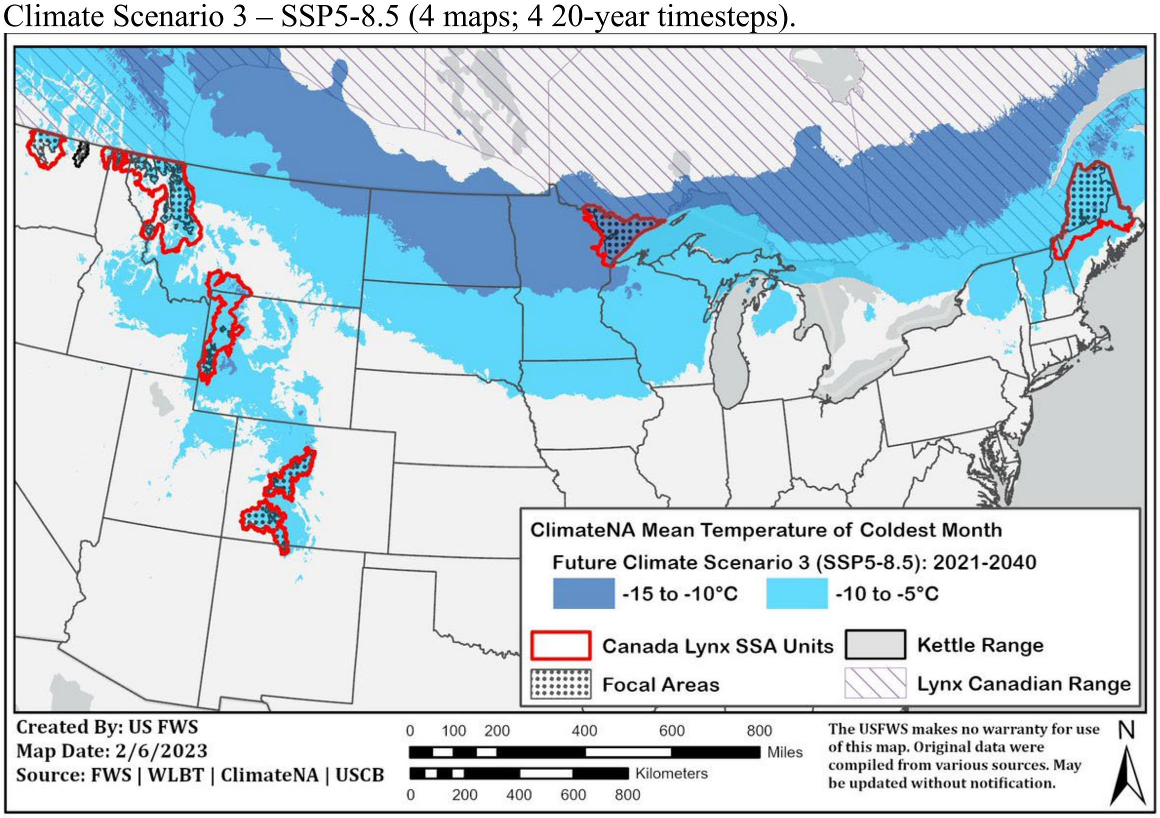
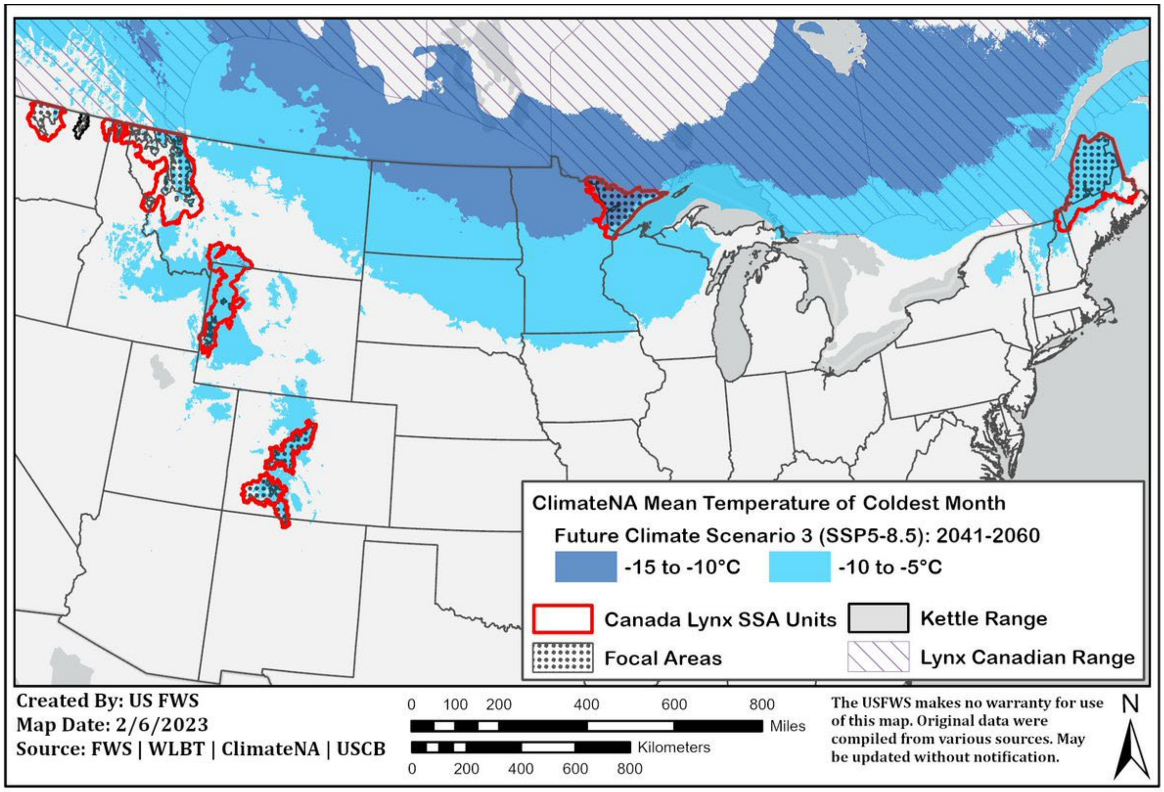


Climate Scenario 3 – SSP5-8.5 (4 maps; 4 20-year timesteps).

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Future Climate Scenario 3 (SSP5-8.5): 2041-2060
-15 to -10°C
-10 to -5°C
Canada Lynx SSA Units
Kettle Range
Focal Areas
Lynx Canadian Range
Created By: US FWS
Map Date: 2/6/2023
Source: FWS | WLBT | ClimateNA | USCB
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Miles
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The USFWS makes no warranty for use of this map. Original data were compiled from various sources. May be updated without notification.
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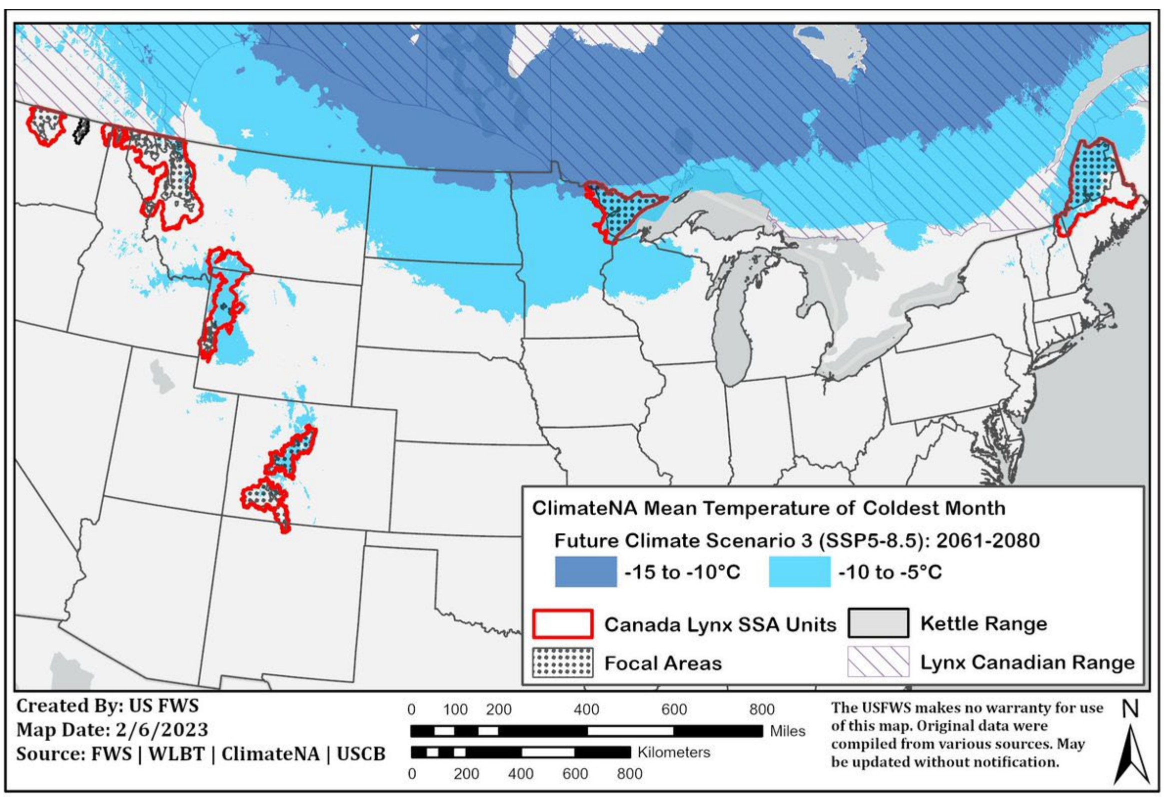
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Future Climate Scenario 3 (SSP5-8.5): 2061-2080
-15 to -10°C
-10 to -5°C
Canada Lynx SSA Units
Kettle Range
Focal Areas
Lynx Canadian Range
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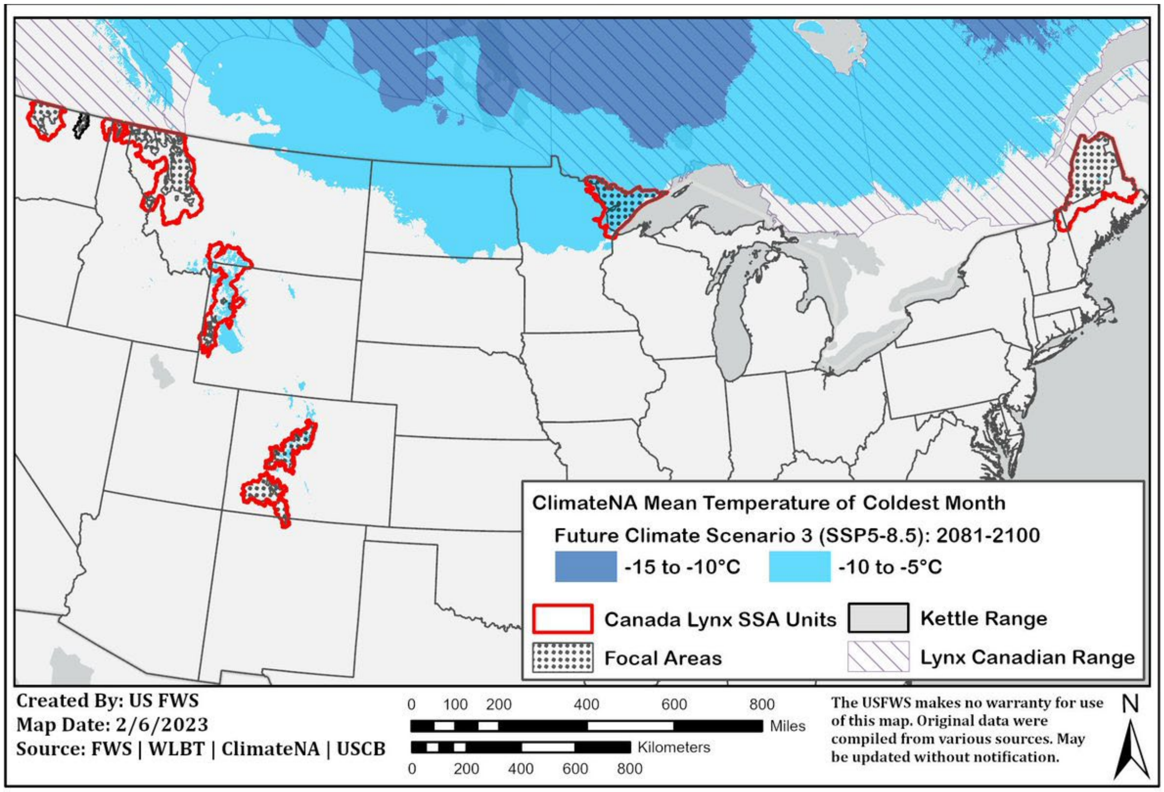
ClimateNA Mean Temperature of Coldest Month
Future Climate Scenario 3 (SSP5-8.5): 2081-2100
-15 to -10°C
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Canada Lynx SSA Units
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Source: FWS | WLBT | ClimateNA | USCB
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Appendix 2. Resiliency Scoring Tables and Maps for Three Future Scenarios and Four 20-year Timesteps through 2100

Canada Lynx SSA Unit Resiliency Scores – Current Condition.

SSA Unit	Habitat Variables		Demographic Variables		Overall Unit Resiliency
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	28,193	91	750 – 1,000	High	**High**
2 Midwest	21,119	100	100 – 200	High	**High**
3 Northern Rockies	20,606	100	200 – 300	High	**High**
4 Northern Cascades	6,067	87	30-35	High	**Moderate**
5 GYA	2,902	100	0-10	Moderate	**Functionally Extirpated**
6 Southern Rockies	19,411	89	100-250	Low	**Moderate**

Future Resiliency – Scenario 1 – 2021-2040.

SSA Unit	Habitat Variables		Demographic Variables		Overall Unit Resiliency
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	5,872	20	Moderate	High	**Moderate**
2 Midwest	20,549	97	Moderate	High	**High**
3 Northern Rockies	18,998	92	Moderate	High	**High**
4 Northern Cascades	3,838	63	Low	High	**Moderate**
5 GYA	2,902	100	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	17,456	90	Moderate	Low	**Moderate**

Future Resiliency – Scenario 1 – 2041-2060.

SSA Unit	Habitat Variables		Demographic Variables		**Overall Unit Resiliency**
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	201	1	Functionally Extirpated	Moderate	**Functionally Extirpated**
2 Midwest	19,125	91	Moderate	High	**High**
3 Northern Rockies	12,445	60	Moderate	High	**Moderate**
4 Northern Cascades	1,595	26	Low	Moderate	**Low**
5 GYA	2,901	100	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	15,924	82	Moderate	Low	**Moderate**

Future Resiliency – Scenario 1 – 2061-2080.

SSA Unit	Habitat Variables		Demographic Variables		**Overall Unit Resiliency**
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	24	0	Functionally Extirpated	Moderate	**Functionally Extirpated**
2 Midwest	16,331	77	Moderate	High	**High**
3 Northern Rockies	8,508	41	Moderate	High	**Moderate**
4 Northern Cascades	607	10	Functionally Extirpated	Moderate	**Functionally Extirpated**
5 GYA	2,646	91	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	13,685	71	Moderate	Low	**Moderate**

Future Resiliency – Scenario 1 – 2081-2100.

SSA Unit	Habitat Variables		Demographic Variables		**Overall Unit Resiliency**
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	5	0	Functionally Extirpated	Low	**Functionally Extirpated**
2 Midwest	6,711	32	Low	High	**Moderate**
3 Northern Rockies	5,768	28	Low	High	**Moderate**
4 Northern Cascades	407	7	Functionally Extirpated	Low	**Functionally Extirpated**
5 GYA	2,075	71	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	11,088	57	Low	Low	**Low**

Future Resiliency – Scenario 2 – 2021-2040.

SSA Unit	Habitat Variables		Demographic Variables		**Overall Unit Resiliency**
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	13,543	47	Moderate	High	**Moderate**
2 Midwest	20,856	99	Moderate	High	**High**
3 Northern Rockies	19,931	97	Moderate	High	**High**
4 Northern Cascades	4,163	69	Low	High	**Moderate**
5 GYA	2,902	100	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	17,664	91	Moderate	Low	**Moderate**

Future Resiliency – Scenario 2 – 2041-2060.

SSA Unit	Habitat Variables		Demographic Variables		**Overall Unit Resiliency**
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	87	0	Functionally Extirpated	Moderate	**Functionally Extirpated**
2 Midwest	17,980	85	Moderate	High	**High**
3 Northern Rockies	12,774	62	Moderate	High	**Moderate**
4 Northern Cascades	1,637	27	Low	Moderate	**Low**
5 GYA	2,901	100	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	15,432	80	Moderate	Low	**Moderate**

Future Resiliency – Scenario 2 – 2061-2080.

SSA Unit	Habitat Variables		Demographic Variables		**Overall Unit Resiliency**
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	1	0	Functionally Extirpated	Low	**Functionally Extirpated**
2 Midwest	6,559	31	Low	High	**Moderate**
3 Northern Rockies	6,433	31	Low	High	**Moderate**
4 Northern Cascades	457	8	Functionally Extirpated	Low	**Functionally Extirpated**
5 GYA	2,023	70	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	10,559	54	Moderate	Low	**Moderate**

Future Resiliency – Scenario 2 – 2081-2100.

SSA Unit	Habitat Variables		Demographic Variables		Overall Unit Resiliency
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	0	0	Functionally Extirpated	Low	**Functionally Extirpated**
2 Midwest	0	0	Functionally Extirpated	Moderate	**Functionally Extirpated**
3 Northern Rockies	1,016	5	Functionally Extirpated	Moderate	**Functionally Extirpated**
4 Northern Cascades	57	1	Functionally Extirpated	Low	**Functionally Extirpated**
5 GYA	540	19	Functionally Extirpated	Low	**Functionally Extirpated**
6 Southern Rockies	5,425	28	Low	Low	**Low**

Future Resiliency – Scenario 3 – 2021-2040.

SSA Unit	Habitat Variables		Demographic Variables		Overall Unit Resiliency
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	1,300	4	Low	High	**Low**
2 Midwest	20,261	96	Moderate	High	**High**
3 Northern Rockies	18,340	89	Moderate	High	**High**
4 Northern Cascades	3,502	58	Low	High	**Moderate**
5 GYA	2,902	100	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	17,532	90	Moderate	Low	**Moderate**

Future Resiliency – Scenario 3 – 2041-2060.

SSA Unit	Habitat Variables		Demographic Variables		Overall Unit Resiliency
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	25	0	Functionally Extirpated	Moderate	**Functionally Extirpated**
2 Midwest	16,493	78	Moderate	High	**High**
3 Northern Rockies	10,573	51	Moderate	High	**Moderate**
4 Northern Cascades	854	14	Functionally Extirpated	Moderate	**Functionally Extirpated**
5 GYA	2,809	97	Functionally Extirpated	Moderate	**Functionally Extirpated**
6 Southern Rockies	14,641	75	Low	Low	**Moderate**

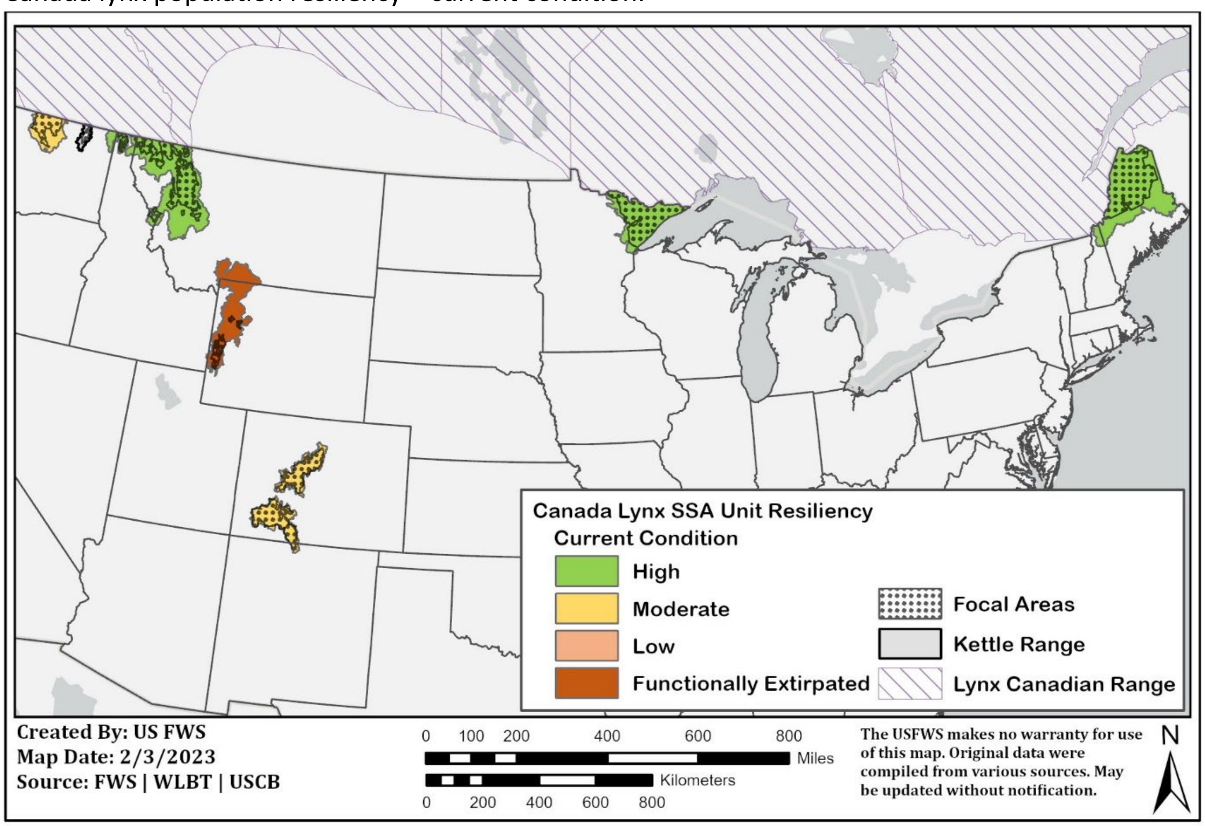
Future Resiliency – Scenario 3 – 2061-2080.

SSA Unit	Habitat Variables		Demographic Variables		Overall Unit Resiliency
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	0	0	Functionally Extirpated	Low	**Functionally Extirpated**
2 Midwest	1,456	7	Functionally Extirpated	Moderate	**Functionally Extirpated**
3 Northern Rockies	1,488	7	Low	Moderate	**Low**
4 Northern Cascades	81	1	Functionally Extirpated	Low	**Functionally Extirpated**
5 GYA	798	27	Functionally Extirpated	Low	**Functionally Extirpated**
6 Southern Rockies	7,064	36	Low	Low	**Low**

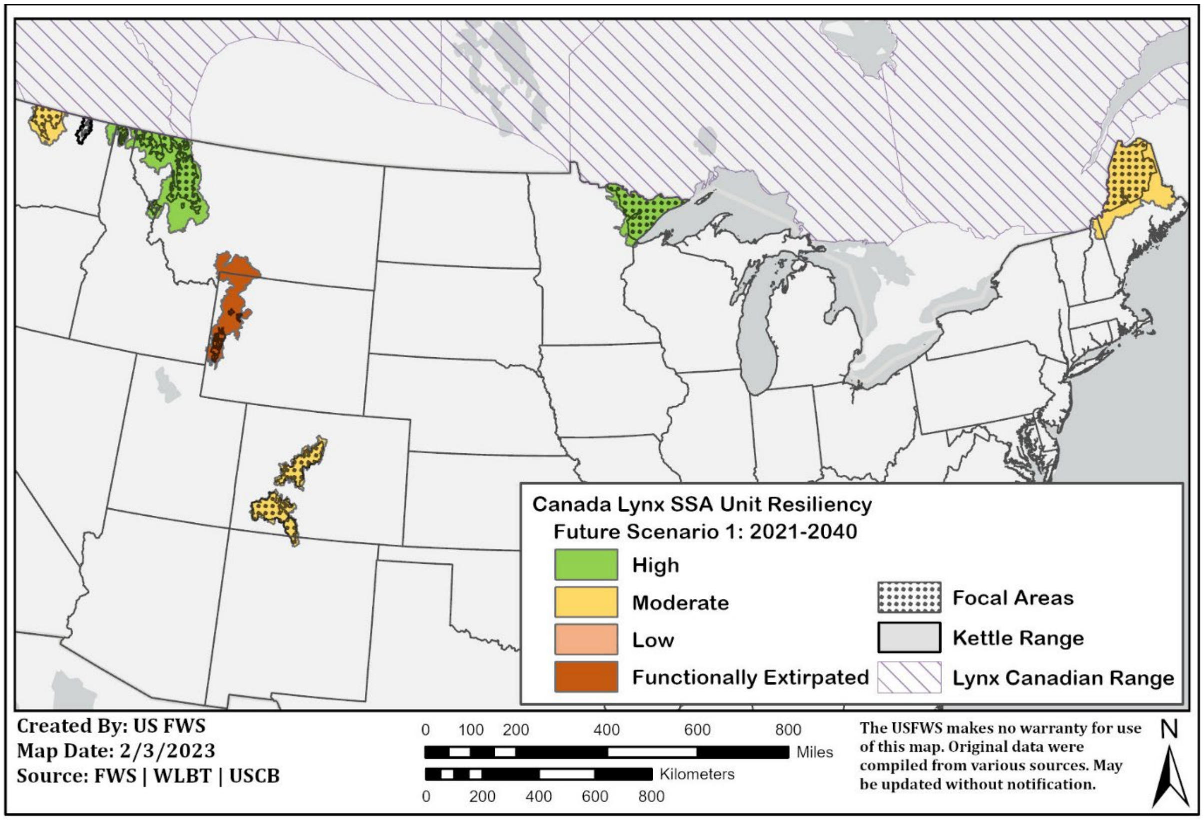
Future Resiliency – Scenario 3 – 2081-2100.

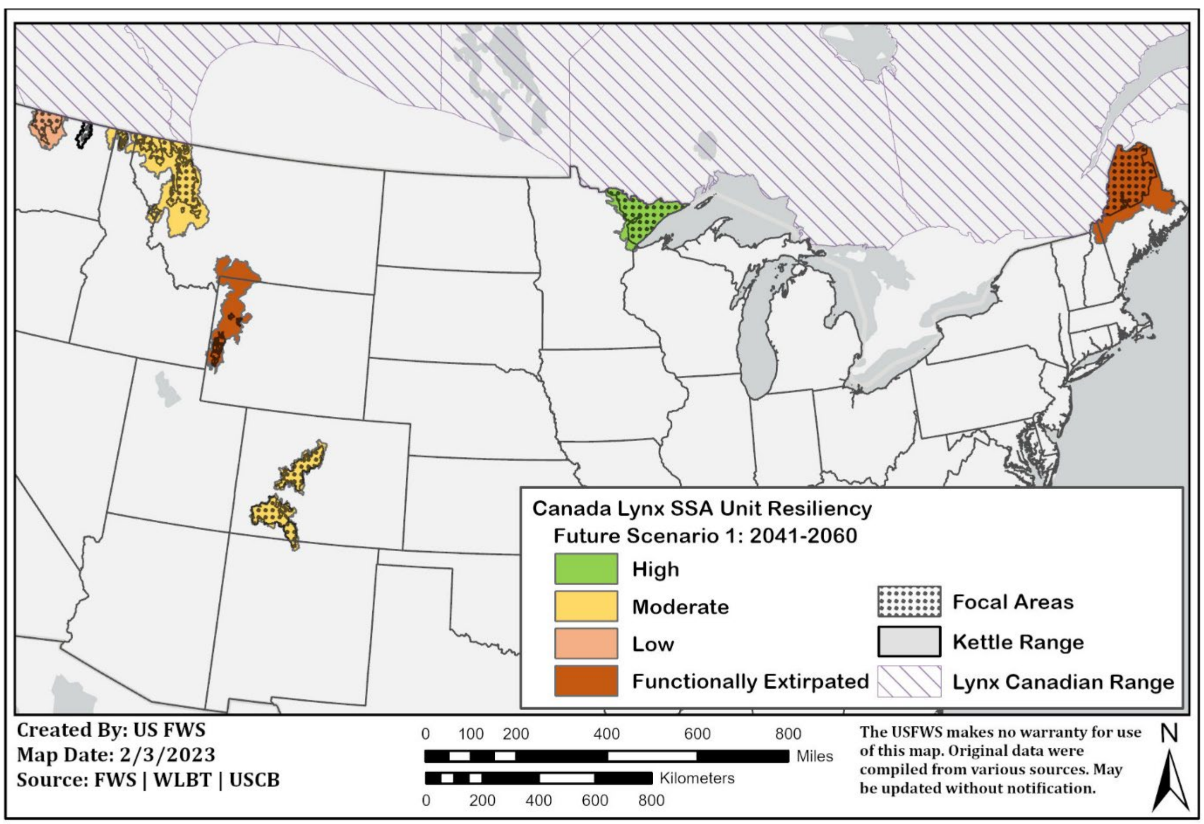
SSA Unit	Habitat Variables		Demographic Variables		**Overall Unit Resiliency**
	Minimum Habitat Amount (km^2)	Percentage of Unit Focal Area in Appropriate Climate Condition	Estimated Lynx Population Size	Connectivity to Species' Core Range	
1 Northeast	0	0	Functionally Extirpated	Low	**Functionally Extirpated**
2 Midwest	0	0	Functionally Extirpated	Moderate	**Functionally Extirpated**
3 Northern Rockies	1	0	Functionally Extirpated	Low	**Functionally Extirpated**
4 Northern Cascades	0	0	Functionally Extirpated	Low	**Functionally Extirpated**
5 GYA	39	1	Functionally Extirpated	Low	**Functionally Extirpated**
6 Southern Rockies	2,538	13	Functionally Extirpated	Low	**Functionally Extirpated**

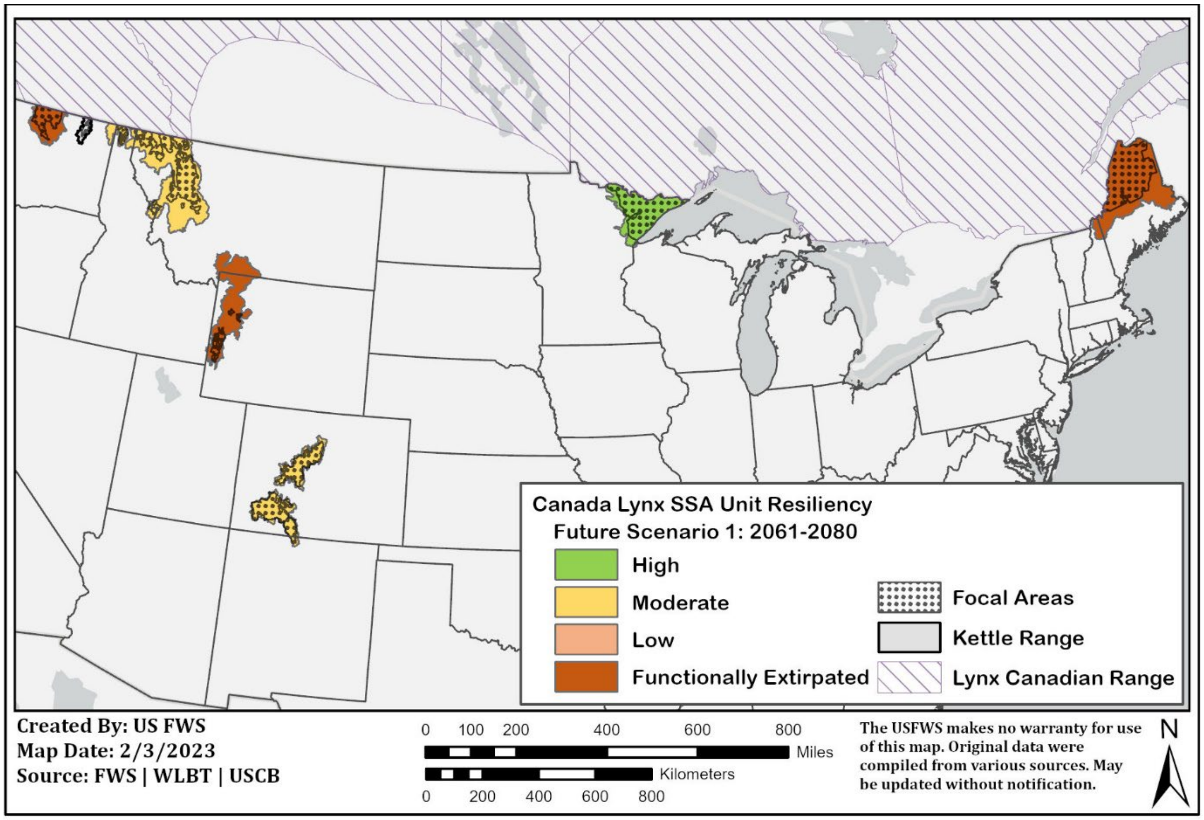
Canada lynx population resiliency – current condition.

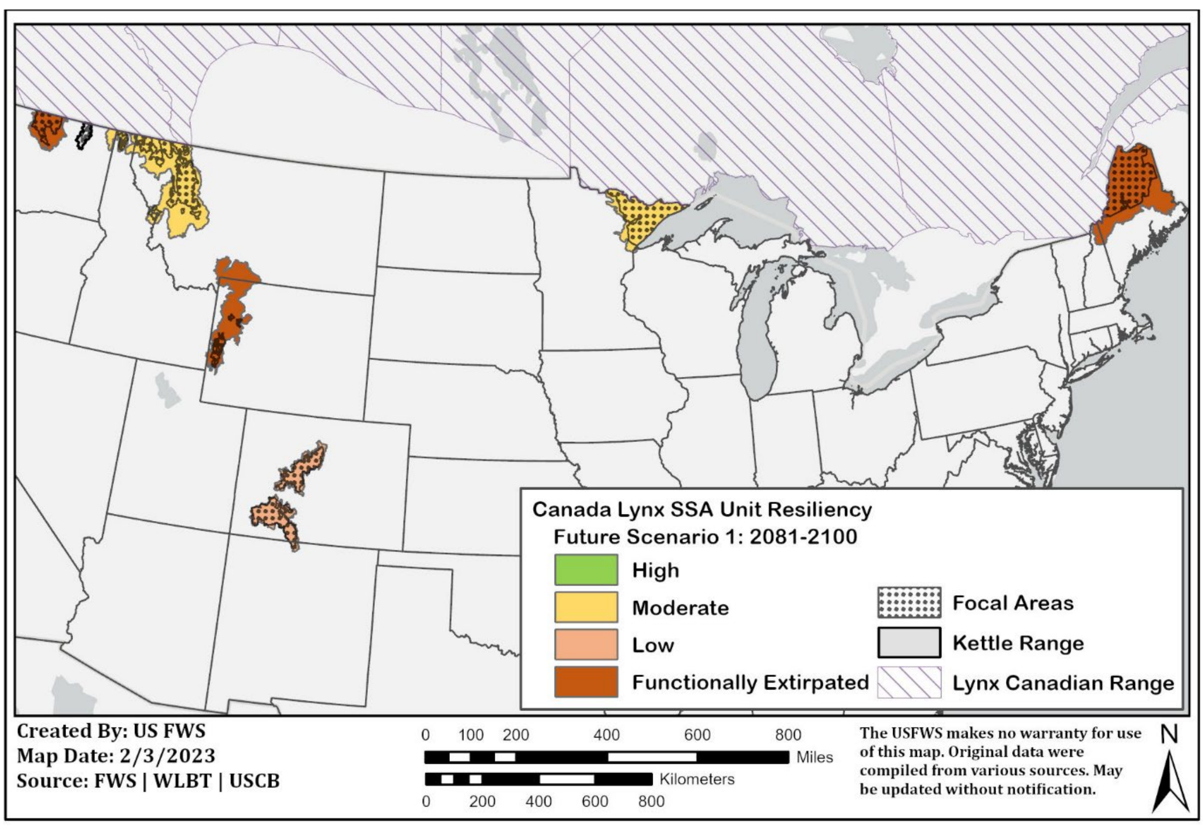


Resiliency Scenario 1 – (4 maps; 4 20-year timesteps).






Canada Lynx SSA Unit Resiliency
Future Scenario 1: 2061-2080
High
Moderate
Low
Functionally Extirpated
Focal Areas
Kettle Range
Lynx Canadian Range
Created By: US FWS
Map Date: 2/3/2023
Source: FWS | WLBT | USCB
0 100 200 400 600 800
Miles
Kilometers
0 200 400 600 800
The USFWS makes no warranty for use of this map. Original data were compiled from various sources. May be updated without notification.
N


Canada Lynx SSA Unit Resiliency
Future Scenario 1: 2081-2100
High
Moderate
Low
Functionally Extirpated
Focal Areas
Kettle Range
Lynx Canadian Range
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0 100 200 400 600 800
Miles
Kilometers
0 200 400 600 800
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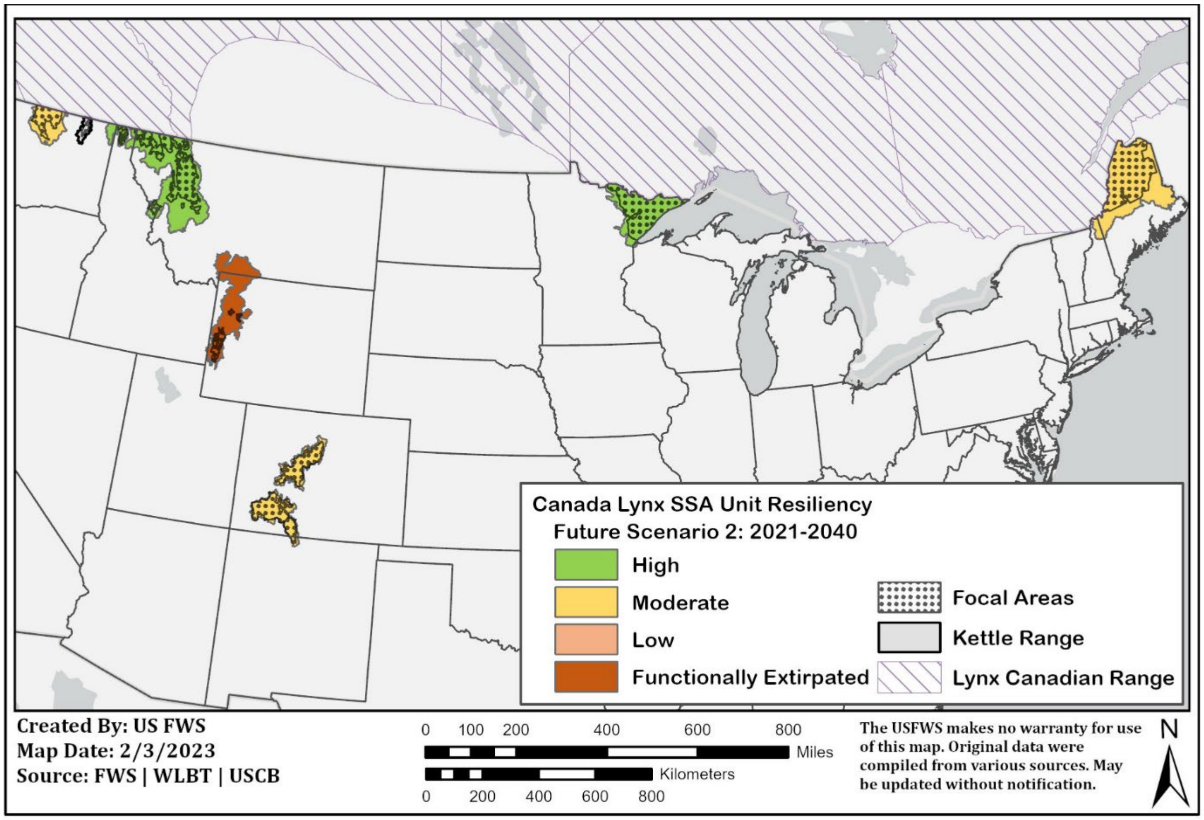
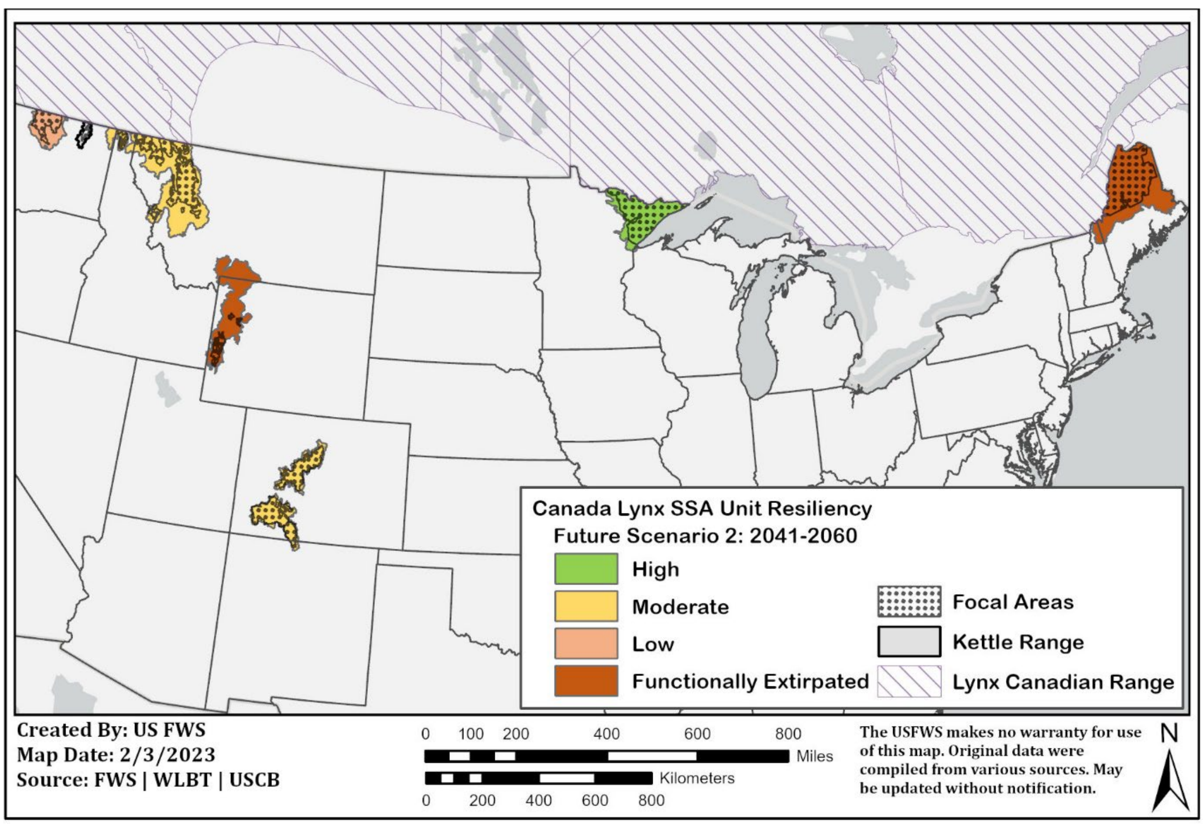
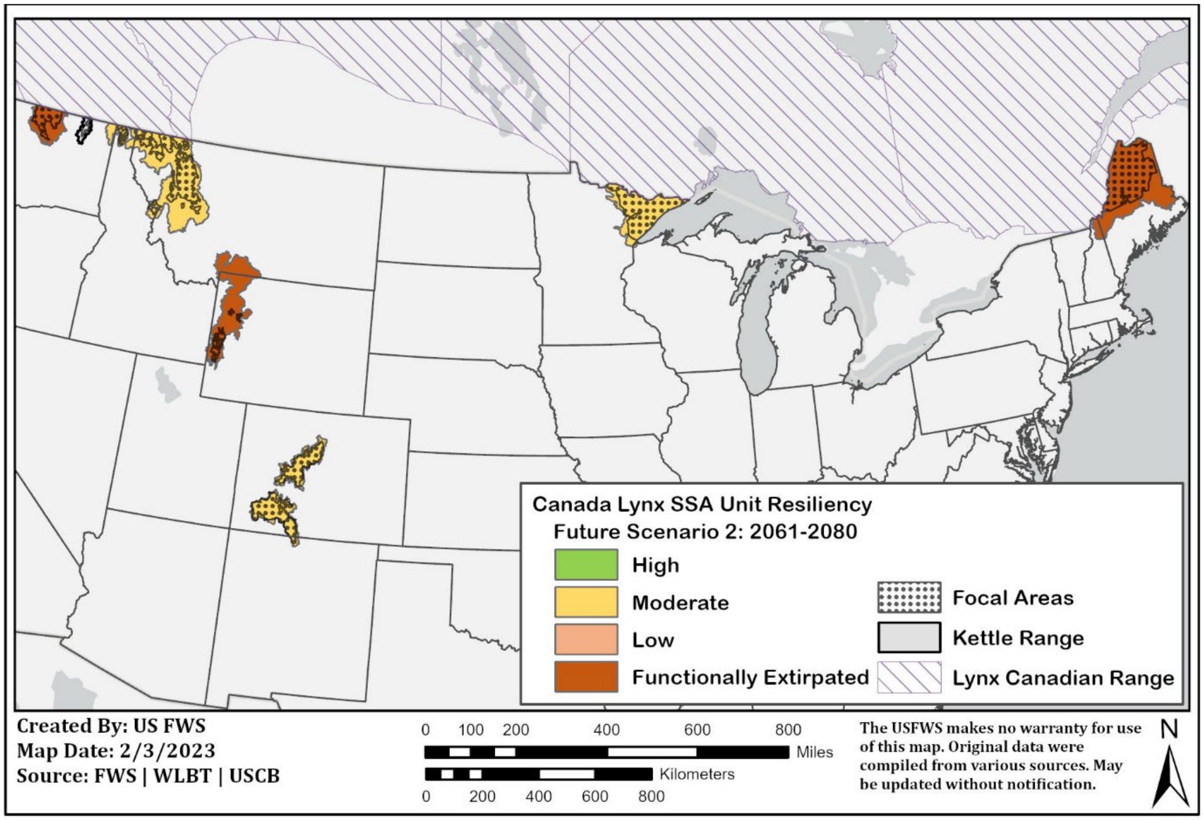
N

Resiliency Scenario 2 – (4 maps; 4 20-year timesteps).







Canada Lynx SSA Unit Resiliency
Future Scenario 2: 2061-2080
High
Moderate
Low
Functionally Extirpated
Focal Areas
Kettle Range
Lynx Canadian Range
Created By: US FWS
Map Date: 2/3/2023
Source: FWS | WLBT | USCB
0 100 200 400 600 800
Miles
Kilometers
0 200 400 600 800
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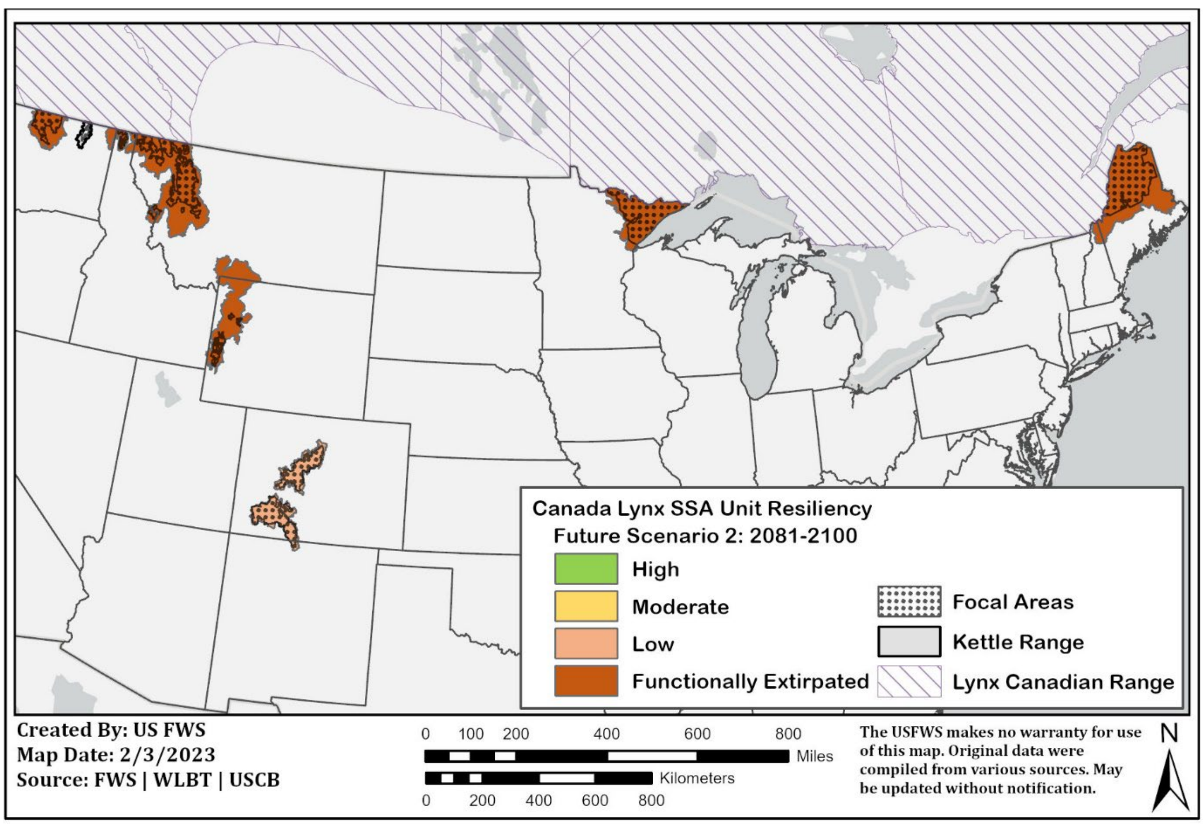
N



Canada Lynx SSA Unit Resiliency
Future Scenario 2: 2081-2100
High
Moderate
Low
Functionally Extirpated
Focal Areas
Kettle Range
Lynx Canadian Range
Created By: US FWS
Map Date: 2/3/2023
Source: FWS | WLBT | USCB
0 100 200 400 600 800
Miles
Kilometers
0 200 400 600 800
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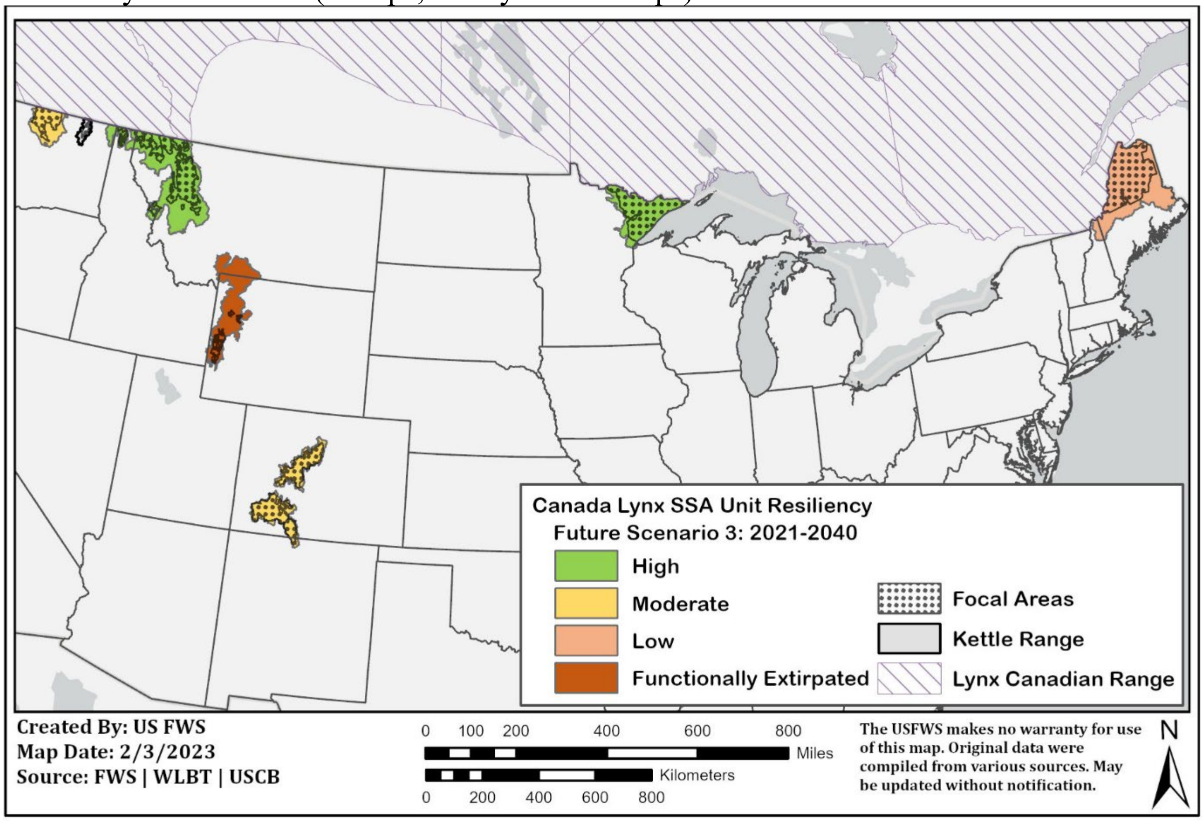
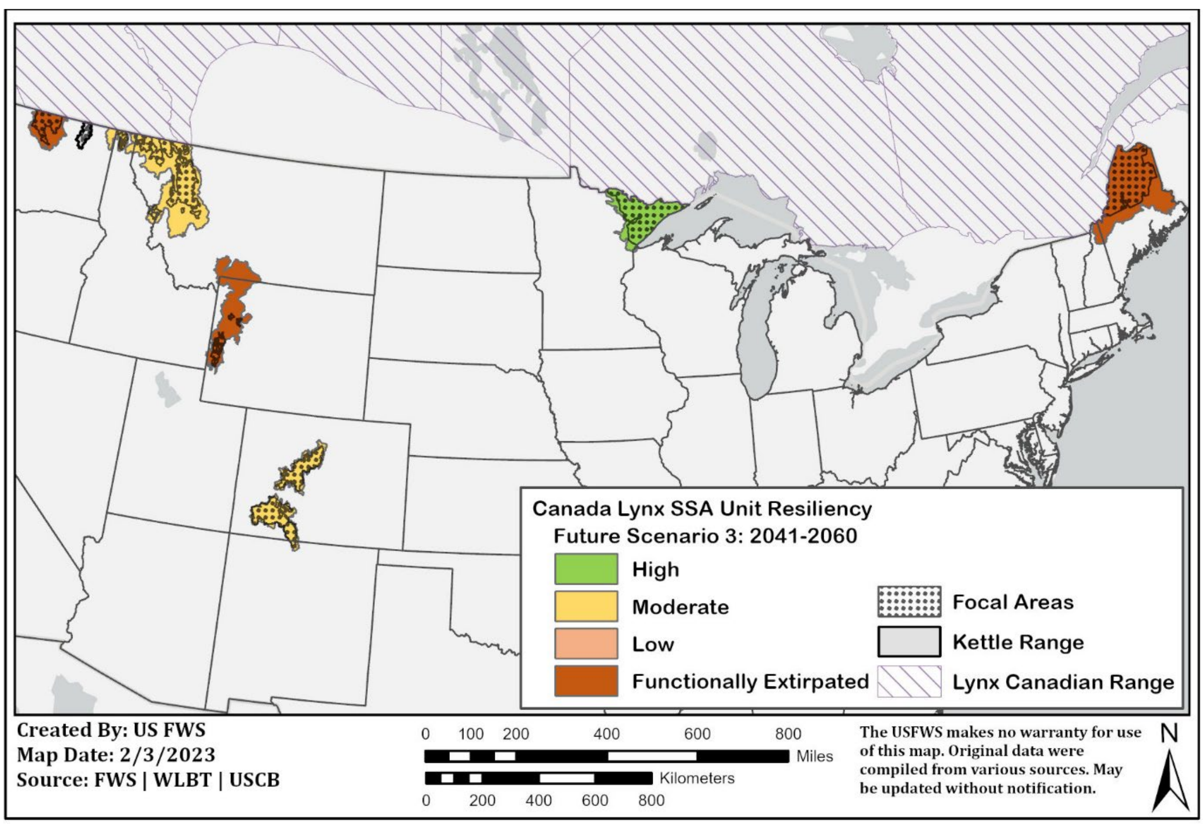
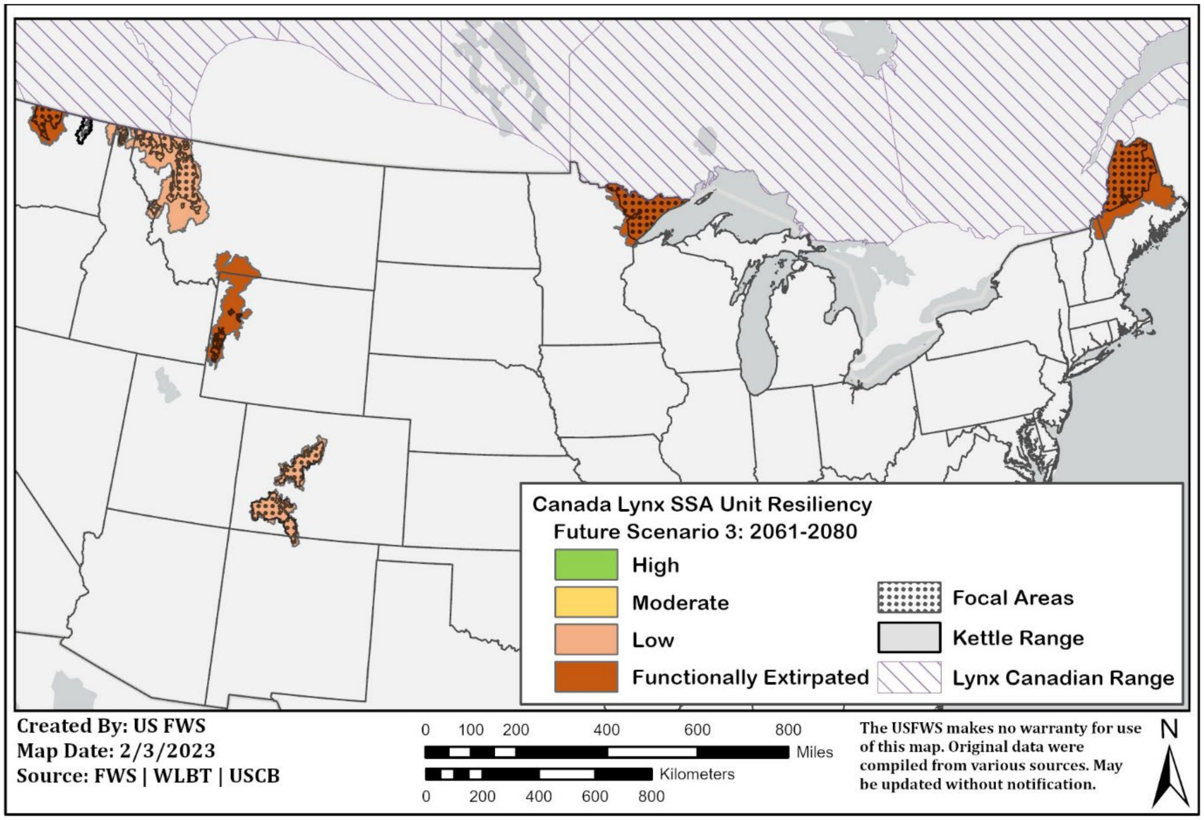
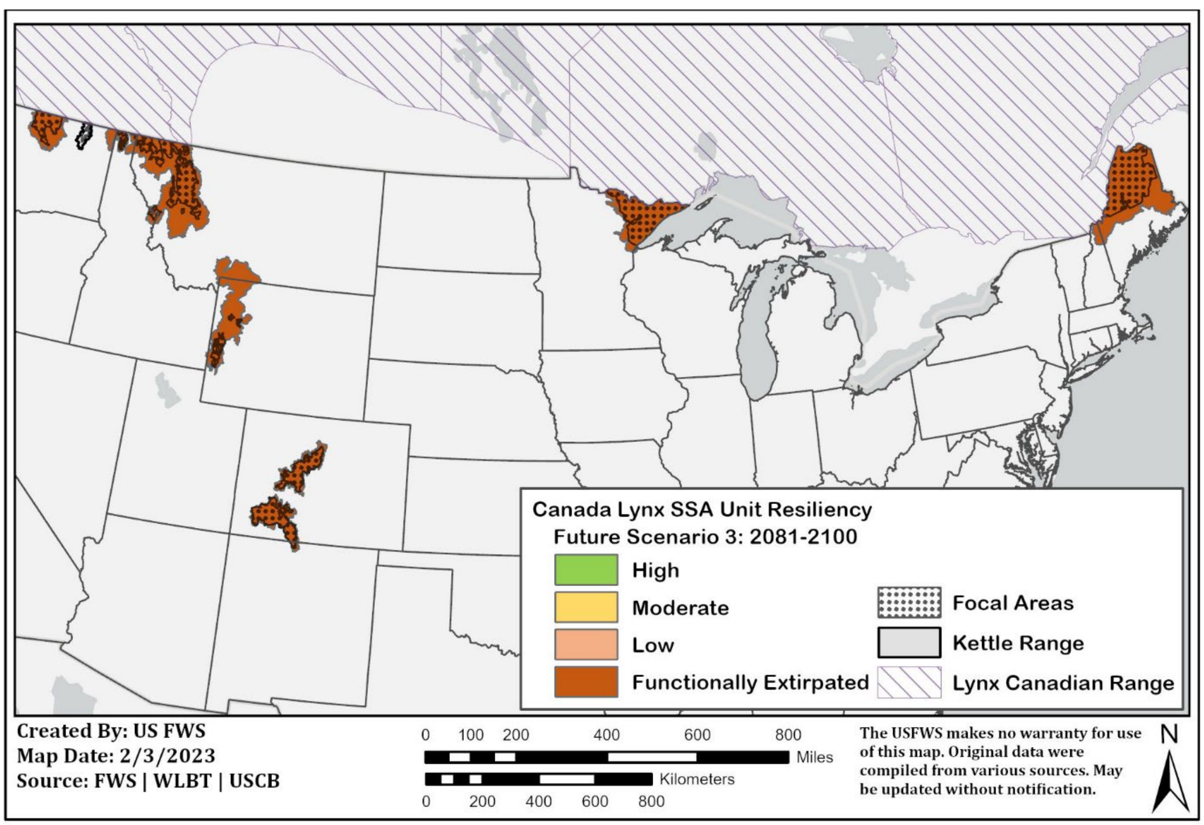
N

Resiliency Scenario 3 – (4 maps; 4 20-year timesteps).






Canada Lynx SSA Unit Resiliency
Future Scenario 3: 2061-2080
High
Moderate
Low
Functionally Extirpated
Focal Areas
Kettle Range
Lynx Canadian Range
Created By: US FWS
Map Date: 2/3/2023
Source: FWS | WLBT | USCB
0 100 200 400 600 800 Miles
Kilometers
0 200 400 600 800
The USFWS makes no warranty for use of this map. Original data were compiled from various sources. May be updated without notification.
N


Canada Lynx SSA Unit Resiliency
Future Scenario 3: 2081-2100
High
Moderate
Low
Functionally Extirpated
Focal Areas
Kettle Range
Lynx Canadian Range
Created By: US FWS
Map Date: 2/3/2023
Source: FWS | WLBT | USCB
0 100 200 400 600 800 Miles
Kilometers
0 200 400 600 800
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N