GRAHAM'S BEARDTONGUE
(*PENSTEMON GRAHAMII*)
AND
WHITE RIVER BEARDTONGUE
(*P. SCARIOSUS* VAR. *ALBIFLUVIS*)

BIOLOGICAL STATUS REPORT
OF
FUTURE CONDITION

Figure 1. Photos of Graham's beardtongue (left) and White River beardtongue (right). Photos by Kevin Megown and Jessi Brunson.

U.S. Fish and Wildlife Service, Department of Interior Region 7
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This document was prepared by:
Jennifer Lewinsohn, Botanist, Utah Ecological Services Field Office

This document was reviewed by:
Paul Abate, Branch Supervisor, Utah Ecological Services Field Office
Laura Romin, Assistant Field Supervisor, Utah Ecological Services Field Office
Sarah Backsen, DOI Region 5&7 Branch Chief

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EXECUTIVE SUMMARY

This report summarizes the results of our projected future scenarios for Graham's beardtongue (*Penstemon grahamii*) and White River beardtongue (*Penstemon scariosus* var. *albifluvis*) to evaluate each species' overall viability. For the purposes of this report, we defined viability as the ability of Graham's and White River beardtongues to sustain wild populations over time. We evaluated the beardtongues' projected future viability using the three conservation biology principles of resiliency, representation, and redundancy (together, the 3Rs) (U.S. Fish and Wildlife Service [USFWS] 2020, pp. 11 - 13). Using the 3Rs, we evaluated the future viability of the beardtongues based on the presence of multiple (redundancy), self-sustaining (resiliency) populations distributed across the range of the species, and their contributions to adaptive capacity (representation) in the face of changing environmental conditions. We relied on our recent characterization of each species' current condition, stressors, and effects of stressors as the baseline from which to evaluate future changes to those factors considered important to the beardtongues (USFWS 2021, entire).

Graham's and White River beardtongues are long-lived perennial plant species that flower in the spring and require pollinators for maximum reproduction. The beardtongues have highly specific soil requirements and occupy exposed oil shale soils of the Green River geologic formation. They require suitable intact soils with microsites for establishment and growth. The health (long-term productivity) of populations is affected by the population size, habitat quantity, and habitat quality available to support stable or increasing populations.

Graham's beardtongue occurs in 27 populations across 5 range units, with a total population of 56,385 individuals, across the Uintah Basin in Duchesne and Uintah Counties in Utah and Rio Blanco County in Colorado (USFWS 2021, entire). White River beardtongue occurs in 17 populations across 5 range units, with a total population of 29,902 individuals, across the Uintah Basin and at an isolated location in the Book Cliffs in Grand and Uintah Counties in Utah and Rio Blanco County in Colorado (USFWS 2021, entire). The occupied habitat area for Graham's and White River beardtongues is 9,585 acres (ac) and 3,462 ac of habitat, respectively. Habitat for the species' pollinators includes beardtongue occupied habitat and a larger pollinator foraging area, equaling 91,232 ac and 29,476 ac, for Graham's and White River beardtongue, respectively.

To assess future resiliency, we evaluated relevant habitat and demographic factors to calculate an overall condition score for each plant population. We evaluated population size, habitat area, habitat quality, and habitat loss for the future condition. Based on the results of these evaluations we rated population condition Good, Moderate, Low, or Extirpated. Some populations were rated Moderate or Low without an energy stressor because their overall condition score was inherently low as a result of their habitat and demographic factor scores. In our assessment, high overall viability means having more populations in Good to Moderate condition. To assess future redundancy, we evaluated the projected number and distribution of populations within the species range relative to the current condition. To assess future representation, we evaluated the projected demographic (population size) and ecological (ecological settings) surrogates of genetic diversity relative to the current condition.

Based on input received from Federal and state agencies, private industry, and the best available information, we developed two plausible future scenarios which include moderate and high levels of energy development. These two scenarios considered impacts to the beardtongues through 2030, because we have sufficient information to project out to 10 years for energy development (oil shale, tar sands, and oil and gas development), which is the primary future stressor for the beardtongues. Beyond 10 years, there is too much uncertainty about the level or distribution of energy development within the beardtongues' populations and ranges, such that projections would become speculative. In the locations where energy stressors occurred for the two scenarios, our analysis included the following assumptions: commercial development activities for oil shale and tar sands will occur in the next 10 years; and the total loss of plants and habitat will occur where oil shale and tar sands are projected. These conservative assumptions allowed us to evaluate worst-case impacts from energy development in combination with other stressors, to bracket the full range of impacts to the beardtongues that may occur, since actual future impacts may range anywhere from their current condition to the future scenarios evaluated here, or may fall in between. We did not develop a scenario that considered "exploration-only" activities for oil shale and tar sands with a smaller surface disturbance extent, even though it would also be a plausible future forecast for oil shale and tar sands. Our evaluation of effects from energy development accounted for the protections afforded to the beardtongues from a 2014 conservation agreement (2014 CA) between the USFWS, Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), Utah Public Lands Coordination Office (PLPCO), Utah Division of Wildlife Resources (UDWR), Uintah County in Utah, and Rio Blanco County in Colorado that is in place through 2034.

For the two future scenarios, we forecasted the species' biological condition based on conservation efforts and the following stressors: oil shale, tar sands, and traditional oil and gas; road construction and maintenance; herbivory; invasive weeds; and climate change. Our future scenarios varied based on two forecasts for oil shale (moderate, high). We did not develop more than one forecast for the other stressors (tar sands, traditional oil and gas, road construction and maintenance; herbivory; invasive weeds; and climate change) because their future, plausible extents are not expected to vary much within the beardtongues' ranges independent of the oil shale stressor.

The two future scenarios we evaluated include:

Scenario 1 – Moderate energy development: We evaluated the future condition of beardtongue populations based on potential impacts from stressors (oil shale, tar sands, and traditional oil and gas; road construction and maintenance; herbivory; invasive weeds; and climate change) and the benefits from conservation efforts. We projected that oil shale exploration and commercial development would occur on lands identified as having a high potential for both activities. The effects of herbivory and invasive weeds may increase in populations that overlap with energy development. Climate change may contribute to stronger effects from herbivory and invasive weeds to all beardtongue populations.

Scenario 2 – High energy development: We evaluated the future condition of beardtongue populations based on potential impacts from stressors (oil shale, tar sands, and traditional oil and gas; road construction and maintenance; herbivory; invasive weeds; and climate change) and the benefits from conservation efforts. We projected that oil shale exploration and commercial development would occur over a larger area that included the same lands as the moderate scenario, plus other lands identified as likely or about as likely as not to support these activities. The potential effects of the other stressors remained the same as evaluated for the moderate energy development scenario.

We acknowledge that our scenarios are projections and may not accurately forecast future events. However, we used the best available science and information for our scenarios and analyses and acknowledged any key assumptions and uncertainties throughout this report. The scenarios we chose are not necessarily the most likely to occur. Rather, they are intended to bracket the full range of plausible future outcomes. Our projections of each species' future viability vary between the moderate and high energy development scenarios, as described below.

Under the moderate energy development scenario, oil shale and traditional oil and gas are the main stressors for Graham's beardtongue, and oil shale is the main stressor for White River beardtongue. In this scenario, these stressors are projected to result in plant and habitat loss in the center of the species' ranges (Table 1; Table 2).

- For Graham's beardtongue, there is a projected loss of 34 percent of the total population (direct loss of 19,035 plants) from energy development, with a remaining total population size of 37,350 individuals in 24 populations. Remaining occupied habitat and pollinator habitat are projected to be 7,642 and 72,455 acres, respectively. The main stressors (i.e., oil shale and traditional oil and gas development) result in the extirpation of three populations and a decline in the condition of four populations compared to their current condition. The current population condition is maintained in the other 20 populations. The species continues to occupy the extent of its current range, and all five range units continue to support populations in Good or Moderate condition. Fourteen populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years).
- For White River beardtongue, there is a projected loss of one percent of the total population (direct loss of 216 plants) from energy development, with a remaining total population size of 29,686 individuals in 16 populations. Remaining occupied habitat and pollinator habitat are projected to be 3,218 and 26,959 acres, respectively. The main stressor (i.e., oil shale development) results in the extirpation of one population and a decline in the condition of one population compared to their current condition. The current population condition is maintained in the other 14 populations. The species continues to occupy the extent of its current range and all five range units continue to support populations in Good or Moderate condition. Eleven populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years).
- Despite the extirpation of populations, levels of redundancy remain high for both species with Graham's beardtongue maintaining 24 populations and White River beardtongue maintaining 16 populations.
- Graham's beardtongue maintains 14 large populations distributed across its range and continues to occupy the five main vegetation types within its range. Our evaluation of

representation indicates that Graham's beardtongue maintains a similar level of ecological diversity within the 24 remaining populations to what it has currently, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the three Graham's beardtongue populations (9, 10, 16), and projected plant loss in other populations would result in significant impacts to Graham's beardtongue's representation.

- White River beardtongue maintains 11 large populations distributed across its range and continues to occupy the five main vegetation types within its range. Our evaluation of representation indicates that White River beardtongue maintains a similar level of ecological diversity within the 16 remaining populations to what it has currently, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the one White River beardtongue population (8), and projected plant loss in other populations would result in significant impacts to White River beardtongue's representation.

Under the high energy development scenario, the main stressors remain the same for the beardtongues; oil shale and traditional oil and gas are the main stressors for Graham's beardtongue and oil shale is the main stressor for White River beardtongue. Oil shale impacts result in more extensive plant and habitat loss in the center of the species' ranges than in the moderate energy development scenario (Table 1; Table 2).

- For Graham's beardtongue, there is a projected loss of 45 percent of the total population (direct loss of 25,591 plants) from energy development, with a remaining total population size of 30,794 individuals in 24 populations. Remaining occupied habitat and pollinator habitat are projected to be 6,037 and 63,580 acres, respectively. The main stressors (i.e., oil shale and traditional oil and gas development) result in the extirpation of three populations and a decline in the condition of six populations compared to their current condition. The current population condition is maintained in the other 18 populations. Fourteen populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years). The species continues to occupy the extent of its current range and all five range units continue to support populations in Good or Moderate condition.
- For White River beardtongue, there is a projected loss of 24 percent of the total population (direct loss of 7,207 plants) from energy development, with a remaining total population size of 22,695 individuals in 15 populations. Remaining occupied habitat and pollinator habitat are projected to be 2,317 and 20,099 acres, respectively. The main stressor (i.e., oil shale development) results in the extirpation of two populations and a decline in the condition of two population compared to their current condition. The current population condition is maintained in the other 13 populations. Nine populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years). The species continues to occupy the extent of its current range and all five range units continue to support populations in Good or Moderate condition.
- Despite the extirpation of populations, levels of redundancy remain high for both species with Graham's beardtongue maintaining 24 populations and White River beardtongue maintaining 15 populations.

- Graham’s beardtongue maintains the same number of large populations (14) distributed across its range as Scenario 1, and continues to occupy the five main vegetation types within its range. Our evaluation of representation indicates that Graham’s beardtongue maintains a similar level of ecological diversity within the 24 remaining populations to what it has currently, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the three Graham’s beardtongue populations (9, 10, 16), and projected plant loss in other populations would result in significant impacts to Graham’s beardtongues’ representation.
- White River beardtongue maintains nine large populations distributed across its range and continues to occupy the five main vegetation types within its range. Our evaluation of representation indicates that White River beardtongue maintains a similar level of ecological diversity within the 15 remaining populations to what it has currently, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the two White River beardtongue populations (8, 13), and projected plant loss in other populations would result in significant impacts to White River beardtongue’s representation.

Under both energy development scenarios, the impact of stressors to the species’ populations depend on population size and condition. For both species, large populations in Good condition are less sensitive to plant and habitat loss than populations in Moderate or Low condition, because there is sufficient habitat area and population size remaining to support the overall population condition.

The 2014 CA provides protections for the beardtongues on Federal and state lands until July 25, 2034. During this time, the beardtongues are afforded the same level of protections on Federal and state lands within designated conservation areas. The 2014 CA identifies 42,993 acres of designated conservation areas that protect 41 percent of the Graham’s beardtongue population (23,333 plants) in 13 populations, and 66 percent of the White River beardtongue population (19,710 plants) in 11 populations. Within designated conservation areas, protections include an avoidance buffer of 300 feet between disturbance and beardtongue plants as well as surface disturbance caps to restrict development. Surface disturbance caps would allow a limited amount of new construction for roads and traditional oil and gas development but would prohibit future oil shale and tar sand exploration and development.

The beardtongues are also afforded protections outside of designated conservation areas on Federal lands, which include: a 300 foot (ft) avoidance buffer; surface disturbance restrictions on steep slopes; areas that are unavailable for leasing or have no surface occupancy (NSO) stipulations; and designated Areas of Critical Environmental Concern (ACECs). Overall, the 2014 CA designated conservation areas and other conservation measures on Federal lands provide protections to 51 percent (28,842 plants) and 76 percent (22,595 plants) of the Graham’s and White River beardtongue total population, respectively (Table 7; Table 8).

Table 1. Summary of Graham's beardtongue population condition scores under current conditions and the moderate energy development (Scenario 1), and high energy development (Scenario 2) future scenarios.

Range Unit	Population	Current Condition	Future Condition		Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)
			Scenario 1 Moderate Development	Scenario 2 High Development	
1. Sand Wash	1	Good	Good	Good	Oil and gas (B)
	2	Good	Good	Good	None
	3	Good	Good	Good	None
	4	Moderate	Moderate	Moderate	None
	5	Good	Good	Good	None
	6	Good	Good	Good	None
2. Seep Ridge	7	Moderate	Moderate	Low	Oil shale (2)
	8	Moderate	Moderate	Moderate	None
	9	Moderate	Extirpated	Extirpated	Oil and gas (B)
	10	Good	Extirpated	Extirpated	Oil and gas (B)
	11	Moderate	Moderate	Moderate	Oil and gas (B); Oil shale (2)
	12	Moderate	Low	Low	Oil and gas (B); Oil shale (2)
	13	Good	Good	Good	Oil and gas (B); Oil shale (B)
	14	Good	Good	Good	None
	15	Good	Good	Moderate	Oil and gas (B); Oil shale (2)
	16	Moderate	Extirpated	Extirpated	Oil and gas (B)
3. Evacuation Creek	17	Good	Moderate	Moderate	Oil shale (B)
	18	Moderate	Moderate	Moderate	Oil shale (B)
	19	Moderate	Low	Low	Oil shale (B)
	20	Good	Good	Good	Oil shale (B)
	21	Moderate	Low	Low	Oil and gas (B)
	22	Good	Good	Good	oil and gas (B); oil shale (B)
4. White River	23	Good	Good	Good	Oil shale (2)
5. Raven Ridge	24	Moderate	Moderate	Moderate	None
	25	Moderate	Moderate	Moderate	None
	26	Moderate	Moderate	Moderate	None
	27	Good	Good	Good	None
Total Population		**56,385**	**37,350 (66%)**	**30,794 (55%)**	
Occupied Habitat		**9,585**	**7,642 (80%)**	**6,037 (63%)**	
Pollinator Habitat		**91,232**	**72,455 (79%)**	**63,580 (70%)**	

Table 2. Summary of White River beardtongue population condition scores under current conditions and the moderate energy development (Scenario 1), and high energy development (Scenario 2) future scenarios.

Range Unit	Population	Current Condition	Future Condition: Scenario 1 Moderate Development	Future Condition: Scenario 2 High Development	Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)
2. Seep Ridge	1	Moderate	Moderate	Moderate	None
	2	Moderate	Moderate	Moderate	None
	3	Good	Good	Good	Oil shale (2)
	4	Good	Good	Good	Oil shale (2)
	5	Moderate	Moderate	Moderate	Oil shale (2)
	6	Moderate	Moderate	Moderate	None
	7	Moderate	Moderate	Moderate	None
3. Evacuation Creek	8	Low	Extirpated	Extirpated	Oil shale (B)
	9	Good	Moderate	Moderate	Oil shale (B)
4. White River	10	Good	Good	Good	Oil shale (B)
	11	Good	Good	Moderate	Oil shale (2)
	12	Moderate	Moderate	Moderate	Oil shale (2)
	13	Moderate	Moderate	Extirpated	Oil shale (2)
	14	Moderate	Moderate	Moderate	None
5. Raven Ridge	15	Moderate	Moderate	Moderate	None
	16	Good	Good	Good	None
6. Book Cliffs	17	Good	Good	Good	Oil and gas (B); Tar sands (B)
Total Population		**29,902**	**29,686 (99%)**	**22,695 (76%)**	
Occupied Habitat		**3,462**	**3,218 (93%)**	**2,317 (67%)**	
Pollinator Habitat		**29,476**	**26,959 (91%)**	**20,099 (68%)**	

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Chapter 1. Introduction, Data, and Analytical Framework

This report is a technical document that evaluates Graham's and White River beardtongues' future biological status based on the best available scientific information. This report was peer and partner reviewed. This version of the document incorporates the best available information through the 2020 field season. The 2020 survey results on BLM lands in Colorado increased the Graham's beardtongue population 22 by 565 plants and reduced the number of White River beardtongue population 10 by 1,039 plants. As a result, there are 53 more Graham's beardtongue plants and 1,039 fewer White River beardtongue plants in BLM conservation areas. We note that our evaluation of the beardtongues' future condition, which was based on information including their population size, extinction risk, and presence of high density clusters, was performed using best available information through the 2019 field season. The 2020 data do not change the results of our future condition evaluation. We received the 2020 data very late in our review process and after our analyses were complete. Therefore, we retained the analyses and tables in the Appendices we calculated using data through the 2019 field season and added the analyses and results using the 2020 data at the end of the Appendix. The draft version of this document dated November 2, 2020 and most of the analyses in the Appendix were based on best available information through the 2019 field season.

This report is not an Endangered Species Act (ESA) policy or decision document, and it does not predetermine the status of these species under the ESA. We did not organize our evaluation of threats to Graham's and White River beardtongues' using a five-factor analysis under the ESA. While this document is not a Species Status Assessment (SSA) Report, several concepts from the Service's SSA Framework (USFWS 2016, entire) are used in this report, such as the concepts of resilience, redundancy, and representation, as well as the organizational structure of future condition scenarios.

Future changes in energy exploration and mining for oil shale, tar sands, and traditional oil and gas, and the potential for cumulative effects of these three energy operations with livestock grazing, nonnative invasive species, and climate change are the stressors that may influence the future condition of Graham's and White River beardtongues (78 FR 47590, August 6, 2013; USFWS 2021, entire). We developed our future condition evaluation based on these stressors, while acknowledging there is uncertainty on how these stressors may change singly and cumulatively, and their effects on each plant species.

This report describes the projected future extent and impact of stressors and characterizes the future condition of the beardtongues' populations. We used reliable projections of the future extent of stressors and conservation efforts based on the best available information and expert opinion (Chapter 2). We then evaluated each species projected future condition based on their biological needs, and the future status of stressors and conservation efforts (Chapter 3). Finally, we summarized the resiliency of the beardtongues' populations, and the redundancy and representation of the two species to describe their projected future viability (Chapter 4).

Below, we provide a summary of the data we used for our analyses, and the analytical framework we used to evaluate the viability of the two species. For more information on previous Federal actions for Graham's and White River beardtongues and the current condition of both species, please see the Biological Report (USFWS 2021, p. 8).

1.1 Data

The occurrence data used for our analyses include compiled data through the 2020 field season from Utah Natural Heritage Program (UNHP) records, Bureau of Land Management (BLM) records, and published survey reports. In coordination with UNHP and BLM, we used a series of quality control checks to remove duplicative data and verify the spatial locations of plant records. For more information on occurrence data, please see the Biological Report (USFWS 2021, p. 9).

We delineated plant populations by following standardized methods used by the national network of Natural Heritage Programs to identify the species' element occurrences (EO; (NatureServe 2004, p. 6). The EOs are plant points that are grouped together based on geographic proximity within a 1.24 mile distance separated by suitable habitat (NatureServe 2004, p. 6). Our population delineations differ from this protocol in a few instances where the distance slightly exceeded 1.24 miles. For the purpose of this assessment, we considered EOs to be synonymous with populations and hereafter will use the term "populations" when describing the distribution of the species.

We reported occupied habitat and pollinator habitat for the beardtongues, as defined in the Biological Report (USFWS 2021, pp. 9 – 10). We defined the two habitat types as follows:

- Occupied habitat contains Graham's beardtongue or White River beardtongue plants and their seedbanks. We delineated a 300-foot (ft) buffer area around plant locations as occupied habitat to account for seedbanks.
- Pollinator habitat contains beardtongue occupied habitat and a larger pollinator foraging area. We delineated a 2,297 ft buffer around Graham's beardtongue plant locations and a 1,640 ft buffer area around White River beardtongue plant locations as pollinator habitat. The buffer distances are based on the foraging distance of each beardtongue's largest pollinator (USFWS 2021, pp. 10, 33 – 34).

We organized populations into range units separated by unoccupied gaps in the species' ranges (USFWS 2021, p. 10). Each beardtongue species occurs in five range units (units numbered 1 to 5 for Graham's beardtongue and units numbered 2 to 6 for White River beardtongue), and the two species occur together in four of those range units (units 2 to 5) in the central and eastern portion of their ranges in Utah and Colorado. Range units also serve as metapopulations (a regional grouping of connected populations) for the two species (Malone 2014). A metapopulation delineation is helpful when evaluating the condition of populations in a given geographic area within each species' range.

We held expert panel meetings on June 25, 2019, and March 5, 2020, to review and discuss pertinent information regarding the future locations and likelihood of energy development (oil shale, tar sands, and oil and gas development) at a geographic scale relevant to the beardtongues. This was necessary because other sources of information, including technical reports and published literature, generally provided information at a coarser scale (e.g. the Uintah Basin or the State of Utah) than what was needed for our analysis. Experts who participated in the panels included staff from the BLM, State of Utah Division of Oil, Gas, and Mining, State of Utah Geological Survey, and the energy development industry.

We used reliable projections of future events and the future locations of stressors based on best available information and expert opinion. We used a published likelihood scale to elicit expert opinion and convey the likelihood of future occurrence with a consistent treatment of uncertainty (Table 3; Mastrandrea *et al*. 2010, p. 3). For more information on our expert panel meetings, please see the meeting notes (USFWS 2019, entire; USFWS 2020, entire).

Table 3. Likelihood scale to estimate likelihood of future outcome.

Likelihood Descriptor	Likelihood of the Outcome
Virtually certain	99 – 100 % probability
Very likely	90 – 100% probability
Likely	66 – 100% probability
About as likely as not	33 – 66% probability
Unlikely	0 – 33% probability
Very unlikely	0 – 10% probability
Exceptionally unlikely	0 – 1% probability

The expert panel likelihood estimates and best available information from published literature and technical reports informed our ten year energy development (oil shale, tar sands, and oil and gas development) projection timeframe. Our evaluation determined that beyond a ten year timeframe, there was too much uncertainty to project energy development within the beardtongues' populations and ranges, such that projections would become speculative (USFWS 2019, entire; USFWS 2020, entire).

1.2 Analytical Framework

To assess the viability of Graham's and White River beardtongues, we applied the conservation biology principles of resiliency, representation, and redundancy (the 3Rs, Chapter 6). Conservation programs are strengthened by adherence to the 3Rs (Shaffer and Stein 2000, pp. 308-311), and these principles are used by practitioners to develop conservation goals and prioritize areas for conservation efforts (Groves *et al*. 2002, pp. 506–509; Tear *et al*. 2005, p. 841; USFWS 2016, entire; Smith *et al.* 2018, p. 304). Viability is the ability of a species to sustain populations over time. To do this, a species must have a sufficient number and distribution of healthy populations to withstand changes in its biological (e.g., herbivores, disease) and physical (e.g., climate change) environment, environmental stochasticity (e.g., wet or dry, warm or cold years), and catastrophes (e.g., severe and prolonged droughts).

Viability is not a single state such as viable or not viable; rather, there are degrees of viability such as less to more viable, or low to high viability (Shaffer and Stein 2000, p. 310; Wolf *et al.* 2015, p. 204; USFWS 2016, entire; Smith *et al.* 2018, p. 304). Generally speaking, the more resiliency, representation, and redundancy a species has, the more protected it is against environmental variation; the more tolerance it has to stressors (one or more factors that may be acting on the species or its habitat, causing a negative effect) on the landscape; and the better able it is to adapt to future changes in environmental conditions. In short, we used the 3Rs framework to assess the health, number, and distribution of Graham's and White River beardtongues' populations across their current range of adaptive diversity.

1.2.1. Resiliency

Population-level resiliency is the ability to sustain populations in the face of stochastic (random) disturbance (Smith *et al.* 2018, p. 304). Stochastic disturbance includes normal year-to-year variation in rainfall and temperatures, as well as unseasonal weather events such as drought, fire, flooding, and storms. Simply stated, resiliency is having the means to recover from bad years (e.g., drought). To be resilient at the species-level, there must be healthy populations that are able to sustain themselves through good and bad years. The healthier the populations and the greater number of healthy populations, the more resiliency a species possesses.

Resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations. Generally, populations need abundant individuals within habitat patches of adequate area and quality to maintain survival and reproduction in spite of environmental variation (Smith *et al.* 2018, p. 304). To assess Graham's and White River beardtongues' future resiliency, we performed the same evaluation of relevant habitat and demographic factors as we did for the current condition and calculated an overall future condition score for each population (section 3.1, Development of Future Scenarios; USFWS 2021, pp. 64 – 68). We compared the current and projected future resiliency of each population under two future scenarios (section 3.2, Moderate Energy Development; section 3.3, High Energy Development).

1.2.2. Redundancy

Species-level redundancy is the ability of a species to withstand catastrophic events (Smith *et al.* 2018, p. 304). Redundancy protects species against the unpredictable and highly consequential events for which adaptation is unlikely. In short, it is about spreading the risk. Redundancy is best achieved by having multiple, resilient populations distributed within the species' ecological settings and across the species' range (Wolf *et al.* 2015, p.5 ; Smith *et al.* 2018, p. 306 – 307). Having multiple populations reduces the likelihood that all populations are affected simultaneously, while having widely distributed populations reduces the likelihood of populations possessing similar vulnerabilities to a catastrophic event. Redundancy can be measured by population number, resiliency, spatial extent, and degree of connectivity.

To assess Graham's and White River beardtongues' future redundancy, we evaluated the projected number and distribution of populations within the species range relative to the current condition under two future scenarios (sections 3.2, Moderate Energy Development and 3.3, High Energy Development).

1.2.3. Representation

Species-level representation is the ability of a species to adapt to near and long-term changes in the environment, and it demonstrates the evolutionary capacity or flexibility of a species (Smith *et al.* 2018, p. 304). Representation is the range of variation found in a species, and this variation--called adaptive diversity--is the source of species' adaptive capabilities. Representation can be measured by the breadth of ecological and genetic diversity of the species. Ecological diversity is the physiological, ecological, and behavioral variation exhibited by a species across its range. Genetic diversity is the number and frequency of unique alleles (different forms of a gene) within and among populations. By maintaining these two sources of adaptive diversity across a species' range, the responsiveness and adaptability of a species over time is preserved.

We held an expert panel meeting on June 2, 2017, to review and discuss pertinent information regarding the range of ecological and genetic variation (representation) found in Graham's and White River beardtongues (USFWS 2017, p. 4). We used the information from the expert workshop to help us identify the appropriate scale and dataset to evaluate ecological variation (section 6.4, Species Representation). To assess Graham's and White River beardtongues' future representation, we evaluated the projected changes in demographic (population size) and ecological (ecological settings) factors, as surrogates for genetic diversity relative to the current condition (sections 3.2, Moderate Energy Development and 3.3, High Energy Development).

Chapter 2. Future Condition: Factors Influencing Viability

In this chapter, we summarized our future projections for stressors (external factors) and conservation efforts that may influence the viability of Graham's and White River beardtongues. The stressors are the same as those we evaluated in our recent Biological Report, and include three types of energy exploration and development (oil shale, tar sands, and traditional oil and gas drilling); road construction; herbivory; invasive weeds; small population size; and climate change. For each stressor, we included a quantitative assessment of the projected future magnitude of the stressor (where possible). For more detail on the stressors and their effects to the beardtongues, please refer to our Biological Report (USFWS 2021, entire).

We begin by stating our assumptions and the future forecast of each stressor, followed by the future protections afforded to the beardtongues, including implementation of the conservation agreement (2014 CA) and regulatory mechanisms.

2.1 Oil Shale

For oil shale, we considered past and current exploration and commercial development activities, expert opinion of likelihood estimates (section 1.2, Analytical Framework), and the best available information. Here, we summarize the likelihood estimates for future exploration and development, and our two future oil shale forecasts. For more detail about this stressor and future likelihood estimates, see Appendix 1.

Exploration Activities

Within the beardtongues' ranges, oil shale exploration activities are occurring on non-Federal lands in Utah, due to fewer restrictions on oil shale leasing and exploration activities (e.g. regulatory review), and lower costs of leasing, royalty rates (payment to landowner on fuel removed), and taxes as compared to Federal lands (Institute for Clean and Secure Energy (ICSE) 2013, pp. 5 – 6, 37 – 48, 51, 52; Industrial Economics, Incorporated (IEC) 2014, pp. 14 – 26; Utah Administration Code 2020, entire; BLM 2017, p.4; Ruple 2017, pp. 24 – 25). Oil shale exploration on non-Federal lands is likely to occur beyond 2030 (Table 4; Ruple 2017, p. 32; USFWS 2019 and 2020a, entire; Utah Division of Oil Gas and Mining (UDOGM) 2019a, 2020a, 2020b, 2020c, entire;).

Table 4. Summary of future oil shale exploration and development in the range of the Graham's and White River beardtongues.

Oil Shale Activities	Landownership	Likelihood of the Outcome	
		2020 – 2030	2030+
Exploration	State and Private Lands (with high economic potential)[1]	Likely	Likely
	BLM Lands (with high economic potential)	Unlikely	Unlikely
Commercial Development	State and Private Lands (Seep Ridge, Holliday block, Enefit South Block)[2]	About as likely as not	Cannot make a reliable prediction
	BLM Lands (with high economic potential)	Unlikely	Cannot make a reliable prediction

On Federal lands in Utah and Colorado, oil shale leasing has declined over time and there is currently one active research, development, and demonstration (RD&D) lease on 160 acres (ac) in Utah outside of beardtongue habitat (Ruple 2017, p. 24; USFWS 2019 and 2020a, entire). The BLM has not received proposals for new RD&D leases (USFWS 2019, p. 4), and it is unlikely that oil shale exploration will occur on Federal lands within the next 10 years due to the additional restrictions and regulations, and higher costs relative to non-Federal lands (Table 4; USFWS 2020, entire; ICSE 2013, pp. 5 – 6, 40 – 48, 51, 52; IEC 2014, pp. 14 - 26). The likelihoods of future exploration may change if there are changes to Federal leasing requirements for oil shale.

Oil shale exploration activities have the potential to increase above current activity levels if the technology improves and the economic oil market becomes more favorable. Likewise, oil shale exploration activities have the potential to decrease below current activity levels if the market

[1] These lands are identified from Utah Geological Survey (UGS) shapefiles provided by Michael Vanden Berg identifying oil shale resource areas of 15 GPT at on the surface to a 400 foot (ft) depth for surface mining.
[2] The predictions are only for the best areas for commercial development identified in parentheses.

price of oil remains low. We anticipate exploration activities will occur on state and private lands at a low level that is similar to current levels of exploration activities, until the extraction technology improves and economic market conditions become more favorable (USFWS 2019, p. 4).

Commercial Development Activities

There is currently no commercial development of oil shale in the beardtongues' ranges despite the vast amount of the resource in the Uinta and Piceance Basins (Weiss *et al.* 1982, p. 1; ICSE 2011, p. 2; ICSE 2013, pp. 9, 23; IEC 2014, p. 14; Aho 2015, p. 334; BLM 2017, p. 14; Mills *et al.* 2019, p. 31).

The lack of an efficient extraction technology and low oil market values are the primary constraints for commercial development (BLM 2017, pp. 75 – 76). Oil shale industry representatives (e.g. Red Leaf Resources, Inc. and Enefit) are optimistic that efficient extraction technologies will be developed within the next ten years, and state the primary constraint for commercial development is the price of crude oil (USFWS 2020, pp. 3 – 4). It is about as likely as not that oil shale commercial development will occur on state and private lands in the next ten years (Table 4; USFWS 2020, entire). The best areas for commercial development within the beardtongues' ranges are state and private lands in three general areas including Seep Ridge area, Holliday block, and Enefit South Block, due to the size of the resource and the consolidated acreage of non-Federal lands. We are not able to provide a reliable prediction for oil shale commercial development beyond 2030, because experts considered the uncertainty to be too great beyond this timeframe (Table 4; BLM 2017, pp. 75 – 76; USFWS 2019 and 2020a, entire). This 10-year forecast period is consistent with an economic forecast of this industry and the considerable uncertainty of predicting beyond this timeframe (IEC 2014, p. 20).

On Federal lands in Utah and Colorado, the BLM has not developed a reasonably foreseeable development scenario because the information on oil shale is too speculative to permit future commercial leasing proposals (BLM 2013, pp. 24, 64). The BLM does not currently allow leasing for commercial development of oil shale, because the agency will need to consider the environmental consequences of future technology and proposed commercial projects before committing to broad scale commercial oil shale development (BLM 2013, pp. 27, A-4 – A-10; BLM 2017, pp. 5, 63 – 68). As such, we no longer consider Federal lands outside of current RD&D areas in Utah and Colorado as likely to be developed in the next ten years (78 FR 47599, August 6, 2013).

Future Forecasts for Oil Shale

We developed two future forecasts (a moderate and high forecast) indicating where surface disturbance may occur due to oil shale exploration and development within the beardtongues' ranges over our forecast timeframe for oil shale of 2020 to 2030. The moderate forecast assumed disturbance would occur on lands with the highest development potential for oil shale, and where exploration activities are in progress. The high forecast assumed disturbance will occur on the same lands as the moderate forecast, plus other non-Federal lands with high economic potential surface deposits (15 gallons per ton (GPT) threshold) and those under lease or permit for oil shale.

For both forecasts, we assumed that total loss of plants and habitat would occur within these disturbed areas, to evaluate the worst-case impacts from oil shale; and that commercial development activities will occur in the next ten years. We did not develop an "exploration-only" forecast, with a smaller surface disturbance area, even though it would also be a plausible future forecast for oil shale, but these smaller impacts would be expected to fall within the range between current conditions and our two future scenarios.

We removed 2014 CA designated conservation areas on Federal and state lands from our analysis of disturbance, because these areas are afforded protections until 2034, which exceeds our forecast timeframe for oil shale. We did not remove 2014 CA designated conservation areas on private lands from our analysis, because protections on those lands expire in 2029, during our forecast timeframe for oil shale (Section 1.1, Regulatory Mechanisms). We summarized the moderate and high forecasts, below.

Oil Shale - Moderate Forecast

The moderate forecast identified disturbance from oil shale activities in the following areas (Figures 2 and 3):

- The best areas for commercial development on state and private (non-Federal) lands included the Seep Ridge, Holliday Block, and Enefit South Block areas (USFWS 2020, entire). Exploration and commercial development are not expected to occur on Federal lands during our forecast timeframe.

The moderate forecast identified that the following areas would not be developed for oil shale:

- 2014 CA designated conservation areas on state lands.

The moderate forecast identified that the oil shale stressor overlaps with six Graham's beardtongue populations (13, 17, 18, 19, 20, 22) and three White River beardtongue populations (8, 9, 10).

Oil Shale - High Forecast

The high future forecast identified disturbance from oil shale activities in the following areas (Figures 4 and 5):

- The best areas for commercial development on state and private (non-Federal) lands included the Seep Ridge, Holliday Block, and Enefit South Block areas (USFWS 2020, entire). Commercial development is not likely to occur on Federal lands.
- All lands (Federal and non-Federal) currently under lease or permit for oil shale.
- State and private (non-Federal) lands with high economic potential (15 GPT) for surface and underground mining as identified by Utah Geological Survey (UGS) shapefiles (USFWS 2020, entire).

The high future forecast identified that the following areas would not be developed for oil shale:

- 2014 CA designated conservation areas on Federal and state lands.
- Federal lands subject to the following resource management plan (RMP) restrictions: 300 ft avoidance buffer; the slope (40 degrees or greater) stipulation, the NSO stipulation, and the Area of Critical Environmental Concern (ACEC) designation (section 1.9, Future Protections Afforded to the Beardtongues).

The high forecast identified that the oil shale stressor overlaps with 11 Graham's beardtongue populations (7, 11, 12, 13, 15, 17, 18, 19, 20, 22, 23) and 8 White River beardtongue populations (4, 5, 8, 9, 10, 11, 12, 13).

<u>Uncertainty</u>

Using best available information, there is too much uncertainty for us to project the following:

- Specific locations or an estimated number of future RD&D leases on Federal lands.
- The timing and type of oil shale extraction technology that will be developed in the future.
- If there will be future technology that results in commercially viable oil shale development in the Uinta Basin.
- The timing of favorable economic oil markets that would result in economically viable commercial oil shale development in the Uinta Basin.
- A certain rate of exploration or disturbance within the identified area over time unless there are approved mining plans.

There are large uncertainties involved in predicting profitability for commercial oil shale development due to the difficulty of:

- Estimating the threshold or "hurdle price" of crude oil needed to motivate investment for the construction of commercial-scale oil shale facilities, given the high capital costs. The threshold would probably be substantially higher than the crude oil market price (Bartis *et al.* 2005, p. 46; ICSE 2013, pp. 134 – 135; Spinti *et al.* 2013, pp. 14 – 17).
- Predicting future crude oil prices due to their high annual volatility (variability) (Bartis *et al.* 2005, pp. 45 – 46; ICSE 2013, pp. 90 – 91; BLM 2017, p. 76).
- Evaluating the Red Leaf Resources, Inc. oil product to predict profitability (IEC 2014, pp. 23 – 24).

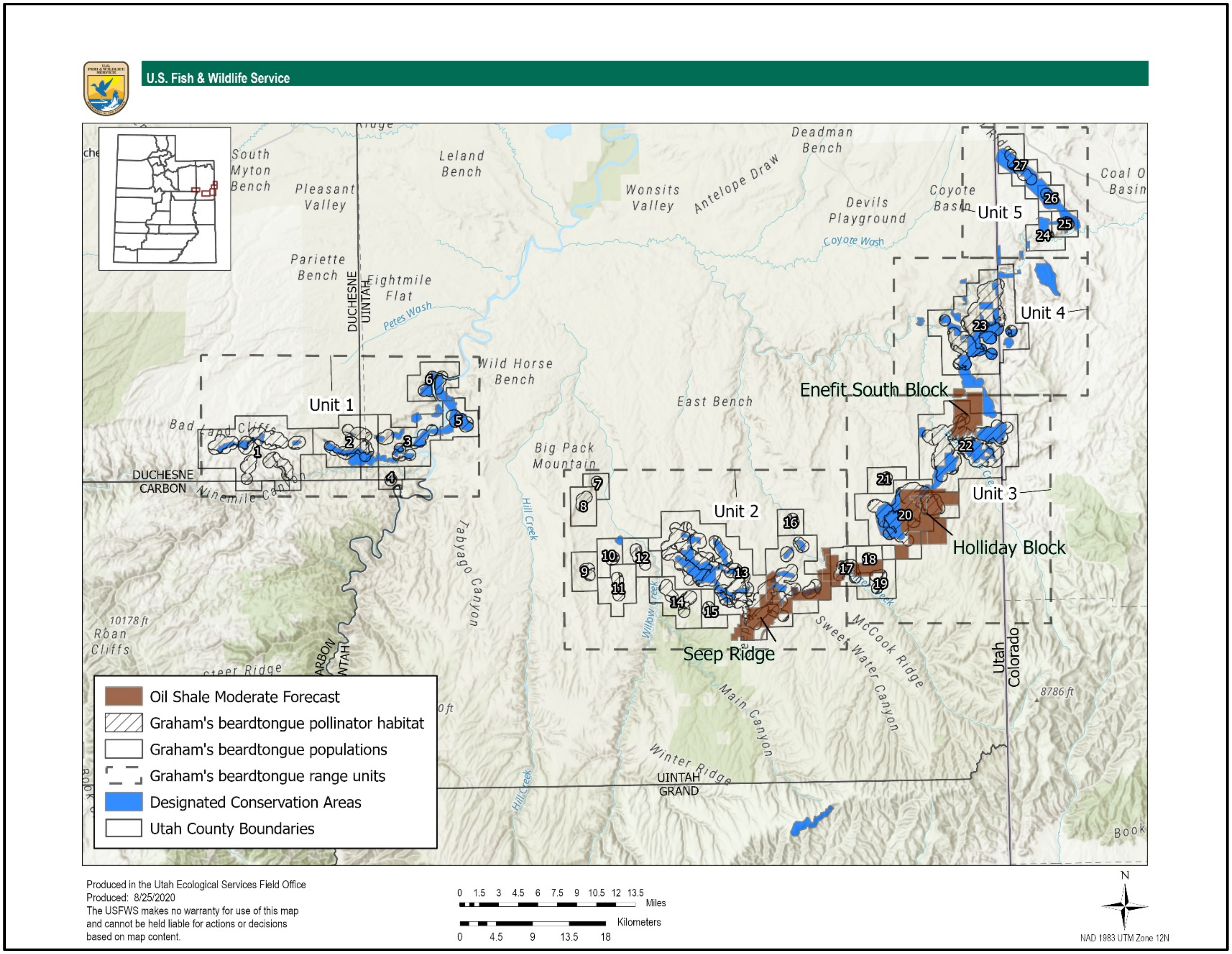

Figure 2. The moderate forecast for oil shale and Graham's beardtongue populations 1 - 27.

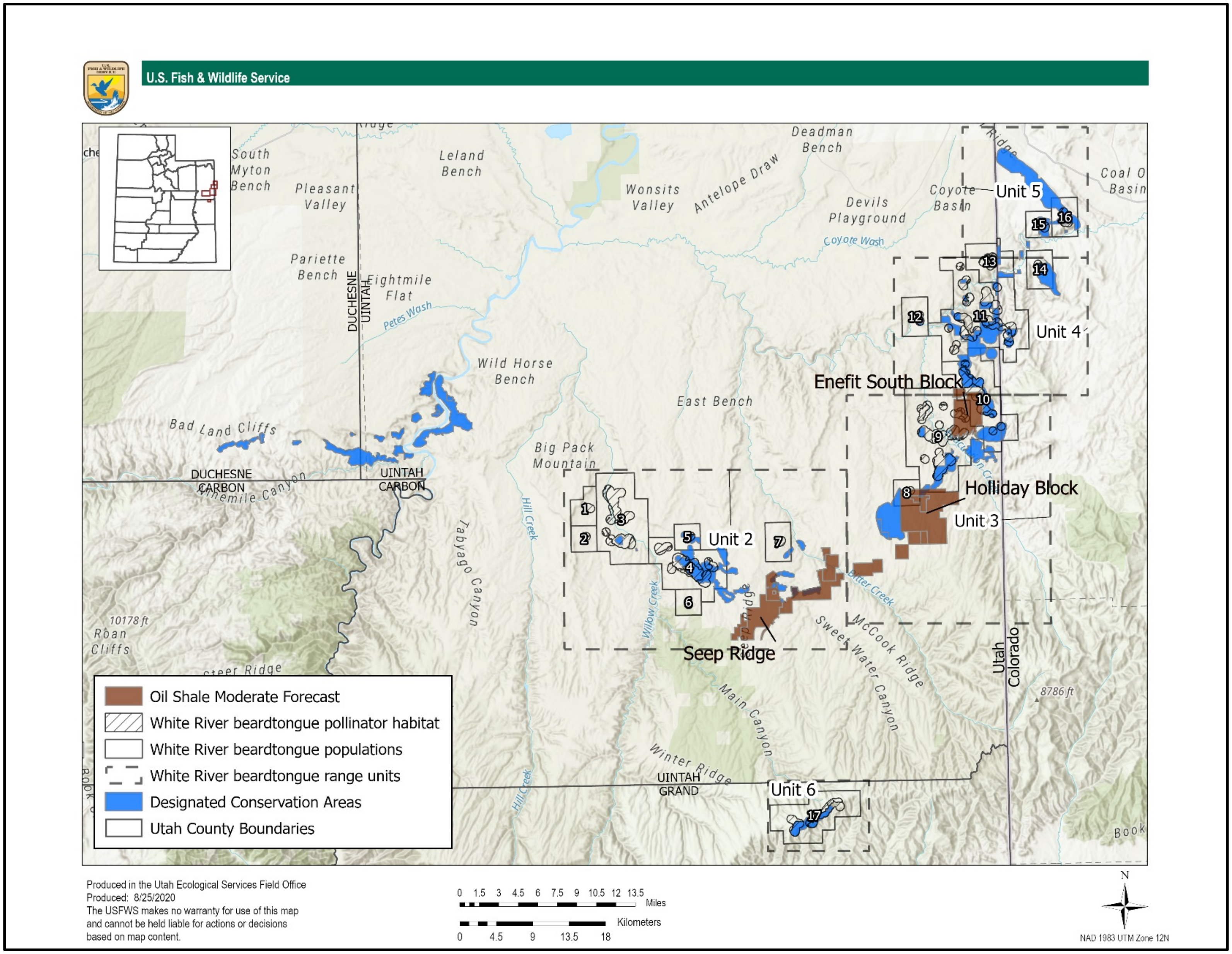

Figure 3. The moderate forecast for oil shale and White River beardtongue populations 1 - 17.

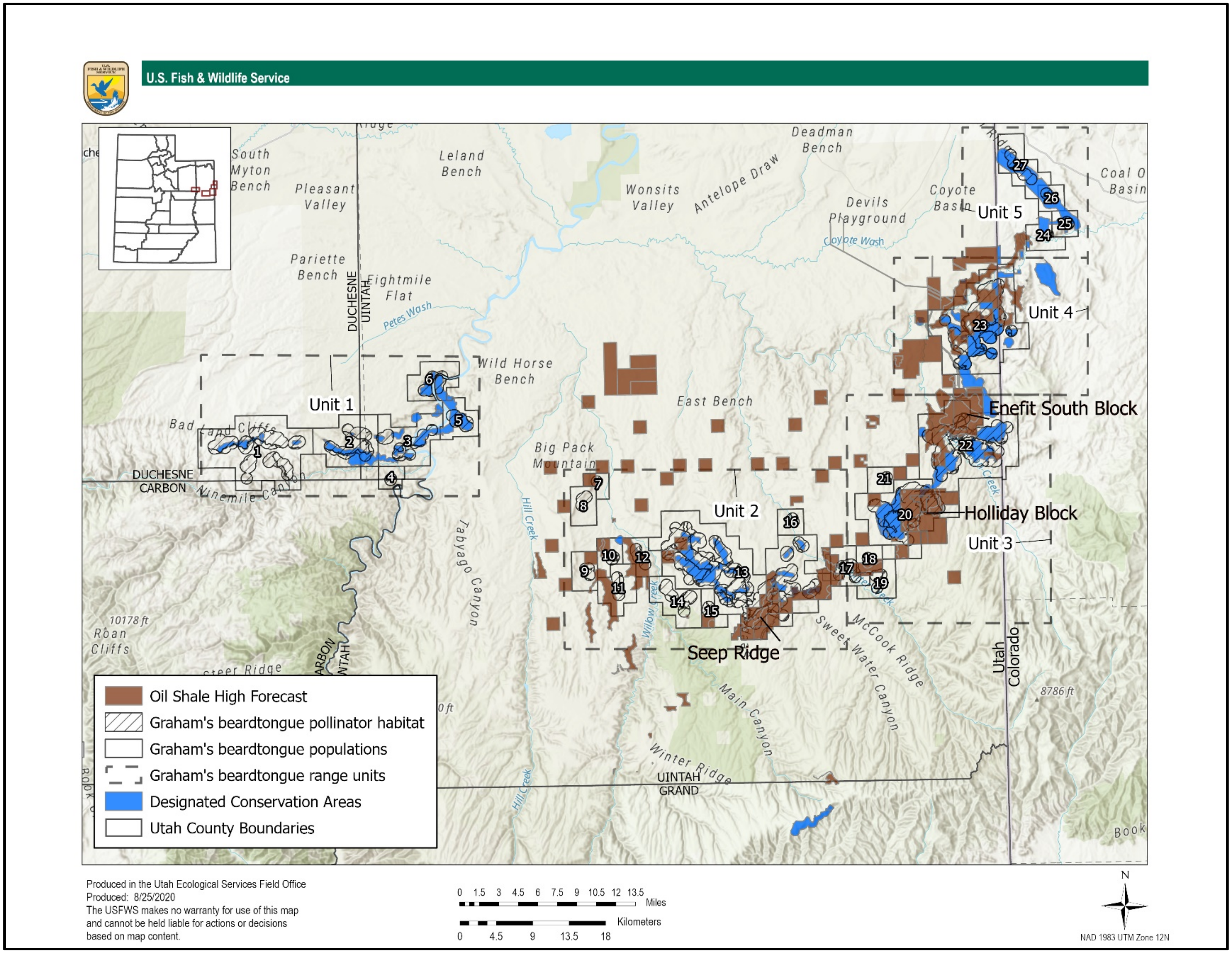

Figure 4. The high forecast for oil shale and Graham's beardtongue populations 1 - 27.

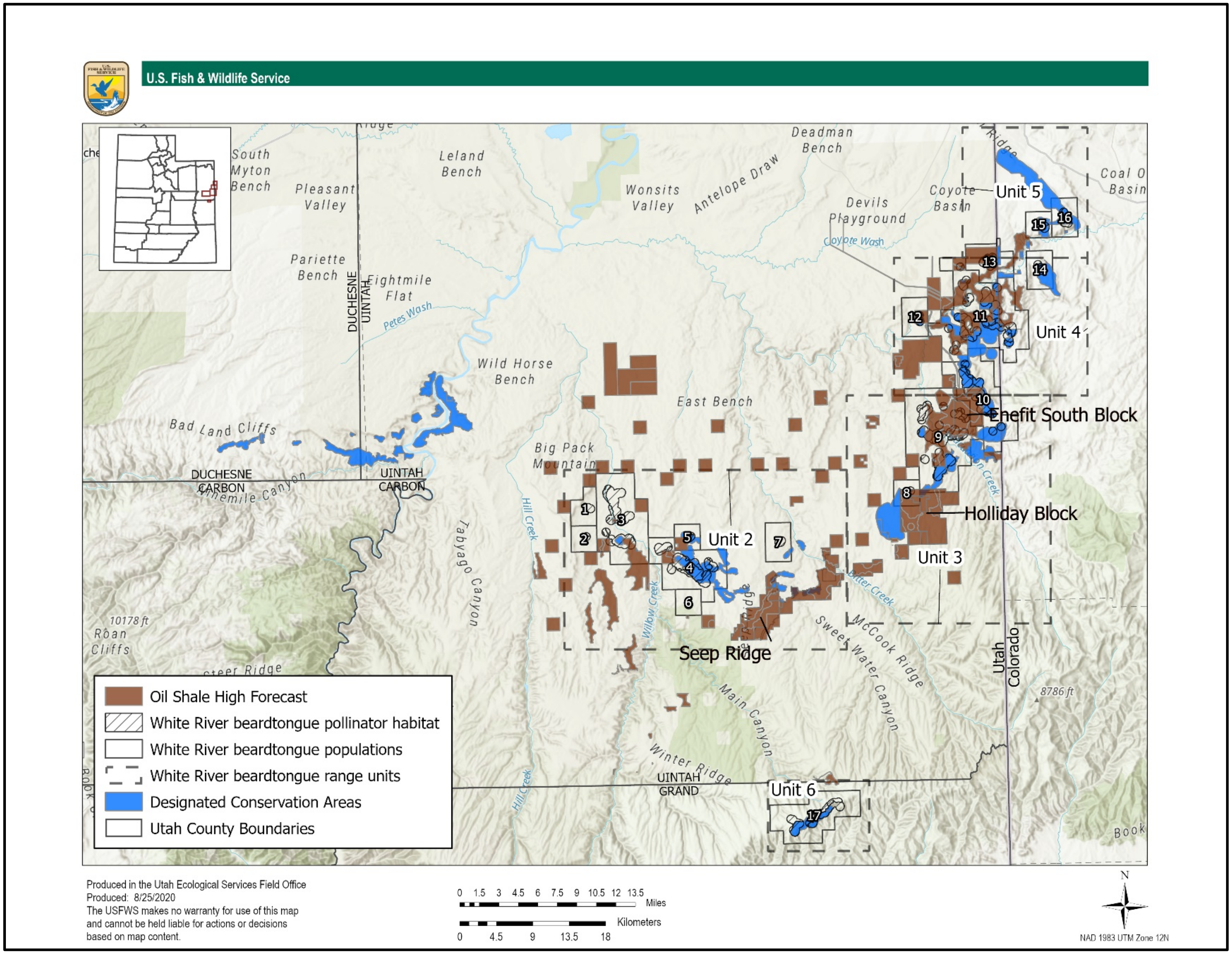

Figure 5. The high forecast for oil shale and White River beardtongue populations 1 – 17.

2.2 Tar Sands

For tar sands, we considered past and current exploration and commercial development activities, expert opinion of likelihood estimates (section 1.2, Analytical Framework), and the best available information. Here, we summarize the likelihood estimates for future exploration and development, and our future tar sands development forecast.

Exploration Activities

Within the beardtongues' ranges, the only past and current tar sands exploration area is the PR Spring Mine on state and private lands in the PR Springs South area next to one White River beardtongue population (17) in the Book Cliffs (Figure 6; USFWS 2021, pp. 48 – 49). Recent exploration activities focused on surface mining techniques on tar sands deposits to a depth of 500 ft below the surface (Boden *et al.* 2018, p. 25; UDOGM 2019b, p. 3; UDOGM 2019c, entire). It is likely that tar sands exploration will continue on state and private lands in the PR Springs Special Tar Sands Area (STSA) South area based on exploration results and the pattern of testing new technologies on the tar sands surface deposits at this location (Table 5; Blackett 1996, p. 1; ICSE 2013, pp. 5 – 6, 26; USFWS 2020, entire). Exploration in the northern part of the PR Springs STSA (PR Springs North) is unlikely in the next 10 years due to the lower quality and quantity of the surface deposits (Table 5; USFWS 2020, entire).

Table 5. Summary of future tar sands exploration and development in the range of the Graham's and White River beardtongues.

Tar Sands Activities	Landownership	Likelihood of the Outcome	
		2020 – 2030	2030+
Exploration	State and Private Lands (Asphalt Ridge, PR Springs South)[3]	Likely	Likely
	State and Private Lands (PR Springs North) [4]	Unlikely	Unlikely
	BLM Lands (outside of active lease areas)	Unlikely	Unlikely
Commercial Development	State and Private Lands (Asphalt Ridge, PR Springs South)[5].	About as likely as not	Cannot make a reliable prediction
	BLM Lands (outside of active lease areas)	Unlikely	Cannot make a reliable prediction

In the PR Springs STSA, the BLM issued combined hydrocarbon leases that allow for tar sands exploration and traditional oil and gas development in the 1980s and 1990s, and had pending

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[3] See USFWS 2020, p. 14. Note: Asphalt Ridge is outside of the beardtongues' ranges.
[4] See USFWS 2020, p. 14.
[5] The predictions are only for the best areas for commercial development identified in parentheses. Note: Asphalt Ridge is outside of the beardtongues' ranges.

conversion applications under review since the 1980s (BLM 1985, entire; BLM 2013, pp. 37 – 40). Locations of proposed lease conversions were predominantly in the PR Springs South area (BLM 1985, p. A-4, A-11). There is only one lease conversion application in process by Enercor that was recently finalized in the PR Springs South area, outside of beardtongue occupied and pollinator habitat (Nordstrom 2020, entire).

Tar sands exploration activities have the potential to increase above current levels if the technology improves and the economic oil market becomes more favorable. Likewise, tar sands exploration activities have the potential to maintain their current status of no activity if the market price of oil remains low. We anticipate exploration activities will occur on state and private lands at a low level that is similar to recent exploration activities until the extraction technology improves, and economic market conditions become more favorable (Table 5; USFWS 2020, entire). We expect future exploration activities to continue within current lease areas in the PR Springs South area (Boden *et al.* 2018, p. 25; Mills *et al.* 2019, p. 32; USFWS 2021, entire; USFWS 2021, pp. 48 – 49).

<u>Commercial Development Activities</u>

There is currently no commercial development of tar sands in the Uinta Basin and the beardtongues' ranges, despite the vast amount of the resource in the Uinta Basin special tar sands areas (STSAs) (Dana and Sinks 1984, p. 220; Blackett 1996, p. 1; BLM 2013, pp. 37 – 40; ICSE 2013, pp. 26 – 30, 230; Boden *et al.* 2018, p. 25; Mills *et al.* 2019, p. 32). The tar sands resource in Utah is considered low grade and occurs in thin layers that would require considerable operating expenses to remove overburden, process, and transport, in addition to transportation and water availability constraints (ICSE 2013, pp. 26 – 30). The current technologies employed for commercial development in Alberta, Canada are not directly applicable to oil shale in the Uinta Basin, and future commercial development, if any, would likely be much smaller in size than Alberta, Canada (ICSE 2013, pp. 26 – 30).

Tar sand industry representatives are optimistic that efficient extraction technologies will be developed in the next ten years, and state the primary constraint for commercial development is the price of crude oil (USFWS 2020, pp. 3 – 4). The best areas for commercial development in the beardtongues' ranges are state and private lands in the PR Springs South area (USFWS 2020, p. 14). We are not able to provide a reliable projection for tar sand commercial development beyond 2030 because experts considered the uncertainty to be too great beyond this timeframe, such that projections would become speculative (Table 5; USFWS 2020, entire). The 10-year forecast period is consistent with an economic forecast of this industry and the considerable uncertainty of predicting beyond this timeframe (IEC 2014, p. 20).

On Federal lands in Utah and Colorado, the BLM has not developed a reasonably foreseeable development scenario because the information on commercial development of tar sands is too speculative to evaluate potential impacts of future development (BLM 2013, pp. 63 – 64). The BLM allows leasing for commercial development of tar sands and will need to consider the environmental consequences of future technology and proposed commercial projects within STSAs (BLM 2013, pp. 27, A-4 – A-10; BLM 2017, pp. 5, 63 – 68). Based on our review of best available information, we no longer consider any of the Federal lands identified as available for tar sands leasing in Utah and Colorado likely to be developed in the near future (78 FR

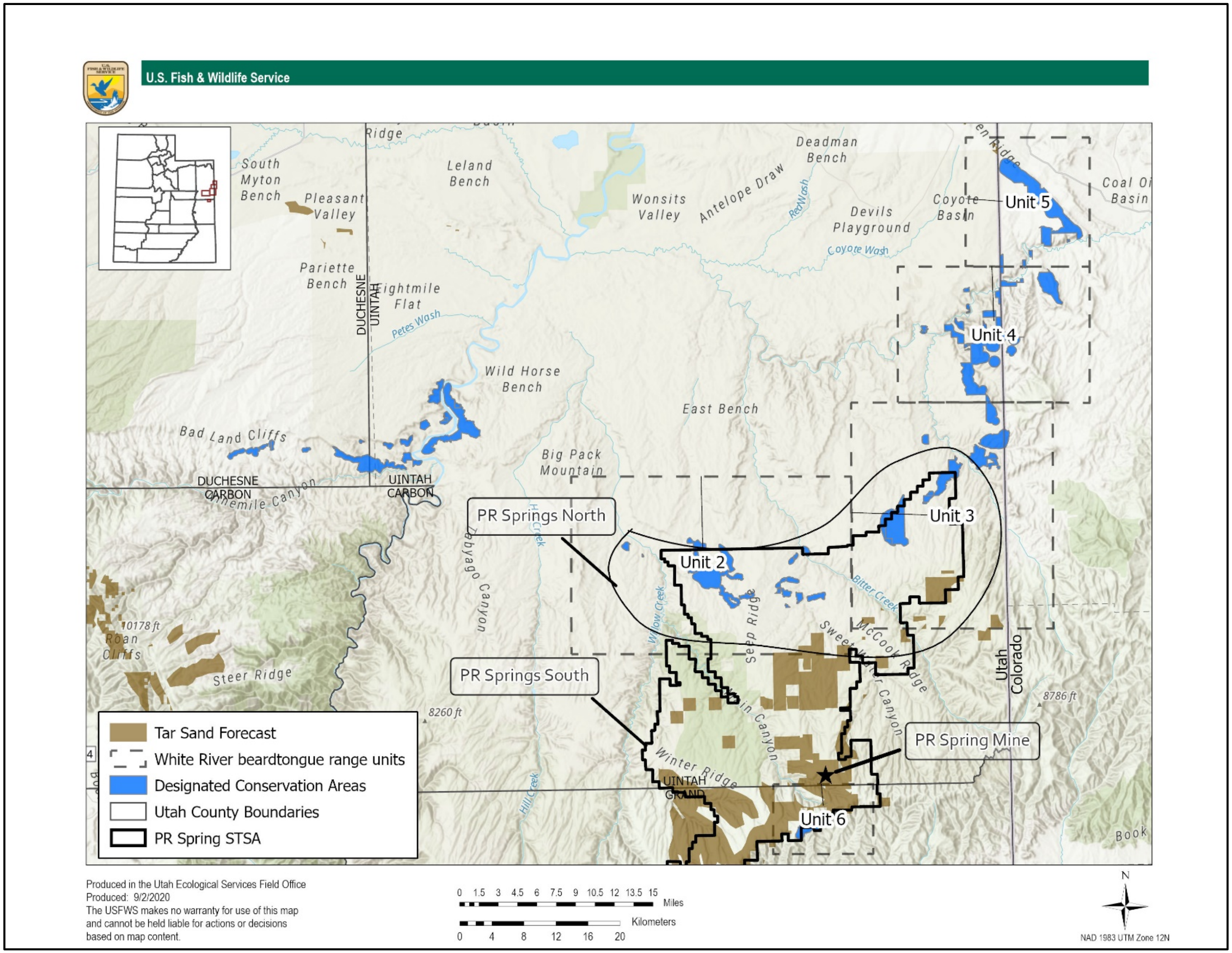

Figure 6. The PR Springs North and South areas and the PR Springs Mine in the PR Springs Special Tar Sand Area (STSA).

47599, August 6, 2013). It is unlikely that tar sands commercial development will occur on Federal lands in the next ten years (Table 5; USFWS 2020, entire). We are not able to provide a reliable prediction beyond 2030 because experts considered the uncertainty to be too great beyond this timeframe (Table 5; BLM 2017, pp. 75 – 76; USFWS 2019, entire; USFWS 2020, entire).

Future Forecast for Tar Sands

We identified one future forecast for tar sands exploration and development where surface disturbance may occur within the beardtongues' ranges over our forecast timeframe for the stressor (2020 – 2030). The forecast included lands under lease or permit for tar sands. Our analysis included the following assumptions: commercial development activities for tar sands will occur in the next 10 years; and the total loss of plants and habitat will occur where disturbance due to tar sands is projected, to evaluate worst-case impacts from this stressor. We did not develop an exploration only forecast with a smaller surface disturbance extent even though it would also be a plausible future forecast for tar sands. Therefore, our scenario is intended to bracket the full range of plausible future impacts, and the actual future impacts of tar sands to the beardtongues may fall anywhere in between their current conditions and the impacts projected in our forecast.

We removed 2014 CA designated conservation areas on Federal and state lands from our future analysis of tar sands impacts, because these areas are afforded protections until 2034, which exceeds our forecast timeframe for tar sands. We did not remove 2014 CA designated conservation areas on private lands from our analysis, because protections expire in 2029, during our forecast timeframe. We summarized the forecast, below.

The tar sands forecast assumed disturbance from tar sands activities would occur in the following areas (Figure 6; Figure 7):

- All lands currently under lease or permit for tar sands.
- State and private (non-Federal) lands with tar sands surface deposits in the PR Springs South area (Book Cliffs).

We also identified that the following areas would not be developed for tar sands:

- 2014 CA conservation areas on Federal and state lands.

The forecast identifies that the tar sands stressor overlaps with one White River beardtongue population (17) (Figure 7), but no Graham's beardtongue populations (Figure 6).

Uncertainty

Using the best available information, there is too much uncertainty for us to predict the following conditions:

- The timing and type of tar sand extraction technology developed in the future.

- If there will be future technology that results in commercially viable tar sand development in the PR Springs STSA.
- The timing of favorable economic oil markets that would result in economically viable commercial tar sand development in the PR Springs STSA and other STSAs in the Uinta Basin.
- A certain rate of exploration or disturbance within the identified area over time unless there are approved mining plans.

There are large uncertainties involved in predicting profitability for commercial tar sand development due to the difficulty of:

- Estimating the costs associated with utilities, infrastructure, and site-specific extraction methods, recovery and upgrading due to the variable composition of the tar sand resource (Oblad *et al.* 1987, pp.330, 346 – 347; ISCE 2013, pp. 216 – 217, 220 – 230). Tar sands commercial development was predicted to be profitable only with a high quality resource deposit similar to the Asphalt Ridge STSA located outside of the beardtongues' ranges (ICSE 2013, p. 228; Spinti *et al.* 2013, pp. 14 – 17).
- Comparing capital and supply costs of different project operations (ISCE 2013, pp. 228 – 230).

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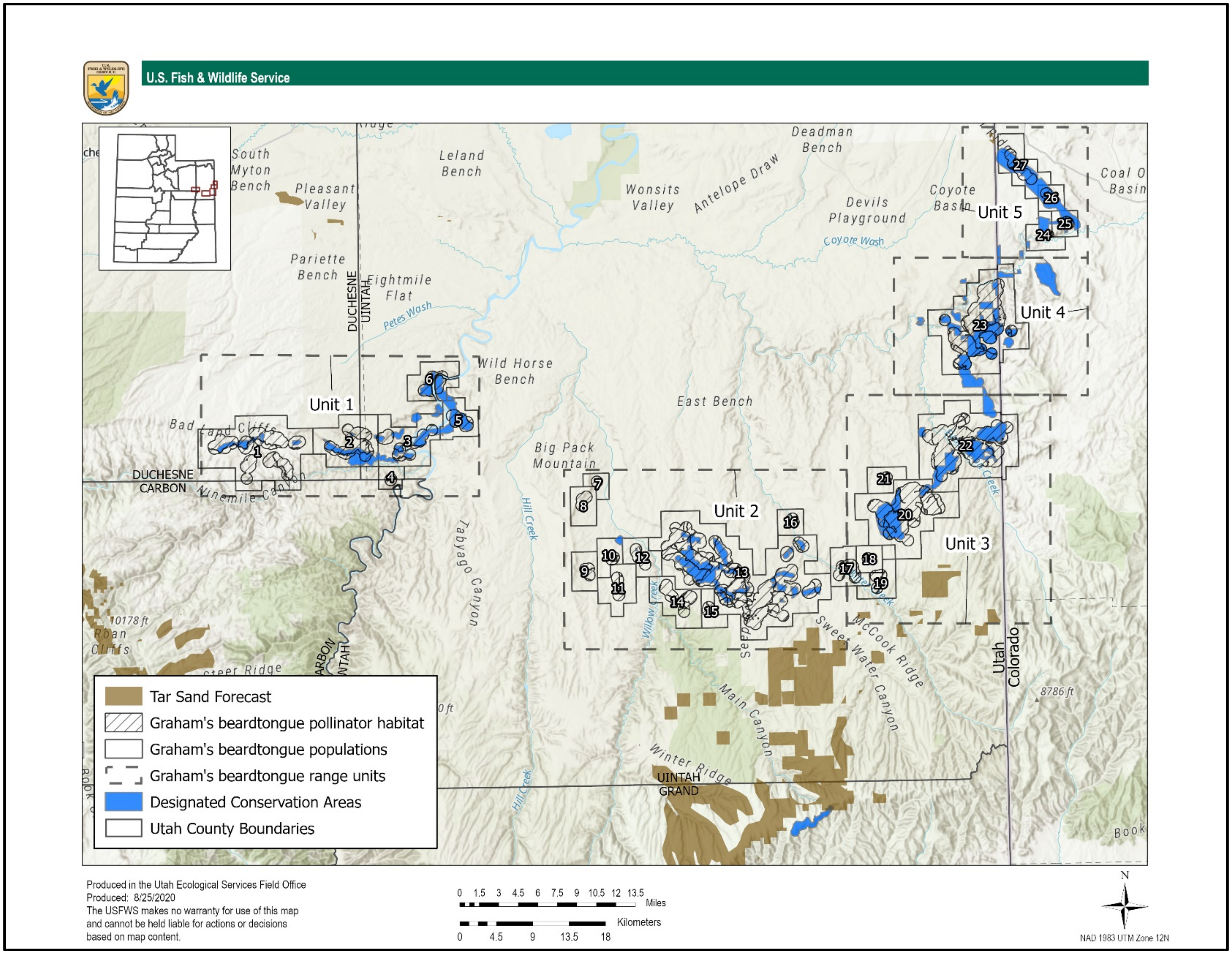

Figure 7. The forecast for tar sands and Graham's beardtongue populations 1 -27.

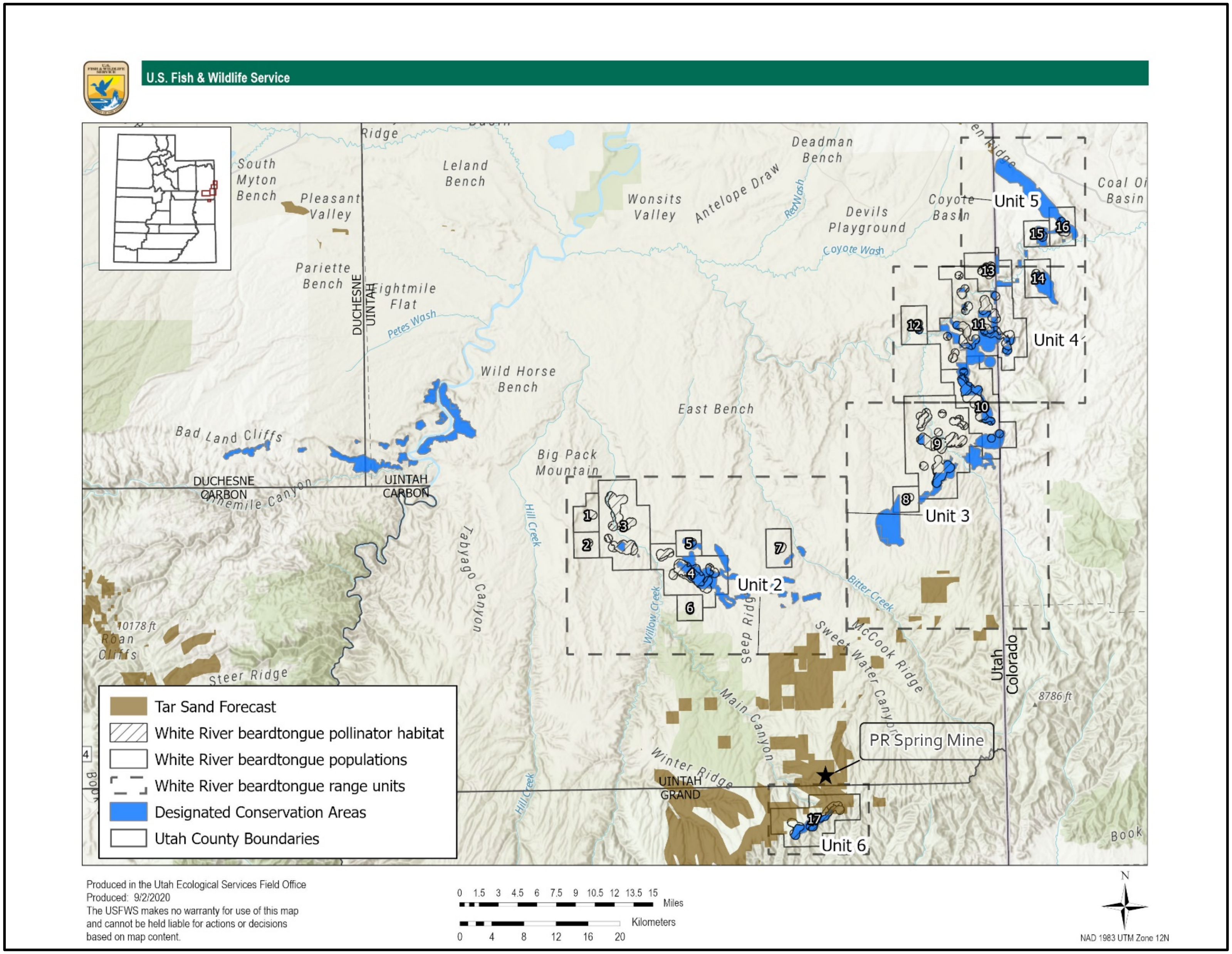

Figure 8. The forecast for tar sands and White River beardtongue populations 1 - 17.

2.3 Traditional Oil and Gas

For evaluation of traditional oil and gas, we considered past and current exploration and commercial development activities, expert opinion of likelihood estimates (section 1.2, Analytical Framework), and the best available information. Here, we summarize the likelihood estimates for future exploration and development, and our future oil and gas forecast.

Exploration Activities

The oil resource within the beardtongues' ranges has been explored to a limited extent in two of the six range units (1 and 2), whereas the majority of past oil exploration to delineate known oil fields has occurred north of their ranges. Based on past exploration efforts, there is one delineated oil field in range unit 2 that overlaps with four Graham's beardtongue populations (9, 10, 11, 12) and two White River beardtongue populations (2, 3), and it occurs primarily on private and state lands. Interest in future oil exploration is low within the beardtongues' ranges because companies are focusing on commercial development within delineated oil fields north of the species' ranges. There is some interest in exploring the Mancos B play (a sandy interval within the Mancos Shale, also referred to as the Prairie Canyon member of the Mancos Shale in the literature) on the Utah – Colorado border, to assess its production potential (Vanden Berg 2018, p. 2; Wiseman and Birgenheier 2019, entire; USFWS 2020, entire). It is likely that 5 to 10 wildcat wells[6] will be drilled over the next 5 to 10 years in Uintah County to explore the oil resource of the Mancos B play; drilling locations within the county have not been determined (USFWS 2020, entire). This would be equivalent to 30 acres of disturbance (assuming 3 acres per well pad and associated infrastructure) somewhere in the county with the potential to overlap 10 Graham's beardtongue populations (1, 9, 10, 11, 12, 13, 15, 16, 21, 22) and one White River beardtongue populations (17) (USFWS 2021, pp. 47 – 52; Moore 2019, entire). We are not able to provide a reliable prediction of oil exploration activities beyond 2030, because future likelihoods will be dependent upon the results of the Mancos B play production potential from the 5 to 10 wildcat wells (Table 6; USFWS 2020, entire).

The natural gas resource within the beardtongues' ranges has already been explored and there is no need or interest to perform exploration in the future (Table 6; USFWS 2020, entire). Based on past exploration efforts, the natural gas resource is present across the beardtongues' ranges, inside and outside of delineated natural gas fields in Uintah County, and we discuss this further in the commercial development section, below.

Commercial Development Activities

We evaluated commercial development activity within the beardtongues' ranges based on publicly available oil and gas well information (Lewinsohn 2020, entire). Within the beardtongues' ranges, existing wells produce natural gas and oil, but most of them are not active and they are plugged and abandoned (Lewinsohn 2020, entire). Within beardtongue pollinator

[6] Wildcat wells are drilled in areas that have not been explored and are considered unproven (Market Business News 2020, entire). These wells are expensive to drill and are considered a high risk venture (Market Business News 2020, entire).

habitat, there are three Graham's beardtongue populations (1, 13, 22) and no White River beardtongue populations with active wells (e.g. producing wells, shut in wells[7], new applications).

Table 6. Summary of future oil and natural gas exploration and development in the range of Graham's and White River beardtongues.

Exploration Activities	Landownership	Likelihood of the Outcome	
		2020 – 2030	**2030+**
Oil	BLM, State and Private Lands (within Mancos B play)	Likely (5- 10 wells drilled)	Cannot make a reliable prediction
Natural Gas	BLM, State and Private Lands	None – Exploration Complete	
Commercial Development Activities	**Landownership**	**Likelihood of the Outcome**	
		2020 – 2030	**2030+**
Oil	BLM, State and Private Lands	Unlikely[8]	Cannot make a reliable prediction
Natural Gas	BLM, State and Private Lands	Likely[9] (0-5 wells drilled per year)	Cannot make a reliable prediction

Future oil commercial development is unlikely within the beardtongues' ranges over the next 10 years, because companies are focusing their development activities within delineated oil fields north of their ranges (Vanden Berg 2018, entire; Table 6). Therefore, we assume for our analysis that no new oil wells[10] will be drilled within the beardtongues' ranges over the next 10 years. We use a ten-year forecast time period for the purpose of our analysis, but investment decision makers and policymakers generally use a 6 to 7-year time period for long-term forecasts (Alquist *et al.* 2011, pp. 30 – 32). Due to the unreliability of longer-term forecasts, we are not able to provide a reliable prediction beyond 2030. Future oil development likelihoods after 2030 will be dependent upon the exploration results of the Mancos B play production potential (Table 6; section 1.4 Traditional Oil and Gas, Exploration Activities; USFWS 2020, entire).

Future natural gas commercial development within the beardtongues' ranges depends upon the market price of natural gas (Vanden Berg 2018, entire; USFWS 2020, entire). Since forecasts of the natural gas price over the next 10 years are predicted to remain low, it is likely that 0 to 5 new natural gas wells will be drilled every year over the next ten years within the beardtongues' ranges (Table 6; McKinsey and Company 2019, entire; World Bank, 2019, p. 1; U.S. U.S.

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[7] Wells that are not producing enough of the resource to be profitable or are not producing due to low market prices (Holland and Hart 2015, entire).
[8] We base this on the anticipated low level of exploration during this time period. We cannot make a reliable prediction of commercial development in the Mancos B play until exploration activities are complete.
[9] The likelihood is based on the U.S. Energy Information Administration (EIA) projections of natural gas prices from 2019 to 2030 (US EIA 2020a)
[10] This is based on the well type defined in the application and permit approval, see Utah AGRC, 2020, entire for the summary of well types.

Energy Information Administration (EIA) 2020b, entire; U.S. EIA 2020c, pp. 3 – 4; USFWS 2020, entire). The most likely area for future commercial development in Uintah County would be to expand the existing Greater Natural Buttes natural gas field in all directions, although this natural gas field is north of the beardtongues' ranges (Chidsey, Jr. 2011, entire; Vanden Berg 2018, p. 3; USFWS 2020, entire).

For the purposes of our analysis, the most likely areas for future commercial development are in delineated oil and gas fields in the beardtongues' ranges. Delineated fields have not reached full field development and afford some infrastructure to reduce costs to the operator. A reasonable upper bound estimate of disturbance would be 50 natural gas wells over the next 10 years, an area equivalent to 150 acres of disturbance (assuming 3 acres per well pad and associated infrastructure (USFWS 2020, entire). We expect flexibility in locating the well pad disturbance areas due to the increased use of horizontal and directional drilling methods to avoid or minimize loss of beardtongue plants and adhere to the 300 ft avoidance buffer restriction on BLM lands and 2014 CA conservation areas (Allis and Vanden Berg 2018, entire). We used a ten year forecast time period for the purpose of our analysis, which is generally consistent with some long-term forecasts for natural gas commercial development (McKinsey and Company 2019, entire; World Bank, 2019, p. 1). Due to the unreliability of long-term forecasts, we were not able to provide a reliable prediction beyond 2030, and future development likelihoods will be dependent upon the price of natural gas (Table 6; U.S. EIA 2020c, p. 3; USFWS 2020, entire).

<u>Future Forecast for Oil and Gas</u>

We identified one future forecast for oil and gas exploration and development to project where surface disturbance may occur within the beardtongues' ranges over our forecast timeframe for the stressor (2020 to 2030). The forecast assumed additional drilling, well pads, and infrastructure will occur within delineated oil and gas fields. We evaluated each population on a case by case basis, and our analysis included the following assumptions: the loss of plants and habitat will occur where there is disturbance due to oil and gas on non-Federal lands; and avoidance of plants by 300 ft will occur with some loss of pollinator habitat on Federal lands.

We included 2014 CA designated conservation areas on Federal and state lands in our analysis because these areas allow some development until the surface disturbance caps are met. These caps specify that a maximum of 5 percent new surface disturbance for Graham's beardtongue and 2.5 percent for White River beardtongue will be allowed per landownership with each range unit (Penstemon Conservation Team 2014, pp. 23 – 24). We considered 2014 CA designated conservation areas on private lands to be similar to other non-Federal lands in terms of availability for development, because protections expire in 2029, during our forecast timeframe. We summarized the forecast, below.

The traditional oil and gas forecast assumed disturbance from oil and gas activities would occur in the following areas (Figure 8; Figure 9):

- Oil exploration activities that result in ten wildcat well locations, each with 3 acres of disturbance, somewhere in Uintah County to explore the Mancos B play.
- Development in Uintah County in existing oil and gas fields.

- Potential disturbance in 2014 CA conservation areas as allowed by surface disturbance caps.

The traditional oil and gas forecast identified that the following areas would not be developed:

- Federal lands subject to the following RMP restrictions: 300 ft avoidance buffer; the slope (40 degrees or greater) stipulation, the NSO stipulation, and the ACEC designation (section 1.9, Future Protections Afforded to the Beardtongues).

The forecast identifies the traditional oil and gas stressor overlapping with 10 Graham's beardtongue populations (1, 9, 10, 11, 12, 13, 15, 16, 21, 23) and one White River beardtongue population (17).

<u>Uncertainty</u>

Using best available information, there is too much uncertainty for us to predict the following:

- The specific location of wildcat wells within Uintah County for oil exploration of the Mancos B play.
- If there will be future oil commercial development in the beardtongues' ranges. This will depend on the results of the Mancos B play oil exploration.
- A certain rate of commercial development within the identified area over time unless there are approved drilling plans.
- Locations of all new wells within the beardtongues' ranges outside of delineated oil and gas fields. New wells are not expected to be associated with an approved plan of development for full field development (e.g. concentrated wells and pad locations) but rather by individual lease-holders to drill a few additional well pads within their lease area.

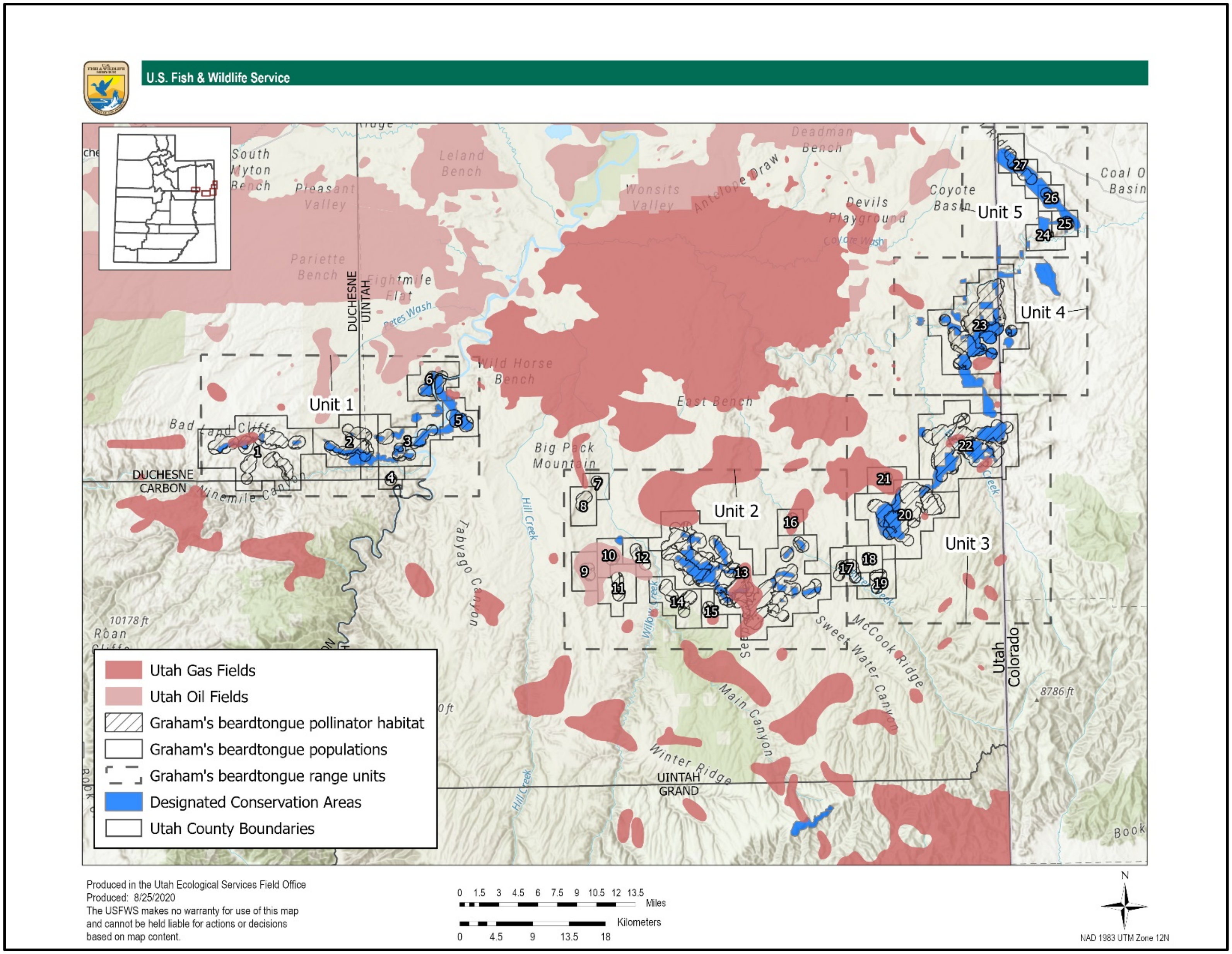

Figure 9. The oil and gas forecast and Graham's beardtongue populations 1- 27.

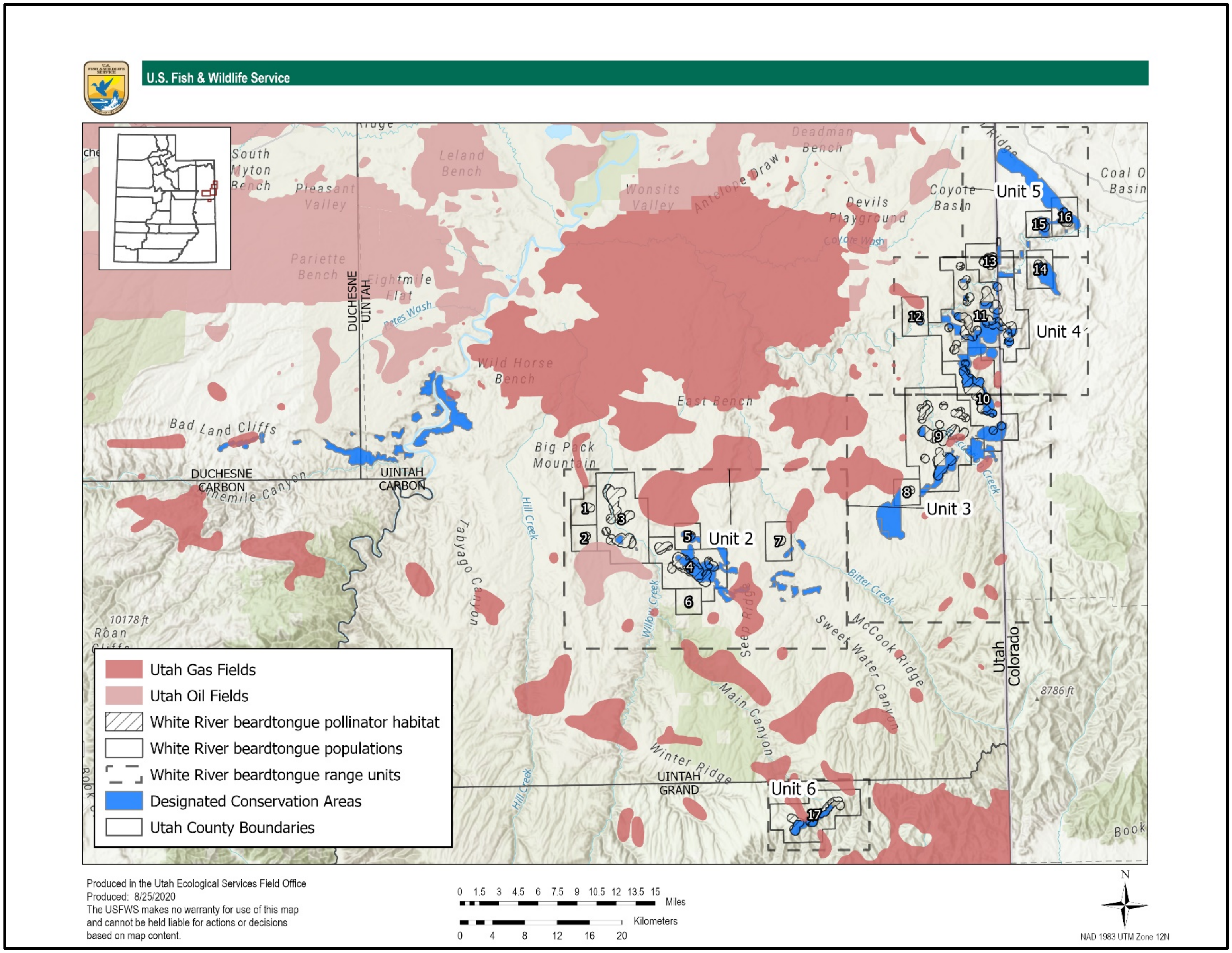

Figure 10. The oil and gas forecast and White River beardtongue populations 1 - 17.

2.4 Road Construction and Maintenance

Road construction and maintenance activities occur on private, state, and BLM lands within Graham's and White River beardtongues pollinator habitat. Many unpaved county roads cross through Graham's and White River beardtongue pollinator habitat, and most of these roads have existed for decades. Existing roads have resulted in small and localized impacts to Graham's and White River beardtongues (USFWS 2021, p. 52). Road construction and paving projects occur infrequently, and we are not aware of other road construction or maintenance projects that are proposed to occur in areas where they would impact Graham's beardtongue or White River beardtongue (Baldwin 2019, entire; Federal Highway Administration (FHWA) 2020, entire; UDOT 2020, entire).

Any future road projects in the beardtongues' ranges would likely be upgrades and widening of existing roads, or new secondary or spur roads associated with energy development (Civco Engineering Inc. 2010, entire). Therefore, we did not perform a separate analysis of this stressor but rather included the effects of this stressor (habitat loss, habitat fragmentation, dust, weeds) as part of our analysis of energy development (oil shale, tar sands, traditional oil and gas).

2.5 Herbivory

Herbivory from native grazers and livestock occurs on a regular basis at a level that the beardtongues are able to withstand, based on population trend monitoring (USFWS 2021, pp. 52 – 54). Occasionally, heavy sheep grazing results in more severe, localized impacts to the beardtongues which may take years to recover from (Penstemon Conservation Team 2015, entire; USFWS 2021, pp. 52 – 54). We have no information that this pattern and impact of herbivory will change in the future. We expect herbivory to continue to exert localized impacts but not population-level impacts to beardtongue populations that are not affected by direct habitat loss from energy development.

For beardtongue populations that experience habitat loss as a result of energy development, changes in herbivory would be site-specific and allotment-specific. The effects of herbivory from native grazers and livestock may increase where available forage is reduced as a result of energy development. In some areas, this may result in more severe localized impacts to beardtongue individuals than current and past impacts. However, land managers can adjust stocking rates based on the amount of available forage, and native grazer populations will likely adjust to available forage and habitat. There is too much uncertainty for us to project future herbivory impacts within specific populations given best available data. To accurately project these impacts, we would need additional information at a site-specific level within beardtongue populations about current herbivores; their patterns and impacts to beardtongue individuals; available forage and grazing patterns; and future grazing management actions.

As part of the 2014 CA, the BLM committed to monitor livestock grazing in beardtongue populations and take corrective actions to reduce impacts, as necessary (section 1.9, Future Protections Afforded to the Beardtongues). Therefore, we expect future herbivory impacts would be addressed by land management actions and would not increase in beardtongues' populations on BLM lands. There is no commitment to take corrective actions within beardtongue populations affected by development on non-Federal lands if future herbivory impacts increase. Therefore, we identified the beardtongues' populations on non-Federal lands as populations where herbivory impacts may increase, as a result of habitat loss from energy development (section 3.1, Development of Future Scenarios).

Overall, herbivory is not a primary driver of the beardtongues' future condition. We have no information to indicate that future herbivory impacts would result in a population-level impact to the beardtongues. There is the potential for herbivory impacts to increase in populations on non-Federal lands that may be impacted by energy development.

2.6 Invasive Weeds and Wildfire

Invasive weeds are present but not extensive across most of the beardtongues' pollinator habitat, and the primary weed is cheatgrass (*Bromus tectorum*) (USFWS 2021, p. 55). Most beardtongue populations contain low amounts of cheatgrass (< 5 percent of habitat area); however, a few populations that contain higher levels of cheatgrass include two Graham's beardtongue populations (20 and 27) and one White River beardtongue population (8) (USFWS 2021, pp. 55 – 57). We expect weed levels to remain low in intact beardtongue occupied habitat and increase in disturbed occupied habitat (USFWS 2021, Appendix B pp. 8 – 11). The effects of invasive weeds may increase in populations that overlap with energy development, particularly at the subpopulation level in remaining habitat areas that are small, directly adjacent to energy development, and fragmented from other subpopulation areas. We considered the effect of invasive weeds in our future condition evaluation with other factors associated with population resiliency (section 3.1. Development of Future Scenarios).

Wildfires do not occur frequently in Graham's and White River beardtongues pollinator habitat, and there is no evidence that their pollinator habitat or range has experienced or currently is experiencing an altered wildfire regime (USFWS 2021, pp. 55 – 57). If the beardtongues occupied habitat were to burn, the wildfire(s) would likely result in patchy, low-intensity burns that the beardtongues' would quickly recover from due to their ability to resprout from their roots (Brunson 2012, entire). For our analysis, we assumed that wildfire frequency and extent in beardtongue populations would generally not change from current levels over the next ten years.

2.7 Small Population Size

Small beardtongue populations are more prone to extinction from stochastic events or stressors than larger populations, or in other words, small populations have lower resiliency (McCaffery 2013, p. 1). As noted in our Biological Report on current condition, we considered 12 of the 27 Graham's beardtongue populations to be small in size (4, 7, 8, 9, 12, 16, 18, 19, 21, 24, 25, 26) because they contain fewer than 67 plants and have an estimated extinction risk greater than 10 percent over a 50 year period (USFWS 2021, pp. 57 – 60). These small populations are distributed across the species' range and collectively comprise less than one percent of all known individuals in the total population. We considered six of the 17 White River beardtongue populations (1, 2, 5, 6, 7, 8) to be small in size because they contain fewer than 200 plants and have an estimated extinction risk greater than 10 percent over a 50 year period (USFWS 2021, pp. 57 – 60). These small populations are distributed across the species' range and collectively comprise less than one percent of all known individuals in the total population. The remaining populations are considered medium or large sized, and have lower estimated extinction risk into the future. We considered the effect of small population size in our future condition evaluation along with other with other factors associated with population resiliency (section 3.1. Development of Future Scenarios).

2.8 Climate Change

As defined by the Intergovernmental Panel on Climate Change (IPCC), the term ‘‘climate’’ refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2013a, p. 1450). Scientific measurements spanning several decades demonstrate that changes in climate are occurring. In particular, warming of the climate system is unequivocal, and many of the observed changes in the last 60 years are unprecedented over decades to millennia (IPCC 2013b, p. 4). The current rate of climate change may be as fast as any extended warming period over the past 65 million years, and is projected to accelerate in the next 30 to 80 years (National Research Council 2013, p. 5).

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of greenhouse gas emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions. Model results yield very similar projections of average global warming until about 2030, and thereafter the magnitude and rate of warming vary through the end of the century depending on the assumptions about population levels, emissions of greenhouse gases, and other factors that influence climate change. Thus, absent extremely rapid stabilization of GHGs at a global level, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by human actions regarding greenhouse gas emissions (IPCC 2013b, 2014; entire). Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2013c, 2014; entire) and within the United States (Melillo *et al.* 2014, entire). Therefore, we use ‘‘downscaled’’ projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (Glick *et al.* 2011, pp. 58–61, for a discussion of downscaling).

Since we are not aware of a downscaled climate model for the range of Graham's and White River beardtongue, we used climate change data from the Multivariate Adaptive Constructed Analogs (MACA) website that uses a downscaling method for model output from 20 global climate models to a 2.5 to 4 mi (4 to 6 km) resolution (https://climate.northwestknowledge.net/MACA/index.php). We used two different emission scenarios, a low emission scenario and a high emissions scenario. The low emissions scenario is the Representative Concentration Pathways (RCP) 4.5 emission scenario, and the high emission scenario is the RPC 8.5 emission scenario used by the IPCC. RCP 4.5 is an intermediate emissions scenario where atmospheric carbon dioxide (CO2) concentrations are expected to equal approximately 650 ppm after the year 2100. In RCP 8.5, emissions aggressively increase to approximately 1370 ppm CO_2 after the year 2100 (IPCC 2014, p. 57; USGS 2017, p. 3). For comparison, current atmospheric CO_2 concentrations are around 400 ppm (USGS 2017, p. 3).

The results of our "downscaled" climate evaluation indicate future climate conditions will be warmer in all seasons under both emission scenarios (Lindstrom 2019, entire). The difference in temperature increase between the two scenarios is within 3.2 ^{O}F through 2070. Spring temperatures under the intermediate emissions scenario (RCP 4.5) and winter temperatures under the high emissions scenario (RCP 8.5) are predicted to increase the most relative to the other seasons. In general, temperatures are predicted to increase by approximately 5 to 6 ^{O}F under the intermediate emissions scenario (RCP 4.5) and approximately 8 to 8.6 ^{O}F under the high emissions scenario (RCP 8.5). Precipitation for all seasons is expected to increase under both scenarios. Spring precipitation under the intermediate emissions scenario (RCP 4.5) and winter precipitation under the high emissions scenario (RCP 8.5) are predicted to increase the most relative to the other seasons. In general, spring, fall, and winter precipitation is predicted to increase between 6 to 9.6 percent under the low emission scenario and between 6.5 to 16 percent under the high emission scenario.

We recognize the effects of increased temperature and precipitation can confound each other, and the effects of increased temperature dominate increased precipitation in some climate models (Stewart *et al.* 2004, p. 224). As temperatures warm, so does evaporation, sometimes negating the effects of increased precipitation because soil water storage may decrease. Evaporative deficit is the difference between water available in the soil and water lost to evapotranspiration. As evaporative deficit increases, the landscape becomes drier, and drought conditions increase.

In order to evaluate a more integrated measure of the combined effect of increased temperature and precipitation levels, we considered a measure of evaporative deficit instead of precipitation alone for our predictions of drought conditions (Lindstrom 2019, entire). The evaporative deficit measure is not available on the MACA website, so we utilized the USGS National Climate Change Viewer (NCVV) at the following website: https://www2.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp. The NCVV averages the results of 33 global climate models and provides predictions for the same two emissions scenarios. We evaluated the same two emissions scenarios for Uintah County, Utah through 2070. Under both scenarios, the evaporative deficit is predicted to be higher than the historical period during the growing season (March to November). The pattern of the evaporative deficit over a single year is the same under both scenarios. The evaporative deficit steadily increases during the spring, peaks in July, and steadily decreases during the fall. The predicted annual evaporate deficit of the high emission scenario is twice as high as the low emission scenario; 0.6 in/month under the high emissions scenario, and 0.3 in/month under the low emissions scenario. Both scenarios indicate the range of Graham's and White River beardtongues may be drier in the future compared to historical conditions.

Future climate conditions have the potential to impact the future condition of Graham's and White River beardtongues. Here, we discuss what could happen in general to the species' range and abundance under warmer and drier conditions based upon what we know about the biology of the species.

Range Effects

Accelerating rates of climate change of the past two or three decades indicate that the extension of species' geographic range boundaries toward the poles or to higher elevations by progressive establishment of new local populations will become increasingly apparent in the relatively short term (Hughes 2000, p. 60). We do not have evidence of a range contraction or shift for Graham's and White River beardtongues. Both species have the ability to occupy different slope aspects based on their current distribution.

Future climate conditions have the potential to reduce the number of suitable microsites available within population areas. There is also the potential for a range reduction for the beardtongues, particularly in combination with other stressors. When we considered characteristics that contribute to vulnerability to climate change such as dispersal ability, highly specific habitat requirements, and ability to shift distribution in response to environmental conditions, Graham's and White River beardtongues would likely rank moderate or high on the vulnerability index at the species-level (Young *et al* 2012, 133 - 139).

Plant Effects

Graham's and White River beardtongues and other long-lived plants in semi-arid environments may be less vulnerable to the effects of climate change if future climate conditions are within the historic range of natural climatic variation experienced by each species (Tielbörger *et al.* 2014, p. 7). As long-lived species, they have the potential to exhibit a small or delayed response to climate conditions compared to shorter-lived species (Tielbörger *et al.* 2014, p. 2). They can employ adaptations in order to survive periods of resource limitation (i.e., drought), and can respond more slowly with respect to changes in abundance compared to changes in biomass and reproduction (Tielbörger *et al.* 2014, p. 5; Schwinning and Sala 2004, entire). We expect adult plant survival to be less sensitive to drought conditions compared to growth, reproduction, and seedling recruitment for both species (USFWS 2021, p. 60, Appendix E).

We also expect adult plant survival to be more sensitive to the duration of drought conditions rather than the severity of drought in a given year based on the legacy effect of past precipitation events (Evans *et al.* 2011, entire). Increased temperatures have the potential to result in increased growth and reproduction if water is not limiting or reduced growth and reproduction if water is limiting (Bita and Gerats 2008, p. 1; Warwell and Shaw 2017, p. 1213). For both species, we expect that plants will exhibit a complex response to increased temperatures based on the availability of moisture during the growing season, and the species' temperature tolerance and threshold. Importantly, a species' ability to adapt to changing climate conditions is dependent on its adaptive capacity (existing genetic variation or representation) (Warwell and Shaw 2017, p. 1213).

In summary, climate change effects present substantial uncertainty regarding the future environmental conditions in the range of Graham's and White River beardtongues but may place an added stress on the species and its habitat, particularly where other stressors are present. Despite characteristics that make the two species vulnerable to climate change, our climate evaluation is too speculative to determine the severity of this stressor to Graham's and White River beardtongues at the population level. Long-lived perennial plants exhibit a range of drought and temperature sensitivity based on physiological (photosynthetic pathway), morphological (rooting depth), and inherent genetic variability (Warwell and Shaw 2017, p. 1205), which all contribute to a species' tolerance (Hoover *et al.* 2015, p. 7 – 11). Additional information regarding each species drought and temperature tolerance is needed for a better assessment of future climate effects. For our analysis, we assumed that climate conditions would generally not change from current levels in beardtongue populations over the next ten years, but may contribute to stronger effects of herbivory and invasive weeds to all beardtongue populations. Over a longer timeframe to 2070, we expect temperatures and drought conditions to increase, but there is substantial uncertainty regarding their impact to the beardtongues.

Uncertainty

Climate models have great utility because they allow us to make projections of how climate may change in the future, but their results should be interpreted cautiously. Models are mathematical representations of what can happen, but they do not always accurately predict future events. Climate models have greatly improved in recent years, but projections for precipitation remain less reliable than those for surface temperature (O'Gorman and Schneider 2009, p. 14744; Trenberth 2011, p. 133; IPCC 2014, p. 56). For our analysis of Graham's and White River beardtongues' future condition, we acknowledge the innate uncertainty associated with climate modeling. Future climate conditions in the beardtongues' ranges are projected to be warmer and drier, but there is substantial uncertainty regarding their impact to the beardtongues.

2.9 Future Protections Afforded to the Beardtongues

In this section we considered the protections afforded to Graham's and White River beardtongues from the 2014 CA and regulatory mechanisms.

Penstemon Conservation Agreement (2014 CA)

The 2014 CA is a voluntary agreement that has a strong implementation record over the past 6 years (USFWS 2021, pp. 38 – 90; Sheppard and Wheeler 2020, pp. 7 – 12). Signatories include the BLM; Utah Department of Natural Resources (DNR); State of Utah School and Institutional Trust Lands Administration (SITLA); Uintah County, Utah; the Utah Public Lands Policy Coordination Office (PLPCO); and Rio Blanco County, Colorado (Penstemon Conservation Team 2014, and 2018 a,b,c, entire).

The 2014 CA states that protections for the beardtongues will continue on Federal and state lands until July 25, 2034, and protections will continue on private lands until July 25, 2029 (Penstemon Conservation Team 2014, entire; Penstemon Conservation Team 2018 a,b,c, entire). We evaluated the 2014 CA protections afforded to the beardtongues until 2034. We did not consider plants in conservation areas designated as Interim, as these areas provide only short-term protections. Although these areas may in the future be converted to permanently designated conservation areas, they do not currently provide assurances for the long-term benefit of the species. This is consistent with our previous evaluation of the 2014 CA (79 FR 46067, August 6, 2014). We are uncertain of the likelihood of 2014 CA protections continuing beyond 2034 when the CA expires, however it may be possible to renew the CA with willing partners. As part of the CA, we committed to re-evaluate the status of the beardtongues in 2028, prior to the expiration of protections on private lands.

As a result of the 2014 CA, designated conservation areas protect 41 percent of the Graham's beardtongue population (23,333 plants) and 66 percent of the White River beardtongue population (19,710 plants) on Federal and State lands, totaling 42,993 acres, through 2034 (Tables 7 and 8). Designated conservation areas provide protections for 13 Graham's beardtongue populations (1, 2, 3, 5, 6, 13, 20, 22, 23, 24, 25, 26, 27) and 11 White River beardtongue populations (3, 4, 5, 9, 10, 11, 12, 14, 15, 16, 17) across both species' ranges (Tables 7 and 8).

The 2014 CA provides that within designated conservation areas, surface disturbance caps will be applied to allow only a limited amount of new construction for roads and traditional oil and gas development. The caps will prohibit future oil shale and tar sand exploration and development. An avoidance buffer of 300 ft between disturbance and beardtongue plants will be used in conjunction with the surface disturbance caps. For more detail on specific protections, please refer to the Biological Report and 2014 CA (Penstemon Conservation Team 2014, and 2018 a,b,c, entire; USFWS 2021, pp. 39 – 43).

On Federal lands, where heavy sheep grazing or other severe herbivory impacts are detected, the BLM committed to implement localized management actions with the permittee to promote future avoidance measures within designated conservation areas and beardtongue populations on Federal lands (Penstemon Conservation Team 2015, entire; USFWS 2021, pp. 52 – 54).

To address invasive weeds, the conservation team is implementing a weed management plan to survey, treat, and monitor weeds in designated conservation areas. This conservation measure reduces the impacts of weeds to the beardtongues in these areas. The conservation team has not yet provided recommendations to land managers regarding wildfire planning and post-wildfire actions in designated conservation areas, as was specified in the 2014 CA. However, wildfire is not expected to be a primary driver of the beardtongues' future condition.

To address small population size, the conservation team developed designated conservation areas to protect small, medium, and large populations of Graham's and White River beardtongues (USFWS 2021, p. 58). The 2014 CA designated conservation areas contain four small populations of Graham's beardtongue (populations 12, 24, 25, 26) and two small populations of White River beardtongue (populations 5, 9).

To address climate change, as called for in the 2014 CA, the conservation team will use spatially explicit modeled climate data (Parameter-elevation Regressions on Independent Slopes Model (PRISM)) to assess climate trends across the beardtongues' ranges (Hornbeck 2020, p. 2). The data collected from weather monitoring can be correlated with demography data to determine basic species responses to climate patterns.

Table 7. Protections afforded to Graham's beardtongue populations through 2034 on designated conservation areas and BLM lands.

Range Unit	Population	Current Population Size	Plants in designated conservation areas	Plants with BLM RMP Protections	Plants afforded Protections (% of Population)
1. Sand Wash	1	954	421	391	812 (85%)
	2	516	186	330	516 (100%)
	3	371	334	35	369 (99%)
	4	46	0	46	46 (100%)
	5	489	489	0	489 (100%)
	6	288	287	0	287 (100%)
		2,664	**1,717**	**802**	**2,519**
2. Seep Ridge	7	50	0	50	50 (100%)
	8	49	0	49	49 (100%)
	9	17	0	0	0 (0%)
	10	266	0	0	0 (0%)
	11	195	0	195	195 (100%)
	12	22	9	0	9 (41%)
	13	11,441	7,204	526	7,730 (68%)
	14	1,263	0	1,263	1,263 (100%)
	15	459	0	459	459 (100%)
	16	33	0	0	0 (0%)
		13,795	**7,213**	**2,542**	**9,755**
3. Evacuation Creek	17	370	0	206	206 (56%)
	18	1	0	1	1 (100%)
	19	9	0	9	9 (100%)
	20	19,735	5,031	256	5,287 (27%)
	21	6	0	6	6 (100%)
	22	11,900	5,427	1,375	7,849 (57%)
		32,021	**10,458**	**1,853**	**13,358**
4. White River	23	7,700	3,740	312	4,052 (53%)
		7,700	**3,740**	**312**	**4,052**
5. Raven Ridge	24	6	6	0	6 (100%)
	25	27	27	0	27 (100%)
	26	1	1	0	1 (100%)
	27	171	171	0	171 (100%)
		205	**205**	**0**	**205**
Total Population		**56,385**	**23,333 (41%)**	**5,509 (10%)**	**28,842 (51%)**

Table 8. Protections afforded to White River beardtongue populations through 2034 on designated conservation areas and BLM lands.

Range Unit	Population	Current Population Size	Plants in designated conservation areas	Plants with BLM RMP Protections	Plants afforded Protections (% of Population)
2. Seep Ridge	1	3	0	3	3 (100%)
	2	8	0	0	0 (0%)
	3	2,278	290	1,422	1,712 (75%)
	4	8,565	7,676	889	8,565 (100%)
	5	10	10	0	10 (100%)
	6	1	0	1	1 (100%)
	7	77	0	0	0 (0%)
		10,942	**7,976**	**2,315**	**10,291**
3. Evacuation Creek	8	1	0	0	0 (0%)
	9	2,050	99	53	152 (7%)
		2,051	**99**	**53**	**152**
4. White River	10	5,506	4,512	166	4,678 (85%)
	11	5,639	2,957	44	3,001 (53%)
	12	1,679	1,678	0	1,678 (100%)
	13	1,290	0	0	0 (0%)
	14	393	393	0	393 (100%)
		14,507	**9,540**	**210**	**9,750**
5. Raven Ridge	15	384	384	0	384 (100%)
	16	617	617	0	617 (100%)
		1,001	**1,001**	**0**	**1,001**
6. Book Cliffs	17	1,401	1,094	307	1,401 (100%)
		1,401	**1094**	**307**	**1401**
Total Population		**29,902**	**19,710 (66%)**	**2,885 (10%)**	**22,595 (76%)**

Regulatory Mechanisms

State and Private Land Protections

The state and county signatories of the 2014 CA have committed to protect the beardtongues on designated conservation areas on their lands, including private lands located within the counties. Designated conservation areas on state lands afford protections to five Graham's beardtongue populations (1, 13, 20, 22, 23) containing 2,990 plants, and three White River beardtongue populations (11, 12, 17) containing 2,182 plants until 2034. Designated conservation areas on private lands afford protections to eight percent of the Graham's beardtongue population (4,389 plants) and six percent of the White River beardtongue population (1,806 plants) on 2,583 acres until 2029. Although conservation agreements are not regulatory mechanisms, signatories can implement conservation measures via regulatory mechanisms, and the State of Utah, Uintah

County, Utah, and Rio Blanco County, Colorado used their regulatory authority to implement the specific protections as outlined in the 2014 CA (Penstemon Conservation Team 2014, and 2018 a,b,c, entire; USFWS 2021, pp. 39 – 43).

There is one state law that protects the beardtongues in Utah on state (SITLA) designated conservation areas and enforces the restrictions identified in the 2014 CA (Utah Code 53C-2-202; SITLA Code R850-150). Uintah County enacted a zoning ordinance to enforce the surface disturbance caps and an avoidance buffer within conservation areas on private lands until 2029 (Penstemon Conservation Team 2014, pp. 28, 35; Uintah County 2018, entire; Penstemon Conservation Team 2019, Appendix A). There are no other regulatory mechanisms that provide protections to the beardtongues on private or state lands in Utah and Colorado.

Federal land Protections

BLM lands include portions of 23 Graham's beardtongue populations (1, 2, 3, 5, 6, 7, 8, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) and 11 White River beardtongue populations (1, 3, 4, 6, 9, 10, 11, 14, 15, 16, 17). Sixteen Graham's beardtongue populations (2, 4, 5, 6, 7, 8, 11, 14, 15, 17, 18, 19, 21, 24, 25, 26) and seven White River beardtongue populations (1, 4, 5, 6, 14, 15, 16) occur entirely on BLM lands.

Graham's and White River beardtongues are BLM sensitive plant species in Utah and Colorado and are afforded protections at least comparable to (if not greater than) the treatment of species which are candidates for Federal listing (BLM 2008a, p. 43). The BLM resource management plans and any specific and indirect protections for the beardtongues are described below for each state.

In Utah, the Vernal Field Office RMP as amended is the regulatory framework for BLM land management where the beardtongues occur (BLM 2008b, entire). The Vernal Field Office RMP and amendments identify the following measures or stipulations that apply to the beardtongues and their habitat:

- Implement the goals and objectives of conservation agreements (BLM 2008b, pp. 128 – 129).
- Implement a 300 ft avoidance buffer for Graham's beardtongue and other sensitive plant species (BLM 2008b, pp. 18, 24).
- The Controlled Surface Use (CSU) stipulation will be applied to protect fragile soils on steep slopes greater than 30 percent unless an engineering plan is developed to prevent erosion (BLM 2008b, pp. 31).
- No disturbance will be allowed for slopes greater than 40 percent unless other alternatives would cause undue or unnecessary degradation (BLM 2008b, pp. 118).
- The NSO stipulation will be applied to fluid mineral leasing, and where appropriate, to all other surface disturbing activities associated with land use authorizations, permits and leases, including other mineral resources (oil shale, tar sands, traditional oil and gas development) (BLM 2008b, p. 30).
- The unavailable for leasing stipulation will be applied to fluid mineral leasing, and where appropriate, all other surface disturbing activities associated with land use authorizations,

permits and leases, including other mineral resources (oil shale, tar sands, traditional oil and gas development) (BLM 2008b, p. 30).

- ACEC designations provide some protection from surface disturbing activities, depending on the restrictions applied to a designated area (BLM 2008b, pp. 35 – 43). There are no ACECs designated in Utah for the beardtongues, but other ACECs occur within both species' ranges.

In Colorado, the White River Field Office RMP as amended is the regulatory framework for BLM land management where the beardtongues occur (BLM 1997, entire; BLM 2015, entire). The White River Field Office RMP and amendments identify the following measures or stipulations that apply to the beardtongues and their habitat:

- The Raven Ridge ACEC designation protects Graham's beardtongue and restricts motorized travel to existing roads and trails, and it includes a NSO stipulation for new oil and gas leases (BLM 1997, pp. 2-19, 2-44).
- The NSO stipulation will be applied within 330 ft of BLM sensitive plant species to fluid mineral leasing, and where appropriate, to all other surface disturbing activities associated with land use authorizations, permits and leases, including other mineral resources (oil shale, tar sands, traditional oil and gas development) (BLM 2015, p. 2-27).
- The CSU stipulation will be applied to protect fragile soils on steep slopes between 35 and 50 percent unless an acceptable plan is developed to prevent erosion (BLM 2015, pp. 1-19, 2-4).
- The NSO stipulation will be applied to slopes 35 percent or greater in landslide areas or 50 percent or greater in steep natural areas unless an acceptable mitigation plan is developed (BLM 2015, p. 1-3).

Outside of designated conservation areas on Federal lands, these measures provide protections to an additional nine percent of the Graham's and White River beardtongue total population (Table 7; Table 8).

In summary, Graham's and White River beardtongues are afforded the same level of protections on state and Federal lands within designated conservation areas until 2034. The species are afforded additional protections outside of designated conservation areas on Federal lands, which include: a 300 ft avoidance buffer; surface disturbance restrictions on steep slopes; areas that are unavailable for leasing and that have NSO stipulations; and ACECs. The designated conservation areas and conservation measures on Federal lands provide protections to 51 percent and 76 percent of the Graham's and White River beardtongues total populations, respectively (Table 7; Table 8).

Chapter 3. Future Condition

We described the current condition of Graham's and White River beardtongues and considered their ecological needs in the Biological Report (USFWS 2021, entire). In this Chapter, we evaluated each species expected future condition using projections and two plausible scenarios. We utilized the current condition as the baseline from which to evaluate changes to those factors considered important to the beardtongues.

The viability of Graham's and White River beardtongues depends on maintaining multiple self-sustaining populations throughout their range into the future. We considered the presence of more populations in Good or Moderate condition distributed across each species' range to be indicative of higher viability.

3.1 Development of Future Scenarios

We developed two future scenarios, moderate energy development and high energy development, using the forecasts described above for oil shale, tar sands, and traditional oil and gas development, to project the locations of energy development within the beardtongues' populations. We considered energy development to be the primary drivers of future population condition over our 10-year timeframe.

The future scenarios differ based on the locations of the oil shale stressor on the landscape between the moderate and high oil shale forecasts. Our analysis included the following assumptions: commercial development activities for oil shale and tar sands will occur in the next 10 years; and the total loss of plants and habitat will occur where the oil shale and tar sands stressors occur. For traditional oil and gas development, we evaluated each population on a case by case basis, and assumed loss of plants and habitat will occur on non-Federal lands, and that avoidance of plants by 300 ft, with some loss of pollinator habitat, will occur on Federal lands.

Within the area of future energy development we accounted for associated development of roads and other infrastructure and the direct and indirect effects to the beardtongue populations from habitat loss, habitat fragmentation, fugitive dust, and invasive weeds by conservatively assuming total loss of plants and habitat where energy development was projected (USFWS 2021, entire).

We acknowledge there is uncertainty on how these stressors may change singly and cumulatively, and their effects on each plant species. The two future energy scenarios included the following:

Scenario 1 – Moderate energy development: We evaluated the impact of conservation efforts and stressors (oil shale, tar sands, and traditional oil and gas; road construction and maintenance; herbivory; invasive weeds; and climate change) on Graham's and White River beardtongues (Figure 10; Figure 11). Our analysis included the following assumptions:

- The moderate oil shale forecast where exploration and commercial development would occur in areas identified as high potential for development on non-Federal (State, private) lands. This area overlaps with:
    - Six populations of Graham's beardtongue (populations 13, 17, 18, 19, 20, 22); and
    - Three populations of White River beardtongue (populations 8, 9, 10).

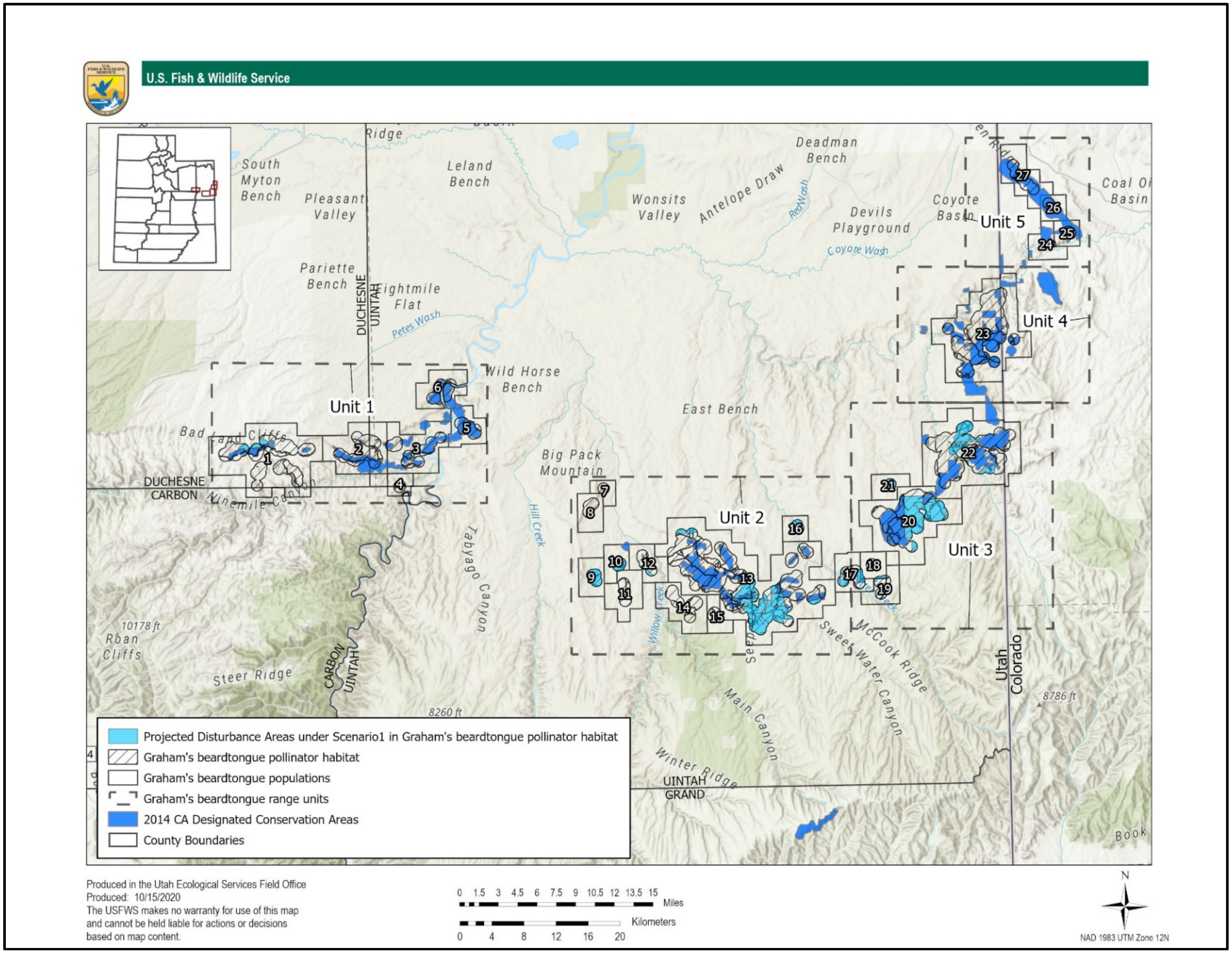

Figure 11. Scenario 1 moderate energy development and Graham's beardtongue populations 1- 27.

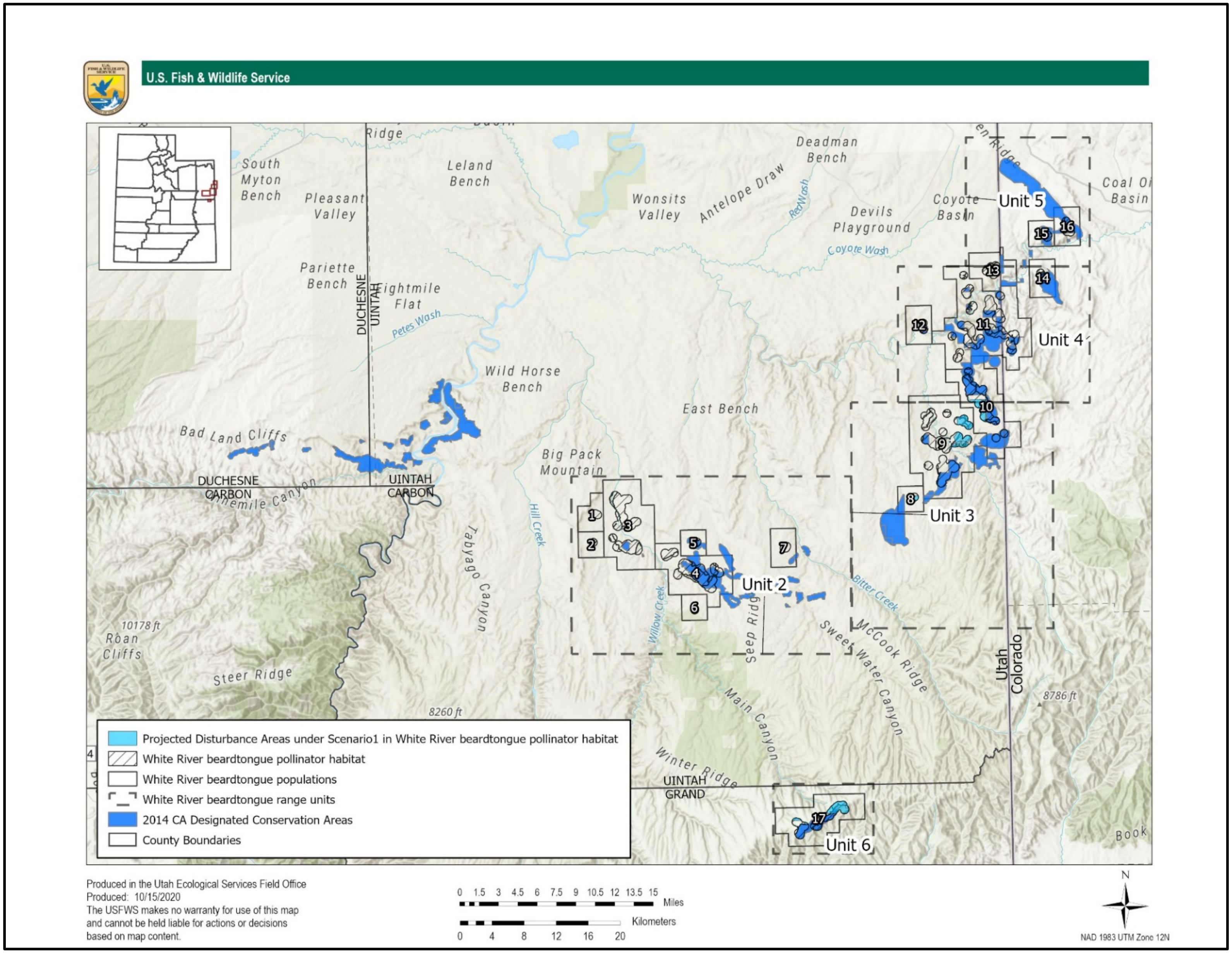

Figure 12. Scenario 1 moderate energy development and White River beardtongue populations 1- 17.

- The tar sands forecast where exploration and commercial development would occur in current lease areas and areas of high exploration potential in the southern PR Springs STSA. This area overlaps with:
  - No populations of Graham's beardtongue; and
  - One population of White River beardtongue (population 17).

- The traditional oil and gas forecast where commercial development would occur in delineated oil and gas fields. This area overlaps with:
  - Ten populations of Graham's beardtongue (populations 1, 9, 10, 11, 12, 13, 15, 16, 21, 22); and
  - One population of White River beardtongue (population 17).

- Road construction and maintenance would be associated with new energy development (oil shale, tar sands, and traditional oil and gas). These areas are already included in our energy development analysis area so we do not analyze this stressor separately.

- Herbivory may increase at a local level within occupied beardtongue habitat on non-Federal lands impacted by energy development. This includes localized areas within six Graham's beardtongue populations (1, 12, 13, 17, 20, 22) and three White River beardtongue populations (9, 10, 17) (Appendix 1).

- Invasive weeds may increase in populations where surface disturbance occurs. This may increase the effect of invasive weeds to populations that overlap with energy development. We evaluated the impact of invasive weeds to habitat quality as part of the habitat future condition evaluation.

- Climate change may contribute to stronger effects of herbivory and invasive weeds to all beardtongue populations.

Scenario 2 – High energy development: We evaluated the impact of conservation efforts and stressors (oil shale, tar sands, and traditional oil and gas; road construction and maintenance; herbivory; invasive weeds; and climate change) on Graham's and White River beardtongues. This scenario identified a larger area for oil shale exploration and development than moderate energy development scenario, in order to evaluate a worst-case scenario, for the purpose of bracketing the full range of plausible future conditions. The assumptions for the other stressors remained the same as the moderate energy development scenario (Figure 12; Figure 13). Our analysis included the following assumptions:

- The high oil shale forecast where exploration and commercial development would occur in areas identified as high potential for development on non-Federal (State, private) lands; non-Federal lands with high economic potential (15 GPT) for surface and underground mining as identified by Utah Geological Survey (UGS); and all lands currently under lease or permit for oil shale. This area overlaps with:
  - Eleven populations of Graham's beardtongue (populations 7, 11, 12, 13, 15, 17, 18, 19, 20, 22, 23); and

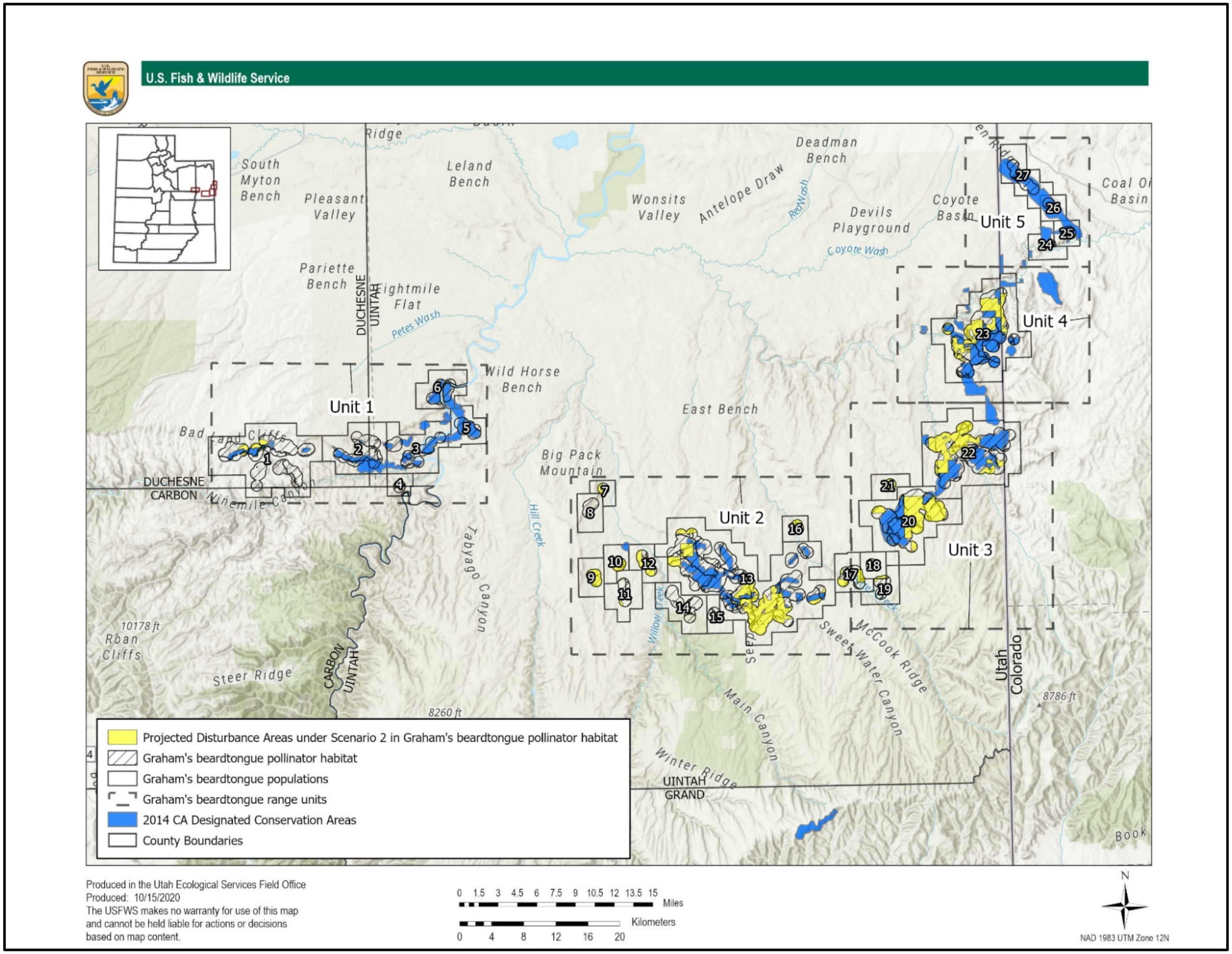

Figure 13. Scenario 2 high energy development and Graham's beardtongue populations 1 - 27.

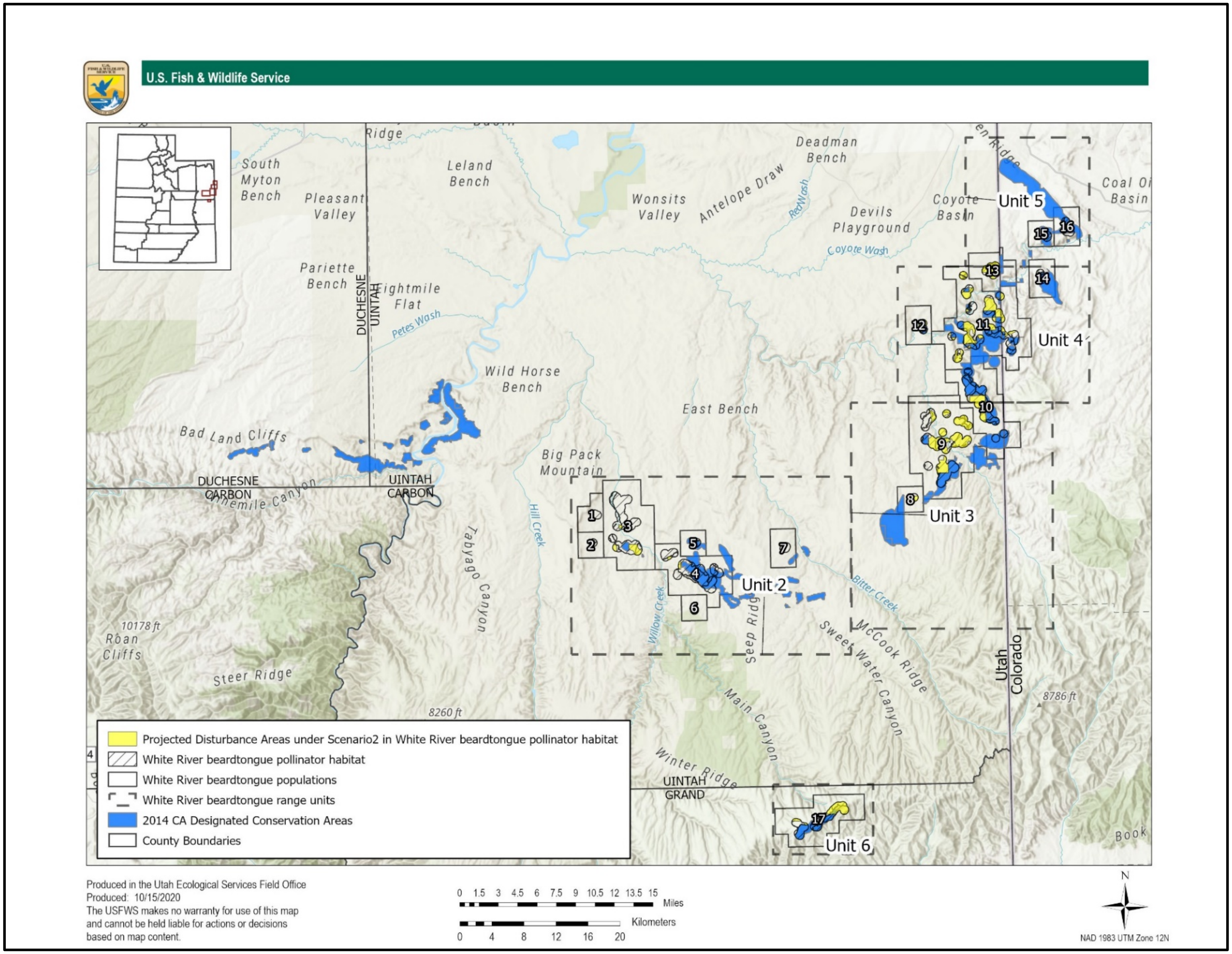

Figure 14. Scenario 2 high energy development and White River beardtongue populations 1 - 17.

    - Eight populations of White River beardtongue (populations 4, 5, 8, 9, 10, 11, 12, 13).

- The tar sands forecast where exploration and commercial development would occur in current lease areas and areas of high exploration potential in the southern PR Springs STSA. This area overlaps with:
    - No populations of Graham's beardtongue; and
    - One population of White River beardtongue (population 17).

- The traditional oil and gas forecast where commercial development would occur in delineated oil and gas fields. This area overlaps with:
    - Ten populations of Graham's beardtongue (populations 1, 9, 10, 11, 12, 13, 15, 16, 21, 22); and
    - One population of White River beardtongue (population 17).

- Road construction and maintenance would be associated with new energy development (oil shale, tar sands, and traditional oil and gas). These areas are already included in our energy development analysis area so we do not analyze this stressor separately.

- Herbivory may increase at a local level within occupied beardtongue habitat on non-Federal lands impacted by energy development near borders and allotment boundary adjustments. This includes localized areas within seven Graham's beardtongue populations (1, 12, 13, 17, 20, 22, 23) and six White River beardtongue populations (3, 9, 10, 11, 12, 17) (Appendix 1).

- Invasive weeds may increase in populations where surface disturbance occurs. This may increase the effect of invasive weeds to populations that overlap with energy development. We evaluated the impact of invasive weeds to habitat quality as part of the habitat future condition evaluation.

- Climate change may contribute to stronger effects of herbivory and invasive weeds to all beardtongue populations.

We used criteria identified in Table 9 and Table 10 to determine the extent of each scenarios' effects within plant populations. We evaluated the likely future condition of each plant population with the same metrics used in our evaluation of current condition, including habitat quality, habitat area, population size, and habitat loss (USFWS 2021, pp. 64 – 70). We then categorized each factor as Good, Moderate, or Low condition based on the resulting score for each population. Some populations in the Low condition category were reassigned to the Extirpated category if the population may be lost to development. These scenarios considered how conditions are likely to change for the species within a 10-year timeframe based on our energy development forecast timeframe. The results of our analysis are described below.

Table 9. Metrics for evaluating future condition for Graham's beardtongue.

Future Condition					
	Population Size Factor		Habitat Factors		
Condition Category	**Probability of Persistence**	**Presence of High Density Clusters**	**Pollinator Habitat Quality**	**Pollinator Habitat Area (ac)**	**Pollinator Habitat Loss Category**
Good	Low Extinction Risk (<5%)	One or More in the Population	Nonnative plant cover 0 - 5%	> 2,600	0 - 5% (Low Loss)
Moderate	Moderate Extinction Risk (6 – 10%)	One or More in the Population	Nonnative plant cover 6 - 25%	1,000 – 2,600	5.1 – 10% (Moderate Loss)
Low	High Extinction Risk (>10%)	None Present	Nonnative plant cover >25%	<1,000	>10% (High Loss)

Table 10. Metrics for evaluating future condition for White River beardtongue.

Future Condition					
	Population Size Factor		Habitat Factors		
Condition Category	**Probability of Persistence**	**Presence of High Density Clusters**	**Pollinator Habitat Quality**	**Pollinator Habitat Area (ac)**	**Pollinator Habitat Loss Category**
Good	Low Extinction Risk (<5%)	One or More in the Population	Nonnative plant cover 0 - 5%	> 1,000	0 - 5% (Low Loss)
Moderate	Moderate Extinction Risk (6 – 10%)	One or More in the Population	Nonnative plant cover 6 - 25%	500 – 1,000	5.1 – 10% (Moderate Loss)
Low	High Extinction Risk (>10%)	None Present	Nonnative plant cover >25%	<500	>10% (High Loss)

3.2 Scenario 1 – Moderate Energy Development

Resiliency under Scenario 1 – Under this scenario, the main stressors for Graham's beardtongue are oil shale and traditional oil and gas, which results in the loss of 34 percent (19,035 plants) of the total population (Table 11). The main stressors change the condition of populations in the center of its range (range unit 2 - Seep Ridge, and range unit 3 - Evacuation Creek), and result in the extirpation of three populations (9, 10, 16) and a decline in the condition of four populations (12, 17, 19, 21) from plant loss or plant and habitat loss. Population condition is maintained in the remainder of its range (range unit 1 - Sand Wash, range unit 4 - White River, and range unit 5 - Raven Ridge).

The Graham's beardtongue projected total population size under Scenario 1 is 37,350, comprised of 24 populations (Table 11). Occupied habitat and pollinator habitat are projected to be 7,642 and 72,455 acres, respectively. The majority of the total population (98 percent) occurs in 12 populations with Good condition; the remaining total population (2 percent) occurs in 12 populations with Moderate (9 populations) and Low (3 populations) condition. Energy development is present within 4 of the 12 populations in Good condition and 3 of the 9 populations in Moderate condition, and we expect these populations to continue to maintain their resiliency in the future despite projected impacts. Fourteen populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years). Populations in Good condition are less sensitive to plant and habitat loss than populations in Moderate or Low condition, because there is sufficient habitat area and population size remaining to support the overall population condition. The species continues to occupy the extent of its current range and all range units continue to support populations in Good or Moderate condition.

Regarding the other stressors, the road construction stressor was included in the evaluation of impacts from energy development (oil shale and traditional oil and gas). The tar sand stressor was not present within Graham's beardtongue's range. The invasive weed stressor did not change the future condition of Graham's beardtongue populations. The herbivory stressor may increase in six Graham's beardtongue populations (1, 12, 13, 17, 20, 22) at a local level, but we do not expect it to change the future condition of Graham's beardtongue populations over a ten-year period. Climate change may increase the effects of invasive weeds and herbivory at a local level, but we do not expect it to change the future condition of Graham's beardtongue populations over a ten-year period.

Under Scenario 1, the main stressor for White River beardtongue is oil shale, which results in the loss of one percent of the total population (216 plants). The main stressor changes the condition of two populations (populations 8, 9) in the center of the species' range (range unit 3 - Evacuation Creek), which results in the extirpation of one population (8) and a decline in the condition of one population (population 9) from loss of plants and habitat. Population condition is maintained in the remainder of the species' range (range unit 2 - Seep Ridge, range unit 4 - White River, range unit 5 - Raven Ridge, and range unit 6 - Book Cliffs).

The White River beardtongue projected total population size under Scenario 1 is 29,686, comprised of 16 populations. Occupied habitat and pollinator habitat are projected to be 3,218 and 26,959 acres, respectively. The majority of the total population (82 percent) occurs in 6 populations with Good condition; the remaining total population (18 percent) occurs in 10 populations with Moderate condition. Energy development is present within 2 of the 6 populations in Good condition and 1 of the 10 populations in Moderate condition, and we expect these populations to maintain their resiliency in the future despite projected impacts. Eleven populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years). Just like Graham's beardtongue, populations in Good condition are less sensitive to plant and habitat loss than populations in Moderate or Low condition because there is sufficient habitat area and population size remaining to support the overall population

Table 11. Scenario 1 - Future condition and size of Graham's beardtongue populations.

Range Unit	Population	Current Condition and Size[11]	Future Condition and Size	Energy Stressor(s)
1. Sand Wash	1	Good (L)	Good (L)	Oil and gas
	2	Good (L)	Good (L)	None
	3	Good (L)	Good (L)	None
	4	Moderate (S)	Moderate (S)	None
	5	Good (L)	Good (L)	None
	6	Good (L)	Good (L)	None
2. Seep Ridge	7	Moderate (S)	Moderate (S)	None
	8	Moderate (S)	Moderate (S)	None
	9	Moderate (S)	Extirpated	Oil and gas
	10	Good (L)	Extirpated	Oil and gas
	11	Moderate (L)	Moderate (L)	Oil and gas
	12	Moderate (S)	Low (S)	Oil and gas
	13	Good (L)	Good (L)	Oil and gas; Oil shale
	14	Good (L)	Good (L)	None
	15	Good (L)	Good (L)	Oil and gas
	16	Moderate (S)	Extirpated	Oil and gas
3. Evacuation Creek	17	Good (L)	Moderate (L)	Oil shale
	18	Moderate (S)	Moderate (S)	Oil shale
	19	Moderate (S)	Low (S)	Oil shale
	20	Good (L)	Good (L)	Oil shale
	21	Moderate (S)	Low (S)	Oil and gas
	22	Good (L)	Good (L)	Oil and gas; Oil shale
4. White River	23	Good (L)	Good (L)	None
5. Raven Ridge	24	Moderate (S)	Moderate (S)	None
	25	Moderate (S)	Moderate (S)	None
	26	Moderate (S)	Moderate (S)	None
	27	Good (L)	Good (L)	None
Total Population		**56,385**	**37,350 (66%)**	

[11] Population size categories – large (L), medium (M), and small (S) are based on extinction risk over 50 years. Large populations have less than 5% extinction risk; medium populations have 6 – 10% extinction risk; and small populations have greater than 10% extinction risk (USFWS 2021, pp. 71 – 72).

Table 12. Scenario 1 - Future condition and size of White River beardtongue populations.

Range Unit	Population	Current Condition and Size[12]	Future Condition and Size	Energy Stressor(s)
2. Seep Ridge	1	Moderate (S)	Moderate (S)	None
	2	Moderate (S)	Moderate (S)	None
	3	Good (L)	Good (L)	None
	4	Good (L)	Good (L)	None
	5	Moderate (S)	Moderate (S)	None
	6	Moderate (S)	Moderate (S)	None
	7	Moderate (S)	Moderate (S)	None
3. Evacuation Creek	8	Low (S)	Extirpated	Oil shale
	9	Good (L)	Moderate (L)	Oil shale
4. White River	10	Good (L)	Good (L)	Oil shale
	11	Good (L)	Good (L)	None
	12	Moderate (L)	Moderate (L)	None
	13	Moderate (L)	Moderate (L)	None
	14	Moderate (L)	Moderate (L)	None
5. Raven Ridge	15	Moderate (L)	Moderate (L)	None
	16	Good (L)	Good (L)	None
6. Book Cliffs	17	Good (L)	Good (L)	Oil and gas; Tar sands
Total Population		29,902	29,686 (99%)	

condition. The species continues to occupy the extent of its current range and all range units continue to support populations in Good or Moderate condition.

Regarding the other stressors, the road construction stressor was included in the evaluation of impacts from energy development (oil shale, tar sands, and traditional oil and gas). The invasive weed stressor did not change the future condition of White River beardtongue populations. The herbivory stressor may increase in three White River beardtongue populations (9, 10, 17) at a local level but we do not expect it to change the future condition of White River beardtongue populations over a ten-year period. Climate change may increase the effects of invasive weeds and herbivory at a local level, but we do not expect it to change the future condition of White River beardtongue populations over a ten-year period.

[12] Population size categories – large (L), medium (M), and small (S) are based on extinction risk over 50 years. Large populations have less than 5% extinction risk; medium populations have 6 – 10% extinction risk; and small populations have greater than 10% extinction risk (USFWS 2021, pp. 71 – 72).

Redundancy under Scenario 1 – Under this scenario, we project a reduction in redundancy for Graham's and White River beardtongues. We project the extirpation of three out of the 27 Graham's beardtongue populations (9, 10, 16) and the extirpation of one out of the 17 White River beardtongue population (8). Despite the extirpation of populations, levels of redundancy remain high for both species with Graham's beardtongue maintaining 24 populations, and White River beardtongue maintaining 16 populations.

Representation under Scenario 1 – Under this scenario, Graham's beardtongue has 14 large populations distributed across its range with at least one large population in each of the five range units; the remaining 10 populations are small (Appendix 1). Graham's beardtongue continues to occupy the five main vegetation types within its range (the Intermountain Basin big sagebrush shrubland and steppe, the Colorado Plateau low sagebrush shrubland and steppe, Pinyon-Juniper woodlands, the Intermountain Basins mixed salt desert scrub, and shale badlands systems; Appendix 1; USFWS 2021, p. 72). Our evaluation of these demographic and ecological surrogates for genetic diversity suggests that Graham's beardtongue will maintain a similar level of ecological diversity within the 24 remaining populations to what it has currently, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the three Graham's beardtongue populations (9, 10, 16), and projected plant loss in other populations would result in significant impacts to Graham's beardtongue's representation.

Under this scenario, White River beardtongue has 11 large populations distributed across its range with at least one large population within each of the five range units (Appendix 1). The remaining 5 populations are small. White River beardtongue continues to occupy the five main vegetation types within its range (the Intermountain Basin big sagebrush shrubland and steppe, the Colorado Plateau low sagebrush shrubland and steppe, Pinyon-Juniper woodlands, the Intermountain Basins mixed salt desert scrub, and shale badlands systems; Appendix 1; USFWS 2021, p. 72). Our evaluation of these demographic and ecological surrogates for genetic diversity suggests that White River beardtongue will maintain a similar level of ecological diversity within the 16 remaining populations to what it has currently, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the one White River beardtongue population (8), and projected plant loss in other populations would result in significant impacts to White River beardtongue's representation.

3.3 Scenario 2 – High Energy Development

Resiliency under Scenario 2 – Under this scenario, the main stressors for Graham's beardtongue are oil shale and traditional oil and gas, which results in the loss of 45 percent (25,591 plants) of the total population (Table 13). The main stressors change the condition of populations in the center of the species' range (range unit 2 - Seep Ridge and range unit 3 - Evacuation Creek), and result in the extirpation of three populations (9, 10, 16) and a decline in the condition of six populations from plant loss or plant and habitat loss (populations 7, 12, 15, 17, 19, 21). Population condition is maintained in the remainder of the species' range (range unit 1 - Sand Wash, range unit 4 - White River, and range unit 5 - Raven Ridge).

The Graham's beardtongue projected total population size under Scenario 2 is 30,794, comprised of 24 populations (Table 13). Occupied habitat and pollinator habitat are projected to be 6,037 and 63,580 acres, respectively. The majority of the total population (96 percent) occurs in 11 populations with Good condition, and the remaining total population (4 percent) occurs in 13 populations with Moderate (9 populations) and Low (4 populations) condition. Energy development is present within 4 of the 11 populations in Good condition and 4 of the 9 populations in Moderate condition, and we expect these populations to continue to maintain their resiliency in the future despite projected impacts. Fourteen populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years). Populations in Good condition are less sensitive to plant and habitat loss than populations in Moderate or Low condition because there is sufficient habitat area and population size remaining to support the overall population condition. For example, populations 22 and 23 retain their Good condition and support many thousands of Graham's beardtongue individuals despite projected plant and habitat loss. The species continues to occupy the extent of its current range and all range units continue to support populations in Good or Moderate condition.

Regarding the other stressors, the road construction stressor was included in the evaluation of impacts from energy development (oil shale and traditional oil and gas). The tar sand stressor was not present within Graham's beardtongue's range. The invasive weed stressor did not change the future condition of Graham's beardtongue populations. The herbivory stressor may increase in seven Graham's beardtongue populations (1, 12, 13, 17, 20, 22, 23) at a local level but we do not expect it to change the future condition of Graham's beardtongue populations over a ten-year period. Climate change may increase the effects of invasive weeds and herbivory at a local level, but we do not expect it to change the future condition of Graham's beardtongue populations over a ten-year period.

Under Scenario 2, the main stressor for White River beardtongue is oil shale, which results in the loss of 24 percent of the total population (7,207 plants) (Table 14). The main stressor changes the condition of four populations (populations 8, 9, 11, 13) in the center of the species' range (range unit 3 (Evacuation Creek) and 4 (White River)), and results in the extirpation of two populations (8, 13) and a decline in the condition of two populations from loss of plants and habitat (populations 9, 11). Population condition is maintained in the remainder of the species' range (range unit 2 - Seep Ridge, range unit 5 - Raven Ridge, and range unit 6 - Book Cliffs).

The White River beardtongue projected total population size under Scenario 2 is 22,695, comprised of 15 populations (Table 14). Occupied habitat and pollinator habitat are projected to be 2,317 and 20,099 acres, respectively. The majority of the total population (76 percent) occurs in 5 populations with Good condition, and the remaining total population (24 percent) occurs in 10 populations with Moderate condition. Energy development is present within 3 of the 5 populations in Good condition and 4 of the 10 populations in Moderate condition, and we expect these populations to maintain their resiliency in the future despite projected impacts. Nine populations in Good and Moderate condition are large in size and have a low extinction risk (< 5 percent over 50 years). Just like Graham's beardtongue, populations in Good condition are less sensitive to plant and habitat loss than populations in Moderate or Low condition because there is sufficient habitat area and population size remaining to support the overall population

Table 13. Scenario 2 Future condition and size of Graham's beardtongue populations.

Range Unit	Population	Current Condition and Size[13]	Future Condition and Size	Energy Stressor(s)
1. Sand Wash	1	**Good (L)**	**Good (L)**	Oil and gas
	2	**Good (L)**	**Good (L)**	None
	3	**Good (L)**	**Good (L)**	None
	4	**Moderate (S)**	**Moderate (S)**	None
	5	**Good (L)**	**Good (L)**	None
	6	**Good (L)**	**Good (L)**	None
2. Seep Ridge	7	**Moderate (S)**	**Low (S)**	Oil shale
	8	**Moderate (S)**	**Moderate (S)**	None
	9	**Moderate (S)**	**Extirpated**	Oil and gas
	10	**Good (L)**	**Extirpated**	Oil and gas
	11	**Moderate (L)**	**Moderate (L)**	Oil and gas; Oil shale
	12	**Moderate (S)**	**Low (S)**	Oil and gas; Oil shale
	13	**Good (L)**	**Good (L)**	Oil and gas; Oil shale
	14	**Good (L)**	**Good (L)**	None
	15	**Good (L)**	**Moderate (L)**	Oil and gas; Oil shale
	16	**Moderate (S)**	**Extirpated**	Oil and gas
3. Evacuation Creek	17	**Good (L)**	**Moderate (L)**	Oil shale
	18	**Moderate (S)**	**Moderate (S)**	Oil shale
	19	**Moderate (S)**	**Low (S)**	Oil shale
	20	**Good (L)**	**Good (L)**	Oil shale
	21	**Moderate (S)**	**Low (S)**	Oil and gas
	22	**Good (L)**	**Good (L)**	Oil and gas; Oil shale
4. White River	23	**Good (L)**	**Good (L)**	Oil shale
5. Raven Ridge	24	**Moderate (S)**	**Moderate (S)**	None
	25	**Moderate (S)**	**Moderate (S)**	None
	26	**Moderate (S)**	**Moderate (S)**	None
	27	**Good (L)**	**Good (L)**	None
Total Population		**56,385**	**30,794 (55%)**	

[13] Population size categories – large (L), medium (M), and small (S) are based on extinction risk over 50 years. Large populations have less than 5% extinction risk; medium populations have 6 – 10% extinction risk; and small populations have greater than 10% extinction risk (USFWS 2021, pp. 71 – 72).

Table 14. Scenario 2 Future condition and size of White River beardtongue populations.

Range Unit	Population	Current Condition and Size[14]	Future Condition and Size	Energy Stressor(s)
2. Seep Ridge	1	Moderate (S)	Moderate (S)	None
	2	Moderate (S)	Moderate (S)	None
	3	Good (L)	Good (L)	Oil shale
	4	Good (L)	Good (L)	Oil shale
	5	Moderate (S)	Moderate (S)	Oil shale
	6	Moderate (S)	Moderate (S)	None
	7	Moderate (S)	Moderate (S)	None
3. Evacuation Creek	8	Low (S)	Extirpated	Oil shale
	9	Good (L)	Moderate (S)	Oil shale
4. White River	10	Good (L)	Good (L)	Oil shale
	11	Good (L)	Moderate (L)	Oil shale
	12	Moderate (L)	Moderate (L)	Oil shale
	13	Moderate (L)	Extirpated	Oil shale
	14	Moderate (L)	Moderate (L)	None
5. Raven Ridge	15	Moderate (L)	Moderate (L)	None
	16	Good (L)	Good (L)	None
6. Book Cliffs	17	Good (L)	Good (L)	Oil and gas; Tar sands
Total Population		**29,902**	**22,695 (76%)**	

condition. The species continues to occupy the extent of its current range and all range units continue to support populations in Good or Moderate condition.

Regarding the other stressors, the road construction stressor was included in the evaluation of impacts from energy development (oil shale, tar sands, and traditional oil and gas). The invasive weed stressor did not change the future condition of White River beardtongue populations. The herbivory stressor may increase in six White River beardtongue populations (3, 9, 10, 11, 12, 17) at a local level but we do not expect it to change the future condition of White River beardtongue populations over a ten-year period. Climate change may increase the effects of invasive weeds and herbivory at a local level, but we do not expect it to change the future condition of White River beardtongue populations over a ten-year period.

[14] Population size categories – large (L), medium (M), and small (S) are based on extinction risk over 50 years. Large populations have less than 5% extinction risk; medium populations have 6 – 10% extinction risk; and small populations have greater than 10% extinction risk (USFWS 2021, pp. 71 – 72).

Redundancy under Scenario 2 – Under this scenario, we project a reduction in redundancy for Graham's and White River beardtongues. We project the extirpation of three out of 27 Graham's beardtongue populations (9, 10, 16) and the extirpation of two out of 17 White River beardtongue populations (8, 13). Despite the extirpation of populations, levels of redundancy remain high for both species with Graham's beardtongue maintaining 24 populations and White River beardtongue maintaining 15 populations.

Representation under Scenario 2 – Under this scenario, Graham's beardtongue has the same number of large (14) and small (10) populations and distribution across its range as Scenario 1 despite a larger projected plant loss (Appendix 1). The species has at least one large population within each of the five range units and continues to occupy the five main vegetation types within its range (the Intermountain Basin big sagebrush shrubland and steppe, the Colorado Plateau low sagebrush shrubland and steppe, Pinyon-Juniper woodlands, the Intermountain Basins mixed salt desert scrub, and shale badlands systems; Appendix 1; USFWS 2021, p. 72). Our evaluation of these demographic and ecological surrogates of genetic diversity suggests that Graham's beardtongue will maintain a similar level of ecological diversity within the 24 remaining populations to what it currently has, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the three Graham's beardtongue populations (9, 10, 16), and projected plant loss in other populations would result in significant impacts to Graham's beardtongues' representation.

Under this scenario, White River beardtongue has one fewer large populations (10) and the same number of small populations (5) and distribution across its range as Scenario 1 (Appendix 1). The species has at least one large population within each of the five range units and continues to occupy the five main vegetation types within its range (the Intermountain Basin big sagebrush shrubland and steppe, the Colorado Plateau low sagebrush shrubland and steppe, Pinyon-Juniper woodlands, the Intermountain Basins mixed salt desert scrub, and shale badlands systems; Appendix 1; USFWS 2021, p. 72). Our evaluation of these demographic and ecological surrogates for genetic diversity suggests that White River beardtongue will maintain a similar level of genetic diversity within the 15 remaining populations to what it currently has, and should have the adaptive capacity to tolerate future climate and habitat conditions. We have no information to indicate that the projected loss of the two White River beardtongue populations (8, 13), and projected plant loss in other populations would result in significant impacts to White River beardtongue's representation.

Uncertainty Discussion – We have uncertainty about the acreage and locations of future energy development within the beardtongues' populations as well as impacts to populations for the two scenarios, as discussed here. We identified recommendations to improve the population condition in the Biological Report (USFWS 2021, pp. 79 – 80).

For our analysis, we assumed traditional oil and gas development would occur in beardtongue populations with delineated oil and gas fields, despite the low level of projected development, and that all beardtongue plants would be lost within delineated fields on non-Federal lands, despite the ability of companies to co-locate wells and infrastructure to avoid loss of plants. Therefore, actual impacts to the species may be less than what is depicted in our projections. We cannot project the location of all new natural gas wells within the beardtongues' ranges outside of delineated gas fields. New wells are not expected to be associated with an approved plan of development for full field development (e.g. concentrated wells and pad locations) but rather by individual lease-holders to drill a few additional well pads within their lease area.

For our analysis, we assumed a larger area of oil shale development in scenario 2 (high energy development) than what was used in scenario 1 (moderate energy development). In both scenarios we assumed that all plants and habitat would be lost from oil shale and tar sands development, so that we could evaluate the worst-case impacts from this stressor; and that commercial development activities for oil shale and tar sands will occur in the next 10 years. The assumptions we made about oil shale and tar sands commercial development activities, and loss of plants and habitat for our analysis allowed us to evaluate the worst-case impacts from oil shale and tar sands in combination with the other stressors.

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APPENDIX 1

In this appendix, we provided more detail on our review of the oil shale stressor; our future herbivory evaluation; our future condition evaluation; downscaled maps of populations and stressors within range units; our representation evaluation; and our workflow for the energy stressor forecasts and the two future scenarios, scenario 1 moderate energy development and scenario 2 high energy development.

1. <u>Oil Shale Stressor</u>

<u>Exploration Activities</u>

The oil shale resource in the Utah and Colorado has been well characterized and priority areas for exploration are those that contain large amounts of oil shale as measured by gallons of shale oil per ton of rock (GPT) (Vanden Berg 2008a, entire; Vanden Berg 2008b, entire; Institute for Clean and Secure Energy (ICSE) 2011, entire; ICSE 2013, pp. 22 – 25; Vanden Berg and Birgenheier 2017, entire). A minimum economic viability threshold of 25 GPT was identified for the industry based on constraints that include overburden depth, thickness of the GPT layer, conflict with traditional oil and gas development, and restrictions on land use (Vanden Berg 2008a, p. 10; Vanden Berg 2008b, p. 33; Vanden Berg and Birgenheier 2017, p.64). Oil shale deposits in the Piceance Basin, Colorado are economically more favorable than in the Uinta Basin, Utah because they are richer in shale oil and are thicker deposits (Vanden Berger and Birgenheier 2017, p. 81) which is likely why large energy companies (e.g. Exxon, Shell, Total) focused their exploration activities in Colorado (Industrial Economics, Incorporated (IEC) 2014, p. 21). In Colorado, past exploration activities were focused on the development of underground (in place heating and extraction) technologies because of the greater depth of the resource (ICSE 2011, pp. 2 – 4; Vanden Berg and Birgenheier 2017, p.81). While the technological feasibility of underground extraction is promising in the Piceance Basin, it is not economically viable (ICSE 2013, p. 24). We considered pilot-scale development projects to be an exploration activity (USFWS 2019, entire; USFWS 2020b, entire).

In Utah, current exploration areas are located along the Mahogany zone, the richest oil shale horizon containing thick layers of rock (70 – 120 feet (ft) thick) that meet or exceed the 25 GPT threshold at or near the ground surface (Boden *et al.* 2018, p. 24; Vanden Berg and Birgenheier 2017, p.81). Current exploration activities are focusing on surface and underground mining techniques of the shallow deposits within 400 ft of the surface (USFWS 2019, pp. 4 – 5; Vanden Berg and Birgenheier 2017, p.81). The Mahogany ledge would be an ideal resource target for horizontal drilling and underground heating if those future technologies are developed (University of Utah 2011, p. 15; Vanden Berg and Birgenheier 2017, p.81). Underground or downhole extraction methods would be the most likely extraction method if the oil shale resource is located between 400 and 3,000 ft from the surface (USFWS 2019, pp. 4 – 5). For more detail on Utah's oil shale history and exploration methods, please see ICSE 2011, entire; ICSE 2013, entire; Aho 2015, entire.

In Utah, Federal lands contain approximately 32.3 billion barrels of oil equivalent; Tribal lands contain approximately 14.1 billion barrels of oil equivalent; state (SITLA) lands contain approximately 11.7 billion barrels of oil equivalent; and private lands contain approximately 6.9 billion barrels of oil equivalent (Ruple 2017, pp. 21, 24).

Commercial Development Activities

The lack of an efficient extraction technology and low oil market values are the primary constraints for commercial development (BLM 2017, pp. 75 – 76). Oil shale industry representatives (e.g. Red Leaf Resources, Inc. and Enefit) are optimistic that efficient extraction technologies will be developed in the next ten years, and state the primary constraint for commercial development is the price of crude oil (USFWS 2020b, pp. 3 – 4). This perspective is consistent with one U.S. oil shale evaluation (Bartis *et al.* 2005, pp. 46 – 47). One estimate identified that the price of crude oil (West Texas Intermediate) would need to be $78 - $105 per barrel in 2019 dollars ($70 - $95 in 2005 dollars) per barrel for U.S. oil shale production to be profitable, although this cost estimate was considered highly uncertain (Bartis *et al.* 2005, entire; ICSE 2013, pp. 9 – 10). Another estimate identified break even prices (all production costs) for various development operations that included the Red Leaf Resources operation with the lowest local price of $71 - $95 per barrel in 2019 dollars ($64 - $86 in 2012 dollars) and other operations with larger break even prices (ICSE 2013, p. 149; IEC 2014, pp. 23 – 24). Positive net earnings were predicted when the price of crude oil was at least $86 or $103 per barrel in 2020 dollars for various commercial development operations ($77 or $92 in 2012 dollars) (ICSE 2013, pp. 135 – 139). The 2019 nominal price of crude oil (West Texas Intermediate) is predicted to be $92.5 in 2030, which may make oil shale operations profitable at that time based on the 2019 break-even price and positive net earnings of Red Leaf Resources, Inc. and other operations (U.S. Energy Information Administration (EIA) 2020a, entire).

There are large uncertainties involved in predicting profitability for commercial oil shale development due to the difficulty of:

- Estimating the threshold or "hurdle price" of crude oil needed to motivate investment for the construction of commercial-scale oil shale facilities, given the high capital costs. The threshold would probably be substantially higher than the crude oil market price (Bartis *et al.* 2005, p. 46; ICSE 2013, pp. 134 – 135; Spinti *et al.* 2013, pp. 14 – 17).
- Predicting future crude oil prices due to their high annual volatility (variability) (Bartis *et al.* 2005, pp. 45 – 46; ICSE 2013, pp. 90 – 91; BLM 2017, p. 76).
- Evaluating the Red Leaf Resources, Inc. oil product to predict profitability (IEC 2014, pp. 23 – 24).

Additional constraints include water availability to support production; transportation infrastructure in the Uinta Basin; refinery upgrades; and potential future greenhouse gas regulations (ICSE 2013, pp. 24 – 25; IEC 2014, pp. 20 – 21). To alleviate transportation constraints, an insulated pipeline to transport waxy crude oil from the Uinta Basin to Salt Lake City refineries was proposed in 2014 but was canceled the following year due to low oil prices (Reuters 2015, entire). Currently, a railroad project is proposed in the Uinta Basin to alleviate some of the transportation constraint for all resource products (e.g. crude oil, mineral, and agricultural products) and the project proponents expect it to be complete within the next five to ten years (84 FR 68274, December 13, 2019; Seven County Infrastructure Coalition 2019, p. 14).

On state and private lands in Utah and Colorado, there is enough oil shale resource to support a sizeable commercial industry (ICSE 2013, p. 5, Ruple 2017, p. 34). On SITLA lands alone, the oil shale resource is roughly equivalent to the entire Prudhoe Bay oil field (ICSE 2013, p. 5). The amount of resource on state and private lands is predicted to support commercial development for a 30 year timeframe (USFWS 2019, entire; USFWS 2020b, entire).

On Federal lands in Utah and Colorado, the BLM has not developed a reasonably foreseeable development scenario because the information on oil shale is too speculative to permit future commercial leasing proposals (BLM 2013, pp. 24, 64). The BLM does not currently allow leasing for commercial development of oil shale, because the agency will need to consider the environmental consequences of future technology and proposed commercial projects before committing to broad scale commercial oil shale development (BLM 2013, pp. 27, A-4 – A-10; BLM 2017, pp. 5, 63 – 68).

Leasing is currently limited to research, development, and demonstration (RD&D) leases for oil shale exploration activities (BLM 2013, p. 4). Some RD&D leases include a larger preference right lease area (PRLA) that could be included in a commercial oil shale lease (BLM 2013, p. 15). The one active RD&D lease in Utah has a PRLA of 4,960 acres in size (BLM 2013, pp. 15 – 16). Prior to commercial leasing, operational permit approval, or expansion into a PRLA, operators need to submit a watershed protection plan for water resources, an airshed review to predict probable air quality effects of operations; an integrated waste management plan; and an environmental protection plan to minimize adverse effects on resources; and perform monitoring; adaptive management; and mitigation of adverse effects (BLM 2017, pp. 5, 55 – 63). This information will inform a subsequent NEPA analysis of the environmental, social and economic effects of reasonably foreseeable development (BLM 2013, pp. 15, 27; BLM 2017, pp. 5, 55 – 63).

The BLM may issue a commercial lease under the following conditions:

- When a lessee satisfies the conditions of its RD&D lease by proving the commercial viability of the technologies they intend to use and the regulations at 43 CFR Part 3926 for conversion to a commercial lease. The PRLA, if any is identified in the RD&D lease, would be included in the converted lease (BLM 2013, Table A-1). The regulations at 43 CFR Part 3926 state the potential developer needs to document there have been commercial quantities of oil shale produced from the RD&D lease; consulted with state and local officials to develop a plan for mitigating the socio-economic impacts of commercial development; paid fees; completed bonding; and complied with general performance standards identified in 43 CFR 3930.
- Once a lessee satisfies the conditions of one RD&D lease, they may obtain a commercial lease outside of the PRLA but within Federal lands open to oil shale leasing without having to obtain another RD&D lease (BLM 2013, pp. 24).
- A potential lessee employs technology proved to be commercially viable on non-Federal lands in Colorado, Utah, or Wyoming, and the Secretary of Interior determines it to be environmentally acceptable (BLM 2013, pp. 24).
- A potential lessee can demonstrate that their methods would not destroy or prevent the recovery of other minerals in designated multi-mineral zones in Colorado (BLM 2013, p. 14).

On Federal lands in Utah and Colorado, while there is a considerable oil shale resource to support a commercial industry, commercial leasing restrictions are in place until certain conditions are met, as discussed above. In Utah, the industry's preferred approach to obtain a Federal commercial lease is for a company to first prove commercial viability on non-Federal lands, then complete the remaining Federal leasing and environmental permitting requirements (USFWS 2020b, p. 3). This approach would streamline the permitting process on Federal lands and negate the need for companies to obtain an RD&D lease. This approach would also result in a time lag for commercial development on Federal lands in Utah. It is unlikely that oil shale commercial development will occur on Federal lands in the next ten years (section 2.1 Oil Shale; USFWS 2020b, entire). We are not able to provide a reliable prediction beyond 2030 because experts considered the uncertainty to be too great beyond this timeframe (section 2.1 Oil Shale; BLM 2017, pp. 75 – 76; USFWS 2019, entire; USFWS 2020b, entire). The 10-year forecast period is consistent with an economic forecast of this industry and the considerable uncertainty of predicting beyond this timeframe (IEC 2014, p. 20).

2. Future Herbivory Evaluation

Below we summarize the potential future herbivory impacts to Graham's and White River beardtongue populations under the two future scenarios, 1 and 2 in Tables 1 and 2. On BLM lands and where there is no energy stressor identified, we expect there will be no change in herbivory relative to current levels.

Table 1. Potential future herbivory in Graham's beardtongue populations compared to current levels of herbivory.

Range Unit	Population	Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)	Landownership	Future Herbivory
1. Sand Wash	1	Oil and gas (B)	Primarily BLM; State	No change on BLM lands. May be potential for increased herbivory on state lands with the energy stressor under both scenarios.
	2	None	BLM	No change
	3	None	Primarily BLM; Private	No change
	4	None	BLM	No change
	5	None	BLM	No change
	6	None	BLM	No change
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
2. Seep Ridge	7	Oil shale(2)	BLM; State	No change. Plants are located on BLM lands. Energy stressor on state lands that contains pollinator habitat only.
	8	None	BLM	No change
	9	Oil and gas (B)	Private	Not applicable. We projected the loss of this population from energy development.
	10	Oil and gas (B)	Private	Not applicable. We projected the loss of this population from energy development.
	11	Oil and gas (B); Oil shale (2)	BLM; Private	No change. Plants are located on BLM lands. Energy stressor on private lands that contains pollinator habitat only.
	12	Oil and gas (B); Oil shale (2)	Primarily Private; BLM	No change on BLM lands. May be potential for increased herbivory on private lands under both scenarios.
	13	Oil and gas (B); Oil shale (B)	Primarily BLM; State (SITLA and DWR)	No change on BLM lands. May be potential for increased herbivory on state lands under both scenarios.
	14	None	BLM	No change
	15	Oil and gas (B);Oil shale (2)	BLM	No change

	16	Oil and gas (B)	State (DWR)	Not applicable. We projected the loss of this population from energy development.
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
3. Evacuation Creek	17	Oil shale (B)	BLM; State; Private	No change on BLM lands. May be potential for increased herbivory on private lands under both scenarios
	18	Oil shale (B)	BLM	No change
	19	Oil shale (B)	BLM	No change
	20	Oil shale (B)	Primarily State; BLM	No change on BLM lands. May be potential for increased herbivory on state lands under both scenarios.
	21	Oil and gas (B)	BLM	No change
	22	Oil and gas (B); Oil shale (B)	BLM; Private; State	No change on BLM lands. May be potential for increased herbivory on private and state lands under both scenarios.
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
4. White River	23	Oil shale (2)	BLM; Private; State	No change on BLM lands. May be potential for increased herbivory on private and state lands under Scenario 2.
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
5. Raven Ridge	24	None	BLM	No change
	25	None	BLM	No change
	26	None	BLM	No change
	27	None	BLM	No change

Table 2. Potential future herbivory in White River beardtongue populations compared to current levels of herbivory.

Range Unit	Population	Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)	Landownership	Future Herbivory
2. Seep Ridge	1	None	BLM	No change
	2	None	Private	No change
	3	Oil shale (2)	BLM; State; Private	No change on BLM lands. May be potential for increased herbivory on private and state lands under Scenario 2.
	4	Oil shale (2)	BLM	No change
	5	Oil shale (2)	BLM	No change
	6	None	BLM	No change
	7	None	State	No change
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
3. Evacuation Creek	8	Oil shale (B)	State	Not applicable. We projected the loss of this population from energy development.
	9	Oil shale (B)	Primarily Private; BLM; State	No change on BLM lands. May be potential for increased herbivory on private and state lands under both scenarios.
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
4. White River	10	Oil shale (B)	BLM; Private	No change on BLM lands. May be potential for increased herbivory on private lands under both scenarios.
	11	Oil shale (2)	BLM; Private; State	No change on BLM lands. May be potential for increased herbivory on private and state lands under Scenario 2.
	12	Oil shale (2)	State	May be potential for increased herbivory on state lands under Scenario 2.

	13	Oil shale (2)	State; Private	No change under Scenario 1. Not applicable for Scenario 2. We projected the loss of this population from energy development.
	14	None	BLM	No change
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
5. Raven Ridge	15	None	BLM	No change
	16	None	BLM	No change
Range Unit	**Population**	**Energy Stressor(s) for Scenario 1 (1), 2 (2), or Both (B)**	**Landownership**	**Future Herbivory**
6. Book Cliffs	17	Oil and gas (B); tar sands (B)	BLM; State	No change on BLM lands. May be potential for increased herbivory on state lands under both scenarios.

3. <u>Future Condition Evaluation</u>

Here we summarize the metrics for evaluating Graham's and White River beardtongues' future condition (Table 3, Table 4), present the scores and spread of scores for each condition category (Table 5), and provide a more detailed summary of future condition under scenario 1 moderate energy development (Table 6, Table 7) and scenario 2 high energy development (Table 8,

Table 9).

Table 3. Metrics for evaluating future condition for Graham's beardtongue.

Future Condition					
	Population Size Factor		Habitat Factors		
Condition Category	**Probability of Persistence**	**Presence of High Density Clusters**	**Pollinator Habitat Quality**	**Pollinator Habitat Area (ac)**	**Pollinator Habitat Loss Category**
Good	Low Extinction Risk (<5%)	One or More in the Population	Nonnative plant cover 0 - 5%	> 2,600	0 - 5% (Low Loss)
Moderate	Moderate Extinction Risk (6 – 10%)	None Present	Nonnative plant cover 6 - 25%	1,000 – 2,600	5.1 – 10% (Moderate Loss)
Low	High Extinction Risk (>10%)	None Present	Nonnative plant cover >25%	<1,000	>10% (High Loss)

Table 4. Metrics for evaluating future condition for White River beardtongue.

Future Condition					
	Population Size Factor		Habitat Factors		
Condition Category	**Probability of Persistence**	**Presence of High Density Clusters**	**Pollinator Habitat Quality**	**Pollinator Habitat Area (ac)**	**Pollinator Habitat Loss Category**
Good	Low Extinction Risk (<5%)	One or More in the Population	Nonnative plant cover 0 - 5%	> 1,000	0 - 5% (Low Loss)
Moderate	Moderate Extinction Risk (6 – 10%)	None Present	Nonnative plant cover 6 - 25%	500 – 1,000	5.1 – 10% (Moderate Loss)
Low	High Extinction Risk (>10%)	None Present	Nonnative plant cover >25%	<500	>10% (High Loss)

Table 5. The scores and spread of scores for each condition category.

Categories	Average Range	Spread
Good	2.01 - 2.6	0.59
Moderate	1.4 - 2	0.6
Low	0.8 - 1.39	0.59

Table 6. Scenario 1 (Moderate Energy Development) - Future condition of Graham's beardtongue populations. DCAs = 2014 conservation agreement designated conservation areas. nonFed = non-Federal.

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
1. Sand Wash	1	3	1	3	3	3	13	2.6	**Good**	Oil and gas	One gas field and all plants are located in DCAs. Energy development would likely be outside of DCA or limited to caps within DCA. Even if we assume double the amount of current loss (98 ac), the percent habitat loss is 2%. Unlikely for pollinator habitat loss to exceed 5%
	2	3	1	3	3	3	13	2.6	**Good**	None	Most plants and pollinator habitat in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
	3	3	1	3	3	3	13	2.6	**Good**	None	Most plants and pollinator habitat in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
	4	1	1	3	1	3	9	1.8	**Moderate**	None	There are no delineated fields. Most of the plants and pollinator habitat are located in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
	5	3	1	3	2	3	12	2.4	**Good**	None	Most plants and pollinator habitat in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
	6	3	1	3	2	3	12	2.4	**Good**	None	Delineated fields are small and outside of pollinator habitat. Most of plants and pollinator habitat in areas with surface disturbance restrictions. Unlikely for

											pollinator habitat loss to exceed 5%
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
2. Seep Ridge	7	1	0	2	1	3	7	1.4	**Moderate**	None	No energy stressor in this population. Unlikely for pollinator habitat loss to exceed 5% for oil and gas.
	8	1	0	3	1	3	8	1.6	**Moderate**	None	No disturbance in pollinator habitat. Unlikely for pollinator habitat loss to exceed 5%
	9	1	0	1	1	2	5	1	**Extirpated**	Oil and gas	This population is within a delineated oil field and has no protections. Likely for additional plant and pollinator habitat loss. Our analysis assumed extinction risk is above 20% due to plant loss. Habitat loss >5% or >10% result in Low future condition.
	10	1	0	1	1	2	6	1	**Extirpated**	Oil and gas	This population is within a delineated oil field and has no protections. Likely for additional plant and pollinator habitat loss. Our analysis assumed extinction risk is above 20% due to plant loss. Habitat loss >5% or >10% result in Low future condition.
	11	3	1	2	1	1	8	1.6	**Moderate**	Oil and gas	A portion of pollinator habitat is on private lands within the delineated oil field (22 acres, 2.4% of pollinator area). Even if pollinator habitat loss exceeds 10%, this population is in moderate condition
	12	1	0	2	1	1	5	1	**Low**	Oil and gas	A portion of pollinator habitat is within the delineated oil field, 149 ac (13%).

	13	3	1	3	3	1	11	2.2	**Good**	Oil and gas; oil shale	There are 204 plants on BLM outside of DCA that are protected from surface disturbance.
	14	3	1	3	2	3	12	2.4	**Good**	None	There are no energy stressors. All plants are on BLM lands. There are 650 plants on BLM within a No Lease area. Unlikely for pollinator habitat loss to exceed 5%
	15	3	1	3	1	3	11	2.2	**Good**	Oil and gas	422 plants in a BLM No Surface Occupancy area. A small portion of pollinator habitat in delineated gas field with one well. Unlikely for pollinator habitat loss to exceed 5%.
	16	1	0	2	1	1	5	1	**Extirpated**	Oil and gas	This population is within a delineated gas field and has no protections. Likely for additional plant and pollinator habitat loss. Our analysis assumed extinction risk is above 20% due to plant loss. Habitat loss >5% or >10% result in Low future condition.
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
3. Evacuation Creek	17	3	1	1	2	1	8	1.6	**Moderate**	Oil shale	There is oil shale development identified for this development on nonFed lands. The portion on the population on BLM lands is contiguous and rather large in habitat area.
	18	1	0	3	1	2	7	1.4	**Moderate**	Oil shale	The habitat area is primarily on BLM lands. Potential for oil shale development on nonFed lands. The moderate level of habitat loss keeps this population in moderate condition.

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
	19	1	0	3	1	1	6	1.2	**Low**	Oil shale	The habitat area is primarily on BLM lands. Potential for oil shale development on nonFed lands.
	20	3	1	3	3	1	11	2.2	**Good**	Oil shale	Most of the remaining habitat area containing plants is located within state and BLM DCAs where surface disturbance caps apply.
	21	1	0	2	1	1	5	1	**Low**	Oil and gas	This population is within a delineated gas field and has 300 ft buffer protections. Likely for additional pollinator habitat loss. Extinction risk is already high. Habitat loss >5% or >10% result in Low future condition.
	22	3	1	3	3	1	11	2.2	**Good**	Oil and gas; oil shale	The remaining habitat area is fairly contiguous and occupied habitat is primarily within BLM and state DCAs. The DCAs should provide good connectivity to support gene flow for the species.
Range Unit	**Popul ation**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
4. White River	23	3	1	3	3	3	13	2.6	**Good**	None	There are no identified stressors in this population
Range Unit	**Popul ation**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
5. Raven Ridge	24	1	0	3	1	3	8	1.6	**Moderate**	None	There are no energy stressors in this population. Our analysis assumed less than 5% habitat loss would occur.
	25	1	0	3	1	3	8	1.6	**Moderate**	None	There are no energy stressors in this population. Plants on BLM are within DCA. Our analysis

											assumed no plant loss and less than 5% habitat loss would occur.
	26	1	0	3	1	3	8	1.6	**Moderate**	None	Population within DCA. No energy stressors. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur.
	27	3	1	2	2	3	11	2.2	**Good**	None	Population within DCA. No energy stressors. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur.

Table 7. Scenario 1 (Moderate Energy Development) - Future condition of White River beardtongue populations. DCAs = 2014 conservation agreement designated conservation areas. nonFed = non-Federal.

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
2. Seep Ridge	1	1	0	3	1	3	8	1.6	**Moderate**	None	Plants are on BLM land. No energy stressors in this population. Our analysis assumed less than 5% habitat loss would occur.
	2	1	0	3	1	3	8	1.6	**Moderate**	None	Plants are on nonFed land. No energy stressors in this population. Our analysis assumed less than 5% habitat loss would occur.
	3	3	1	3	3	1	11	2.2	**Good**	None	No energy stressors in this population. Even with >10% habitat loss, stays in Good condition.
	4	3	1	3	3	1	11	2.2	**Good**	None	No energy stressors in this population. Most of the plants are within DCAs. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur. Even with >10% habitat loss, stays in Good condition.
	5	1	0	3	1	3	8	1.6	**Moderate**	None	Plants are within DCAs and some pollinator habitat in NSO area on BLM lands. There are no energy stressors in this population. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur.
	6	1	0	3	1	2	7	1.4	**Moderate**	None	Plants are on BLM lands, almost half of pollinator habitat in a no lease area. There are no energy stressors in this population. Our analysis assumed less than 10% habitat loss would occur.
	7	1	0	3	3	3	10	2	**Moderate**	None	The plants are on nonFed land managed by Utah Department of Natural Resources (DNR). There are no energy stressors in this population. Our analysis assumed

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
											less than 5% habitat loss would occur.
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
3. Evacuation Creek	8	1	0	2	1	1	5	1	**Extirpated**	Oil shale	Plants and half of pollinator habitat in area of oil shale development. Our analysis assumed total loss of plants and habitat on nonFed lands.
	9	1	0	3	3	1	8	1.6	**Moderate**	Oil shale	There is connectivity for remaining plants on BLM and nonFed lands in conservation area.
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
4. White River	10	3	1	3	3	1	11	2.2	**Good**	Oil shale	Plants on BLM lands are within DCAs. Pollinator habitat on nonFed lands with oil shale stressor. Despite >10% habitat loss, population remains in Good condition. Due to the connectivity and surrounding BLM lands, retained the high quality habitat condition of the population.
	11	3	1	3	3	3	13	2.6	**Good**	None	There are no energy stressors in this population. It remains in Good condition.
	12	3	1	2	1	3	10	2	**Moderate**	None	Plants are protected in a SITLA DCA. No energy stressor in this population. Habitat on BLM land is directly adjacent to a no surface occupancy area. Our analysis assumed <5% habitat loss. If the habitat quality is reduced to moderate, the population condition would be Moderate.
	13	1	0	2	2	3	8	1.6	**Moderate**	None	There is no energy stressor in this population. The population

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
											condition remains the same as current condition.
	14	3	1	3	1	2	10	2	**Moderate**	None	Plants are protected in a BLM DCA. No identified future stressors in this population. Habitat on BLM land is located within a large DCA. Our analysis assumed <10% habitat loss because current loss is already at 3%, with some pollinator habitat on nonFed lands. If the habitat loss remains below 5%, the population condition is Good.
Range Unit	**Popul ation**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
5. Raven Ridge	15	3	1	2	1	3	10	2	**Moderate**	None	Plants are protected in a BLM DCA. No energy stressor in this population. Habitat on BLM land is located within a large DCA connected to population 16. Our analysis assumed <5% habitat loss because current loss is <1%, and no pollinator habitat on nonFed lands.
	16	3	1	3	2	2	11	2.2	**Good**	None	Plants are protected in a BLM DCA. No energy stressor in this population. Habitat on BLM land is located within a large DCA connected to population 15. Our analysis assumed <10% habitat loss because current loss is 2%, with some pollinator habitat on nonFed lands.
Range Unit	**Popul ation**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
6. Book Cliffs	17	3	1	3	3	3	13	2.6	**Good**	Oil and gas; tar sands	Plants are protected on BLM lands and BLM and SITLA DCAs. Our analysis assumed <5% habitat loss

											because of surface disturbance caps.

Table 8. Scenario 2 (High Energy Development) - Future condition of Graham's beardtongue populations. DCAs = 2014 conservation agreement designated conservation areas. nonFed = non-Federal.

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
1. Sand Wash	1	3	1	3	3	3	13	2.6	**Good**	Oil and gas	There is one delineated gas field and all plants within the field are located in DCAs. Potential for additional development but that would likely be outside of DCA or limited to caps within DCA. Even if we assume double the amount of current loss (98 ac), the percent habitat loss is 2%. Unlikely for pollinator habitat loss to exceed 5%
	2	3	1	3	3	3	13	2.6	**Good**	None	There are no energy stressors. Most of the plants and pollinator habitat are located in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
	3	3	1	3	3	3	13	2.6	**Good**	None	There are no energy stressors. Most of the plants and pollinator habitat are located in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
	4	1	1	3	1	3	9	1.8	**Moderate**	None	There are no energy stressors. Most of the plants and pollinator habitat are located in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
	5	3	1	3	2	3	12	2.4	**Good**	None	There are no energy stressors. Most of the plants and pollinator habitat are located in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
	6	3	1	3	2	3	12	2.4	**Good**	None	Delineated fields are small and outside of pollinator habitat. Most of the plants and pollinator habitat are located in areas with surface disturbance restrictions. Unlikely for pollinator habitat loss to exceed 5%
Range Unit	**Popul ation**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
2. Seep Ridge	7	1	0	2	1	2	6	1.2	**Low**	Oil shale	40% of pollinator habitat within oil shale lease area on nonFed lands. This area is under lease but not identified as likely for oil shale exploration (e.g. no surface deposit). The pollinator buffer is located on steep slopes not likely to be disturbed. Drilling is within delineated field outside and west of pollinator habitat. Future drilling likely to occur in/near delineated field. Unlikely for pollinator habitat loss to exceed 5% for oil and gas. If oil shale exploration occurs, assume 60% of pollinator habitat and all plants remains. Assume reduced habitat quality.
	8	1	0	3	1	3	8	1.6	**Moderate**	None	There are no energy stressors, no disturbance in pollinator habitat. Unlikely for pollinator habitat loss to exceed 5%
	9	1	0	1	1	2	5	1	**Extirpated**	Oil and gas	This population is within a delineated oil field and has no protections. Likely for additional plant and pollinator habitat loss. Assume extinction risk is above 20% due to plant loss. Habitat loss >5% or >10% result in Low future condition.
	10	1	0	1	1	2	6	10	**Extirpated**	Oil and gas	This population is within a delineated oil field and has no protections. Likely for

											additional plant and pollinator habitat loss. Assume extinction risk is above 20% due to plant loss. Habitat loss >5% or >10% result in Low future condition.
	11	3	1	2	1	1	8	1.6	**Moderate**	Oil and gas; oil shale	A portion of pollinator habitat is on private lands within the delineated oil field and oil shale surface deposits (92 acres, 9.7% of pollinator area). Even if pollinator habitat loss exceeds 10%, this population is in moderate condition
	12	1	0	2	1	1	5	1	**Low**	Oil and gas; oil shale	A portion of pollinator habitat is within the delineated oil field, 149 ac (13%). A large portion of the pollinator habitat on private lands has surface deposits of oil shale that are not leased (877 ac, 79%).
	13	3	1	3	3	1	11	2.2	**Good**	Oil and gas; oil shale	There are 204 plants on BLM outside of DCA that are protected from surface disturbance by 300 ft.
	14	3	1	3	2	3	12	2.4	**Good**	None	There are no energy stressors, no wells in pollinator habitat. All plants are on BLM lands. There are 650 plants on BLM within a No Lease area. Unlikely for pollinator habitat loss to exceed 5%
	15	3	1	3	1	1	9	1.8	**Moderate**	Oil and gas; oil shale	422 plants in a BLM No Surface Occupancy designated area. A small portion of pollinator habitat in delineated gas field with one well also with an oil shale lease. Pollinator habitat loss to exceed 10%.
	16	1	0	2	1	1	5	1	**Extirpated**	Oil and gas	This population is within a delineated gas field and has no protections. Likely for additional plant and pollinator

											habitat loss. Assume extinction risk is above 20% due to plant loss. Habitat loss >5% or >10% result in Low future condition.
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
3. Evacuation Creek	17	3	1	1	2	1	8	1.6	**Moderate**	Oil shale	There is oil shale development identified on nonFed lands. The portion of the population on BLM lands is contiguous and rather large in habitat area.
	18	1	0	3	1	2	7	1.4	**Moderate**	Oil shale	The habitat area is primarily on BLM lands. Potential for oil shale development on nonFed lands. The moderate level of habitat loss keeps this population in moderate condition.
	19	1	0	3	1	1	6	1.2	**Low**	Oil shale	The habitat area is primarily on BLM lands. Potential for oil shale development on nonFed lands.
	20	3	1	3	3	1	11	2.2	**Good**	Oil shale	Most of the remaining habitat area containing plants is located within state and BLM DCAs where surface disturbance caps apply.
	21	1	0	2	1	1	5	1	**Low**	Oil and gas	This population is within a delineated gas field and has 300 ft buffer protections. Likely for additional pollinator habitat loss. Extinction risk is already high. Habitat loss >5% or >10% result in Low future condition.
	22	3	1	3	3	1	11	2.2	**Good**	Oil and gas; oil shale	The remaining habitat area is fairly contiguous and occupied habitat is primarily within BLM and state DCAs. The DCAs should provide good connectivity to support gene flow for the species.

4. White River	23	3	1	3	3	1	11	2.2	**Good**	Oil shale	There is oil shale development on nonFed lands. The portion on the population on BLM lands is contiguous and within DCAs subject to surface disturbance caps.
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
5. Raven Ridge	24	1	0	3	1	3	8	1.6	**Moderate**	None	There are no energy stressors in this population. Our analysis assumed less than 5% habitat loss would occur.
	25	1	0	3	1	3	8	1.6	**Moderate**	None	There are no energy stressors in this population. Plants on BLM are within DCA. Our analysis assumed no plant loss and less than 5% habitat loss would occur.
	26	1	0	3	1	3	8	1.6	**Moderate**	None	Population within DCA. No energy stressors. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur.
	27	3	1	2	2	3	11	2.2	**Good**	None	Population within DCA. No energy stressors. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur.

Table 9. Scenario 2 (High Energy Development) - Future condition of White River beardtongue populations. DCAs = 2014 conservation agreement designated conservation areas. nonFed = non-Federal.

Range Unit	Population	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
2. Seep Ridge	1	1	0	3	1	3	8	1.6	**Moderate**	None	The plants are on BLM land. There are no energy stressors in this population. Our analysis assumed less than 5% habitat loss would occur.
	2	1	0	3	1	3	8	1.6	**Moderate**	None	The plants are on nonFed land. There are no energy stressors in this population. Our analysis assumed less than 5% habitat loss would occur.
	3	3	1	3	3	1	11	2.2	**Good**	Oil shale	Remaining plants on BLM lands, some in DCA. Remaining habitat area fairly contiguous. Even with >10% habitat loss, stay in Good condition.
	4	3	1	3	3	1	11	2.2	**Good**	Oil shale	Most of the plants DCAs. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur. Even with >10% habitat loss, stay in Good condition.
	5	1	0	3	1	3	8	1.6	**Moderate**	Oil shale	Plants in DCAs. Very small portion of pollinator habitat on nonFed lands with oil shale stressor. This is directly adjacent to conservation area and NSO area on BLM lands. Our analysis assumed little to no plant loss and less than 5% habitat loss would occur.

	6	1	0	3	1	2	7	1.4	**Moderate**	None	Plants are on BLM lands, almost half of pollinator habitat in no lease area. There are no energy stressors in this population. Our analysis assumed less than 10% habitat loss would occur.
	7	1	0	3	3	3	10	2	**Moderate**	None	Plants are on nonFed land (DNR). There are no energy stressors in this population. Our analysis assumed less than 5% habitat loss would occur.

Range Unit	Popul ation	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
3. Evacuation Creek	8	1	0	2	1	1	5	1	**Extirpated**	Oil shale	Plants and half of pollinator habitat in area of oil shale development. Our analysis assumed total loss of plants and habitat on nonFed lands.
	9	1	0	3	3	1	8	1.6	**Moderate**	Oil shale	There is connectivity for remaining plants on BLM and nonFed lands in DCA.

Range Unit	Popul ation	Probability of Persistence	Presence of High Density Clusters	Habitat Quality	Habitat Area	Habitat Loss	Sum	Average	Future Condition Category	Energy Stressor	Notes
4. White River	10	3	1	3	3	1	11	2.2	**Good**	Oil shale	Plants on BLM lands in DCAs. Pollinator habitat on nonFed lands with oil shale stressor. Despite >10% habitat loss, population remains in Good condition. Due to the connectivity and surrounding

											BLM lands, retained high quality habitat condition of the population.
	11	3	1	2	3	1	10	2	**Moderate**	Oil shale	Remaining habitat is connected to population 10 and most of the plants on BLM lands in DCAs. There is the potential for additional habitat in Colorado on BLM lands. There is lower connectivity in this population, so downgraded the habitat quality to moderate. If the habitat quality remains high, this population could remain in Good condition.
	12	3	1	2	1	3	10	2	**Moderate**	Oil shale	Plants are protected in a SITLA DCA. No energy stressors in this population. Habitat on BLM land is directly adjacent to a no surface occupancy area. Our analysis assumed <5% habitat loss. If the habitat quality is reduced to moderate, the population condition would be Moderate.
	13	1	0	1	1	1	4	0.8	**Extirpated**	Oil shale	Plants in a private DCA. Oil shale is a future stressors in this population. The population condition changes once protections end in 2029, going from Moderate to Low.
	14	3	1	3	1	2	10	2	**Moderate**	None	Plants in a BLM DCA. No energy stressors in this population. Habitat on BLM land is located within a large DCA. Our analysis assumed <10% habitat loss because current loss is already at 3%, with some pollinator habitat on

											nonFed lands. If the habitat loss remains below 5%, the population condition is Good.
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**
5. Raven Ridge	15	3	1	2	1	3	10	2	**Moderate**	None	Plants in a BLM DCA. No energy stressors in this population. Habitat on BLM land is located in a large DCA connected to population 16. Our analysis assumed <5% habitat loss because current loss is <1%, and no pollinator habitat on nonFed lands.
	16	3	1	3	2	2	11	2.2	**Good**	None	Plants in a BLM DCA. No energy stressors in this population. Habitat on BLM land is located in a large DCA connected to population 15. Our analysis assumed <10% habitat loss because current loss is 2%, with some pollinator habitat on nonFed lands.
Range Unit	**Population**	**Probability of Persistence**	**Presence of High Density Clusters**	**Habitat Quality**	**Habitat Area**	**Habitat Loss**	**Sum**	**Average**	**Future Condition Category**	**Energy Stressor**	**Notes**

6. Book Cliffs	17	3	1	3	3	3	13	2.6	**Good**	Oil and gas; tar sands	Plants on BLM lands and BLM and SITLA DCAs. Our analysis assumed <5% habitat loss because of surface disturbance caps.

4. Maps

Below we provide maps of Graham's and White River beardtongue populations by range unit. Information depicted includes beardtongue pollinator habitat, 2014 conservation agreement conservation areas, Scenario 1 and 2 energy stressors, and landownership. Graham's beardtongue Scenario 1 and 2 maps are depicted in Figures 1 – 10; White River beardtongue Scenario 1 and 2 maps are depicted in Figures 11 – 20.

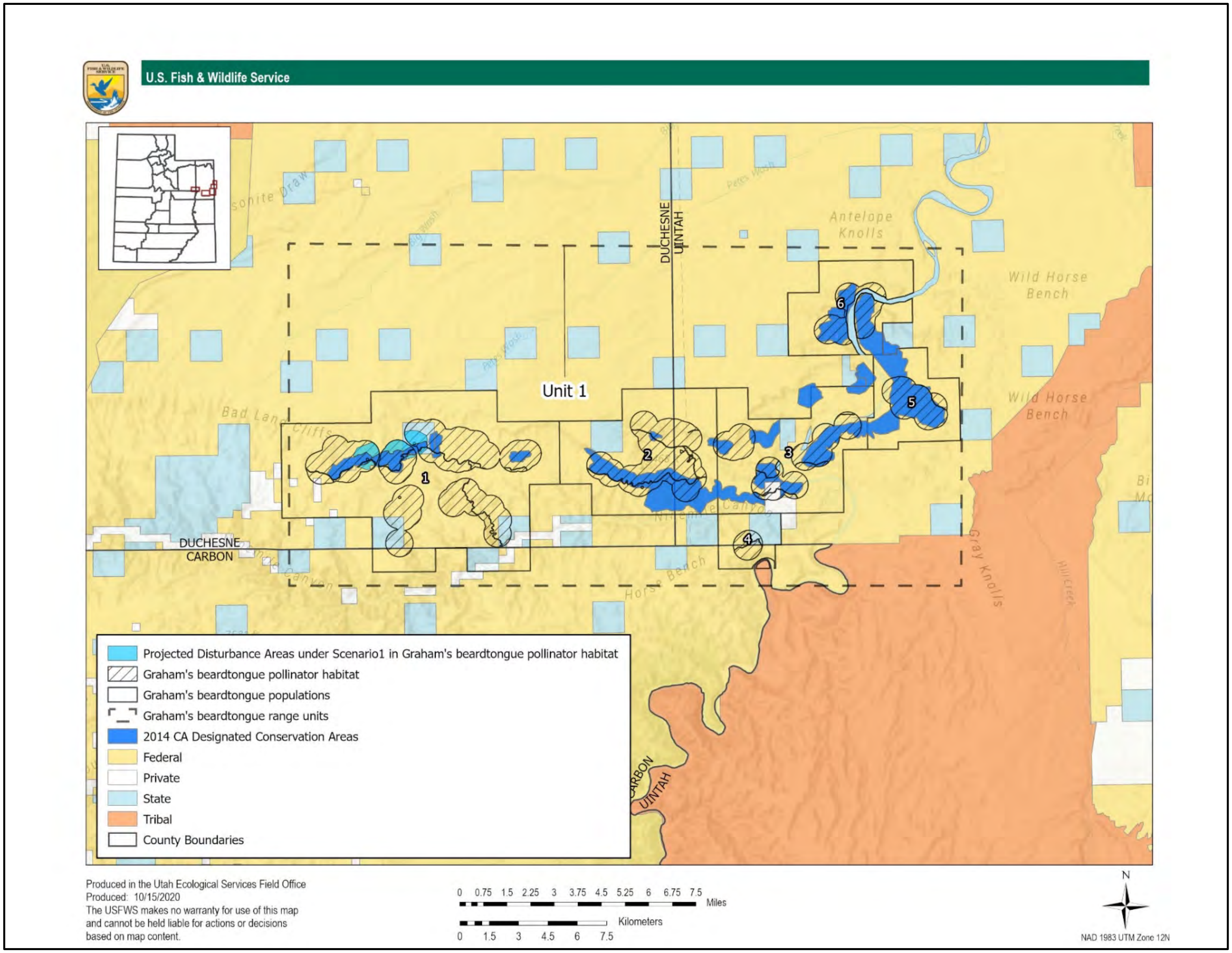


Figure 1. Graham's beardtongue populations 1 – 6 in range unit 1 and Future Scenario 1.

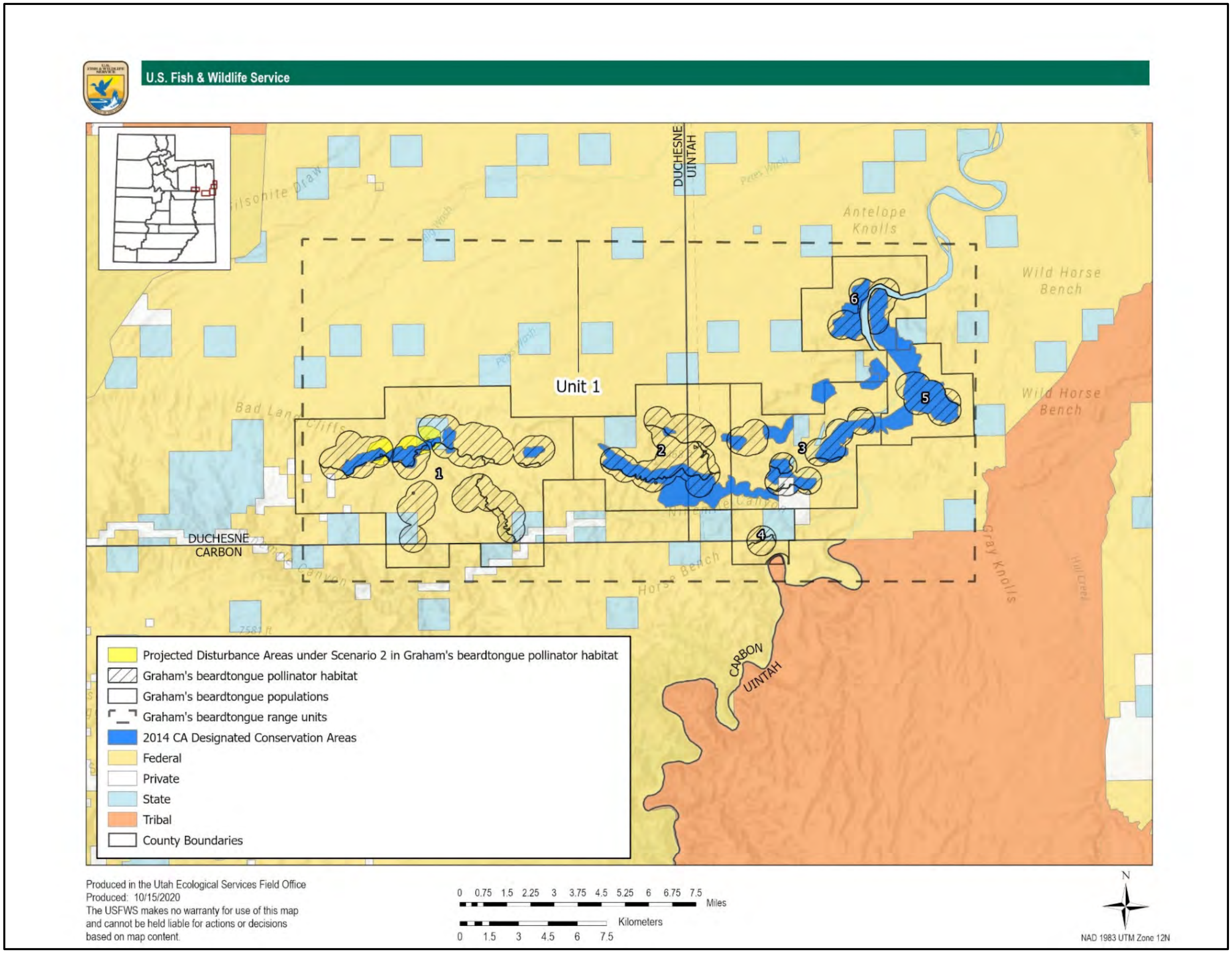


Figure 2. Graham's beardtongue populations 1 – 6 in range unit 1 and Future Scenario 2.

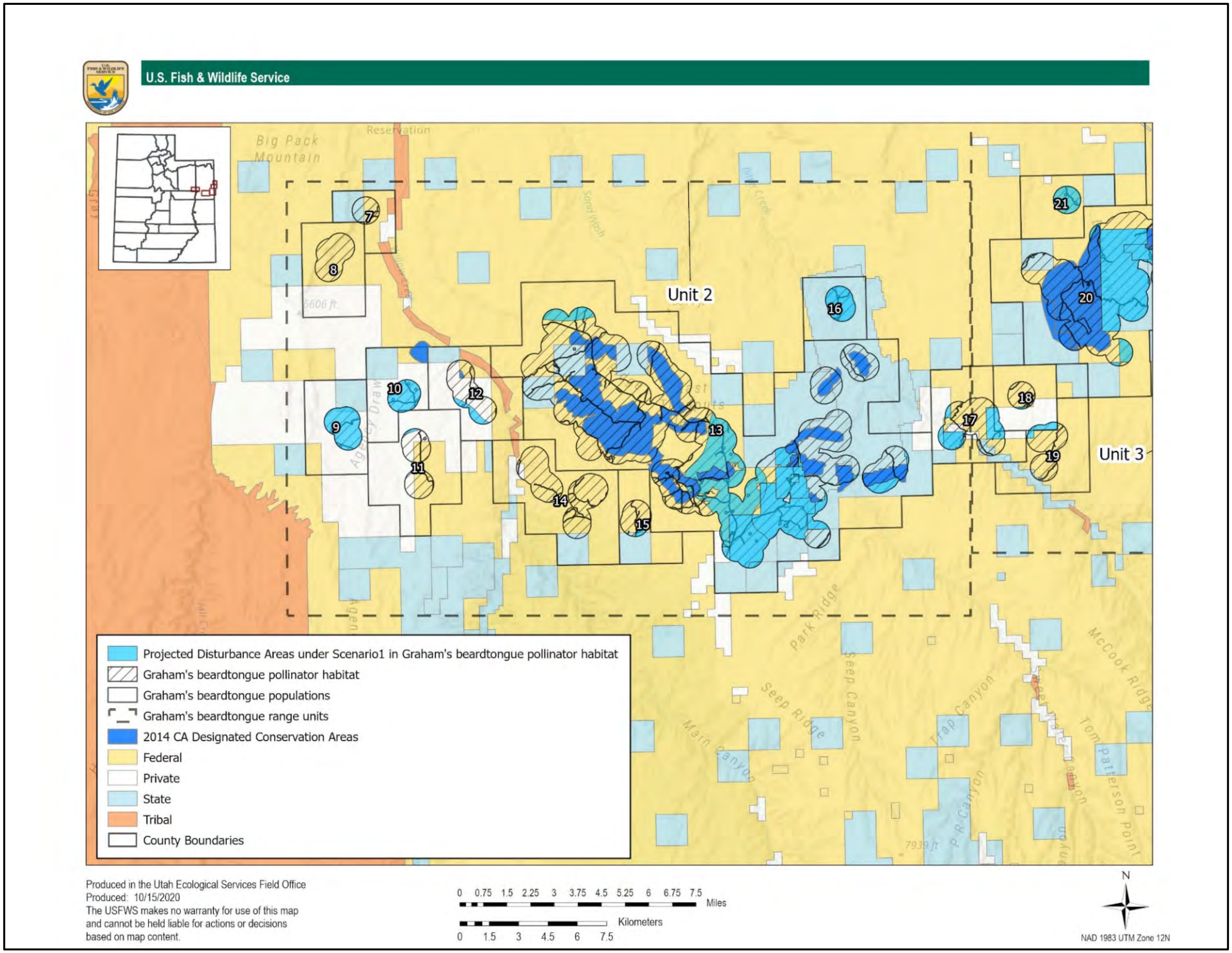


Figure 3. Graham's beardtongue populations 7 – 16 in range unit 2 and Future Scenario 1.

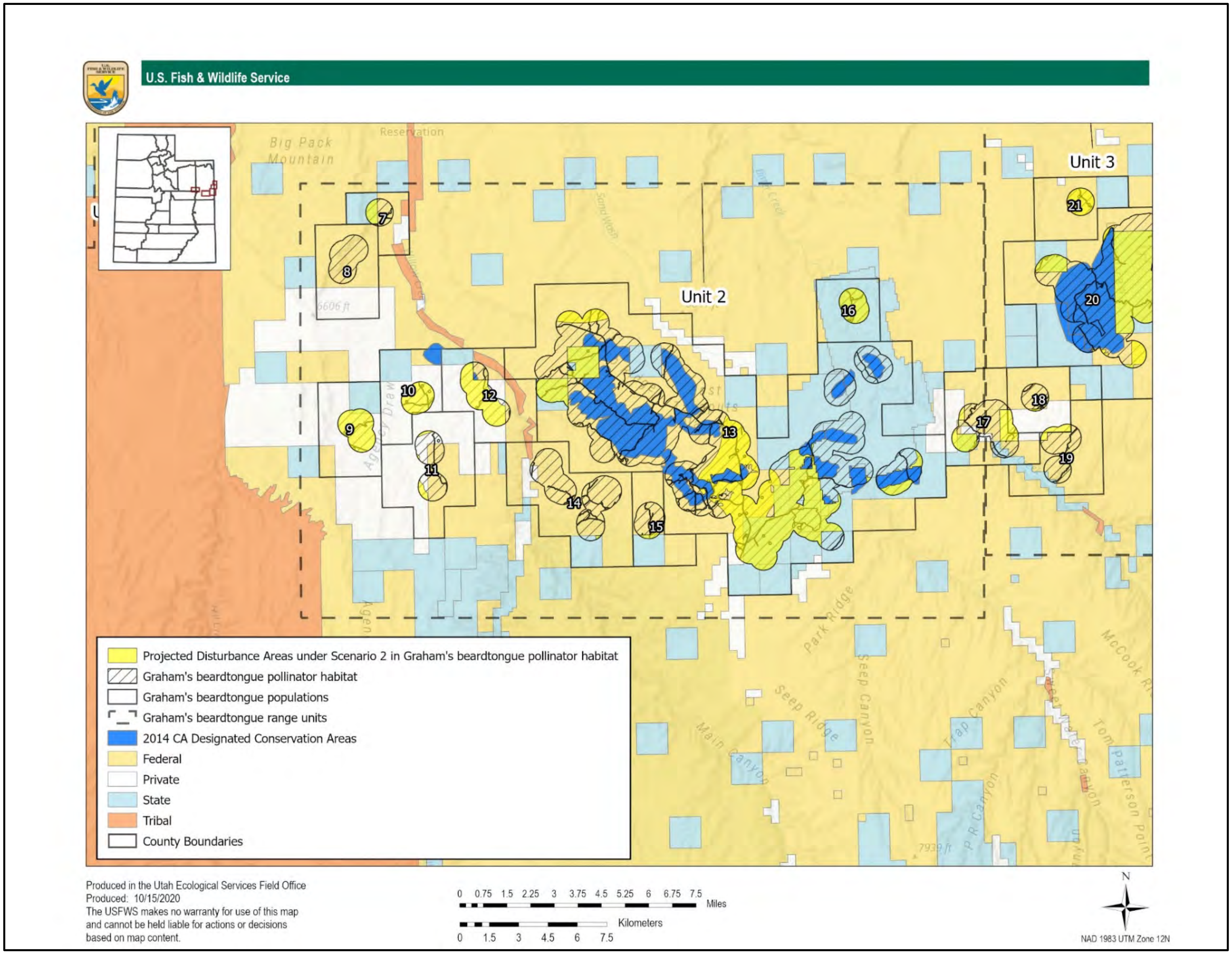


Figure 4. Graham's beardtongue populations 7 – 16 in range unit 2 and Future Scenario 2.

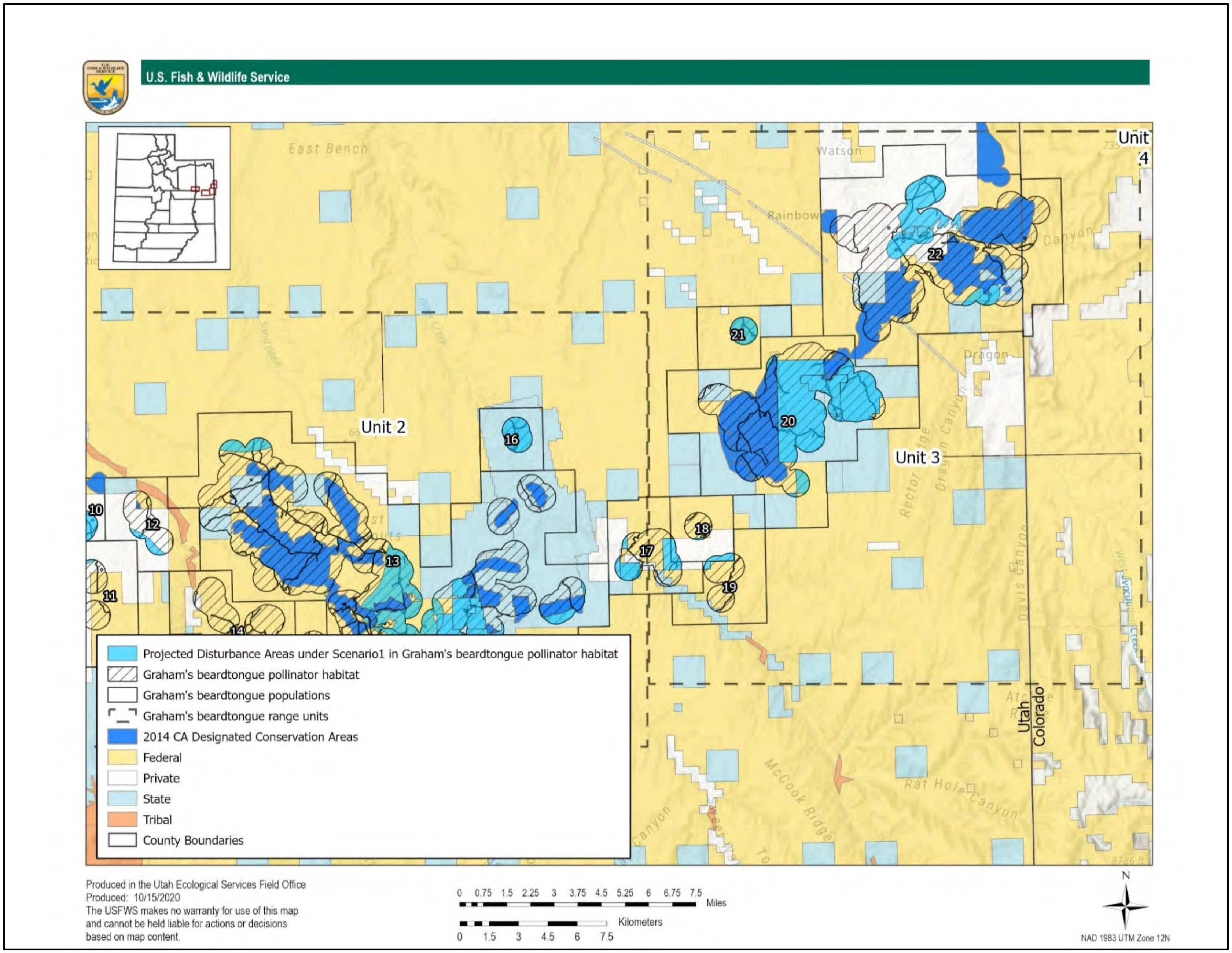


Figure 5. Graham's beardtongue populations 17 – 22 in range unit 3 and Future Scenario 1.

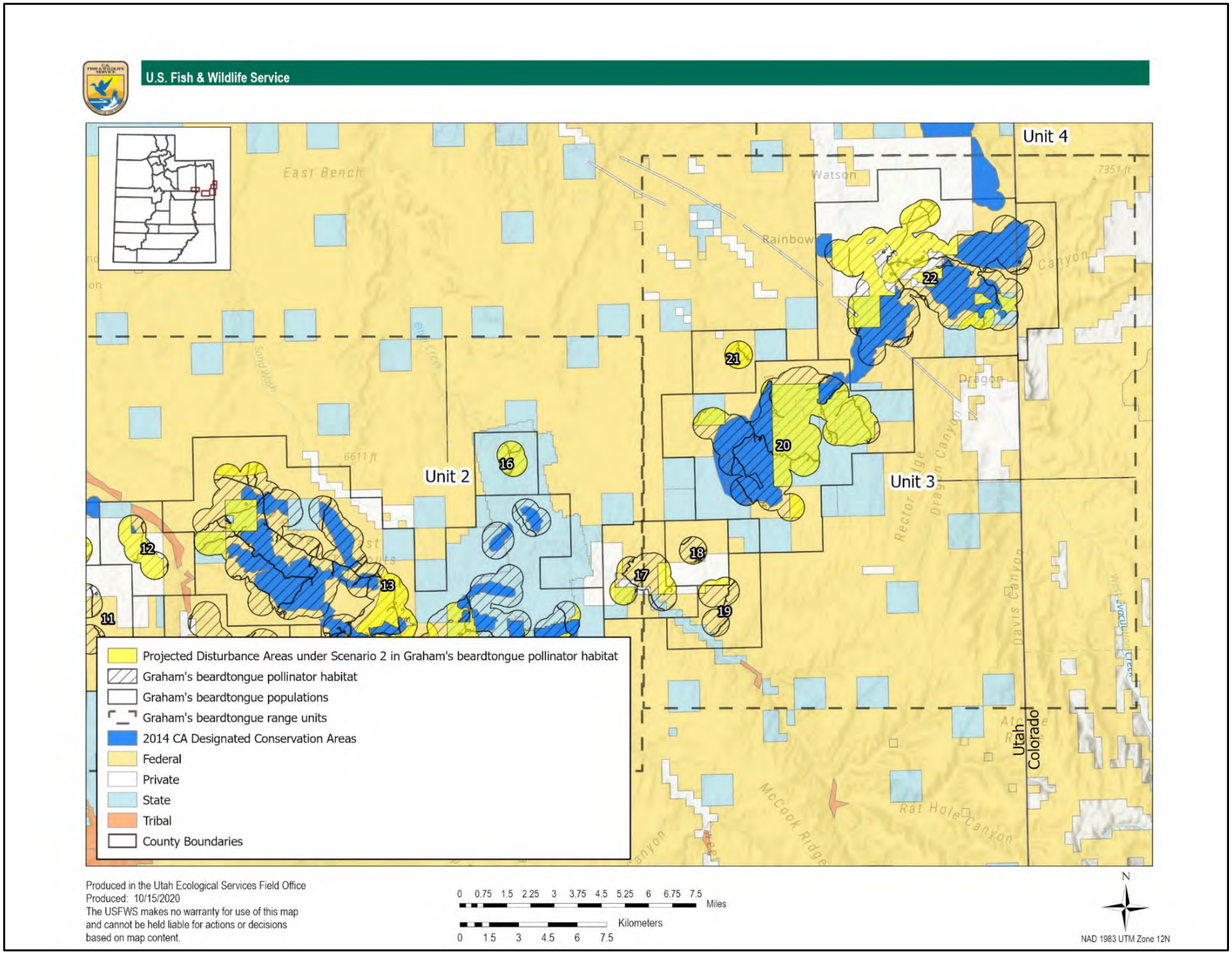


Figure 6. Graham's beardtongue populations 17 – 22 in range unit 3 and Future Scenario 2.

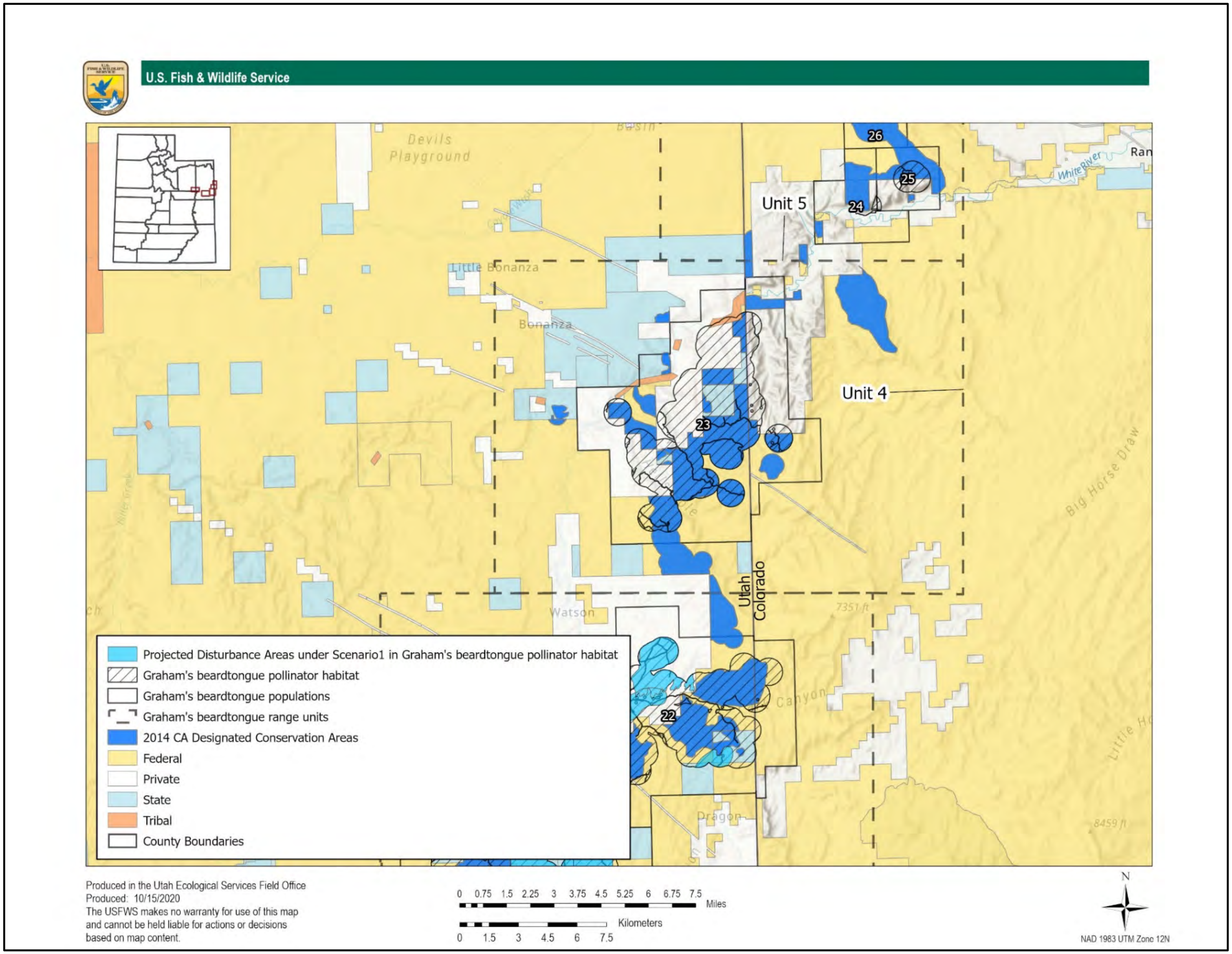


Figure 7. Graham's beardtongue population 23 in range unit 4 and Future Scenario 1.

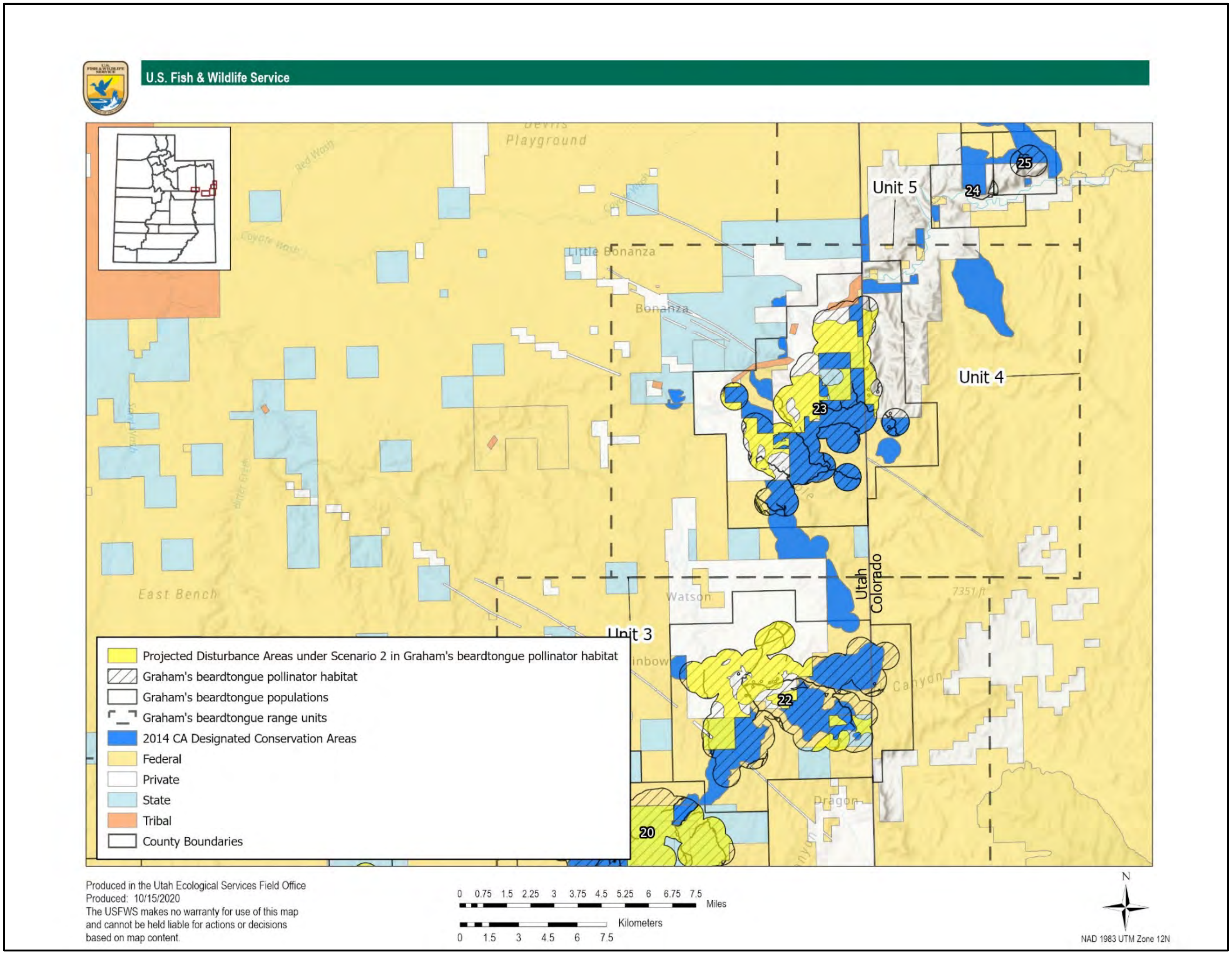


Figure 8. Graham's beardtongue population 23 in range unit 4 and Future Scenario 2.

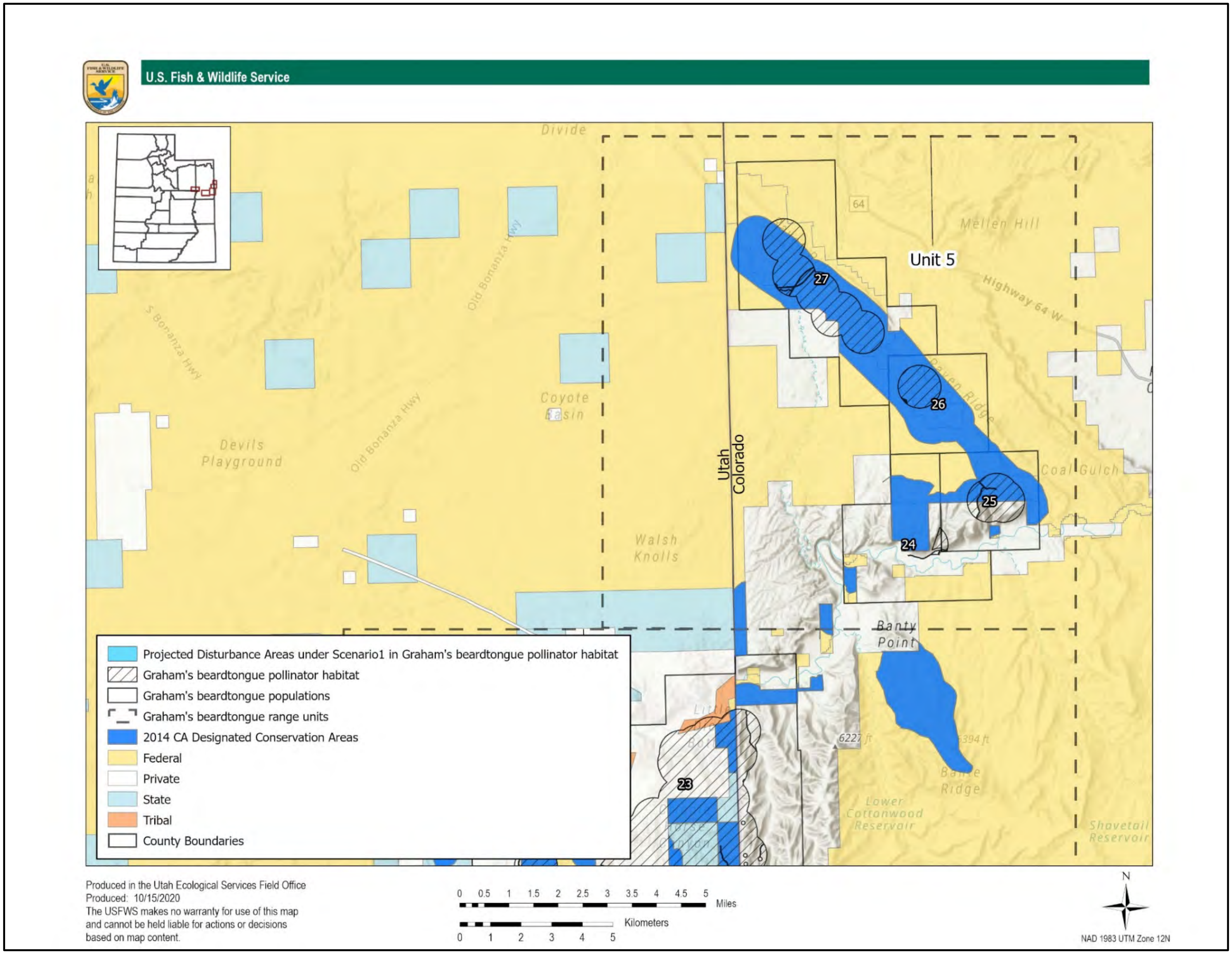


Figure 9. Graham's beardtongue populations 24 - 27 in range unit 5 and Future Scenario 1.

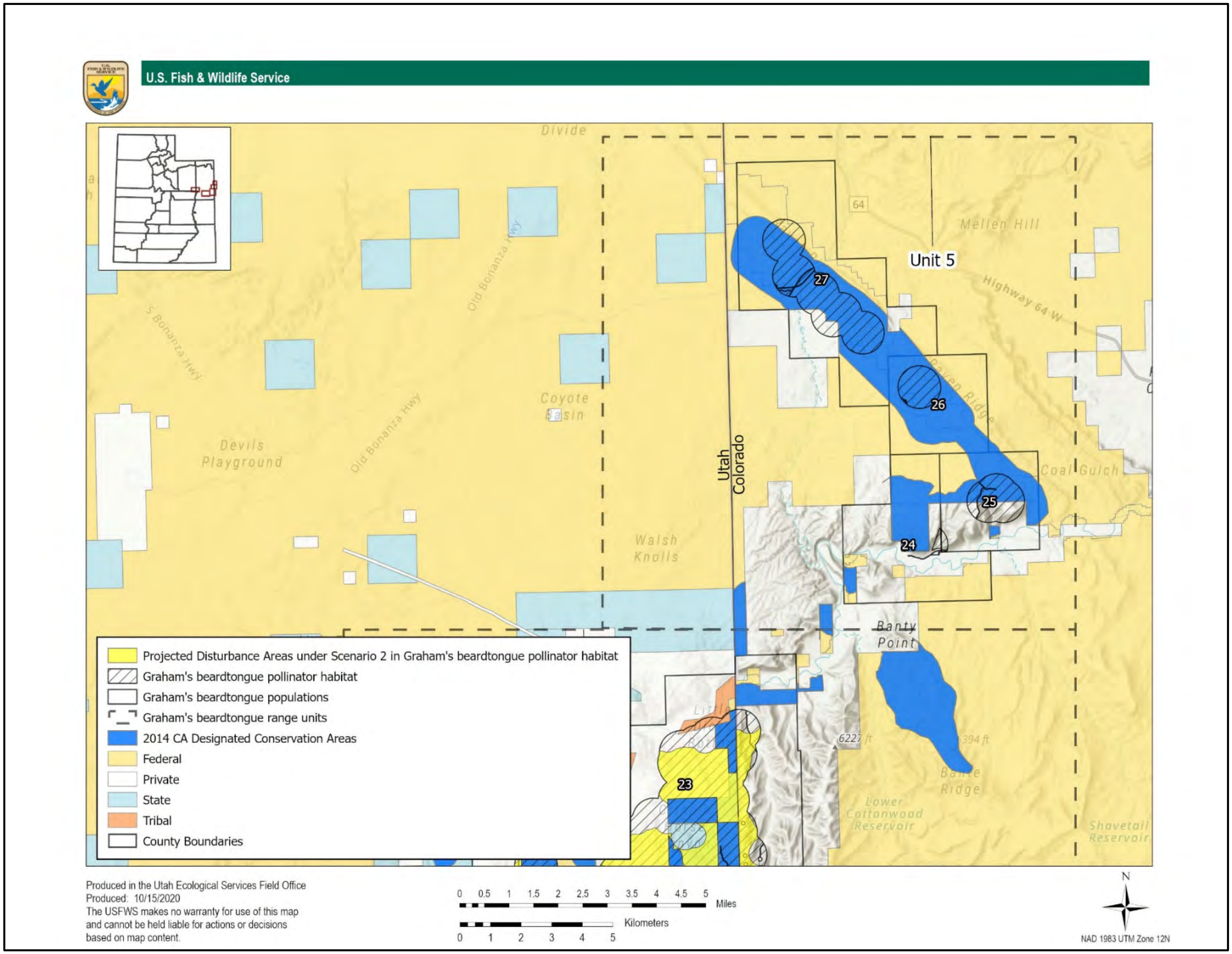


Figure 10. Graham's beardtongue populations 24 - 27 in range unit 5 and Future Scenario 2.

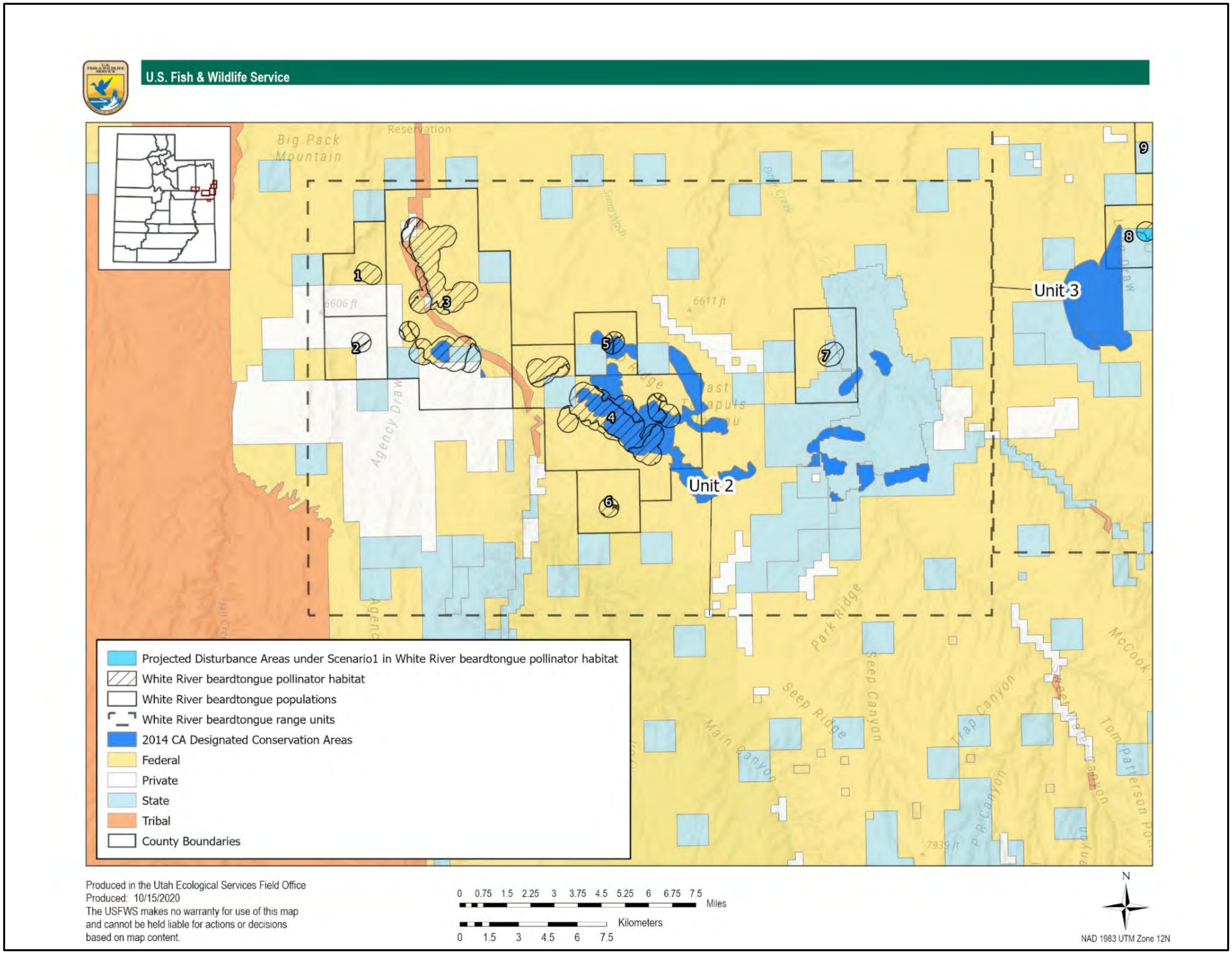


Figure 11. White River beardtongue populations 1 - 7 in range unit 2 and Future Scenario 1.

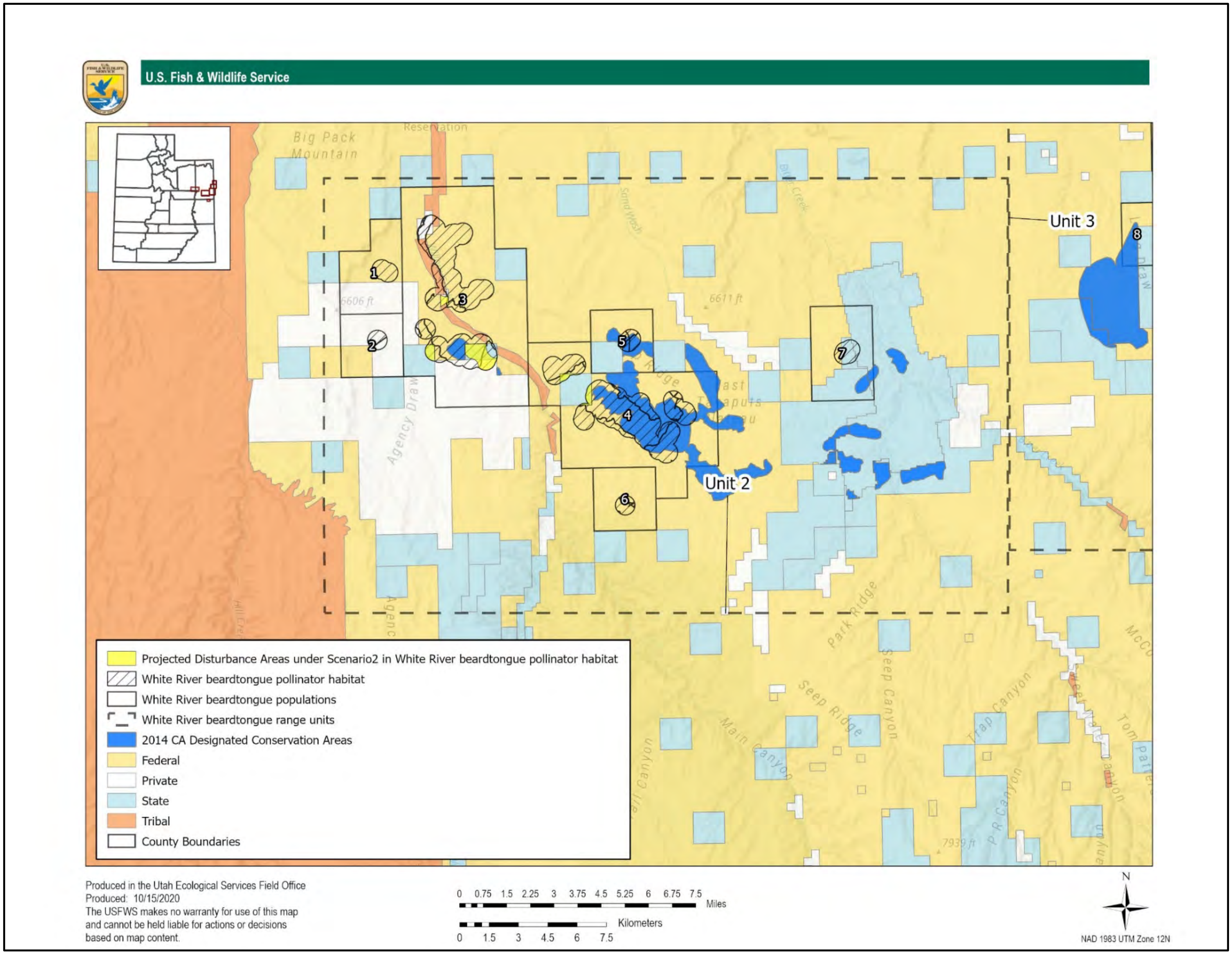


Figure 12. White River beardtongue populations 1 - 7 in range unit 2 and Future Scenario 2.

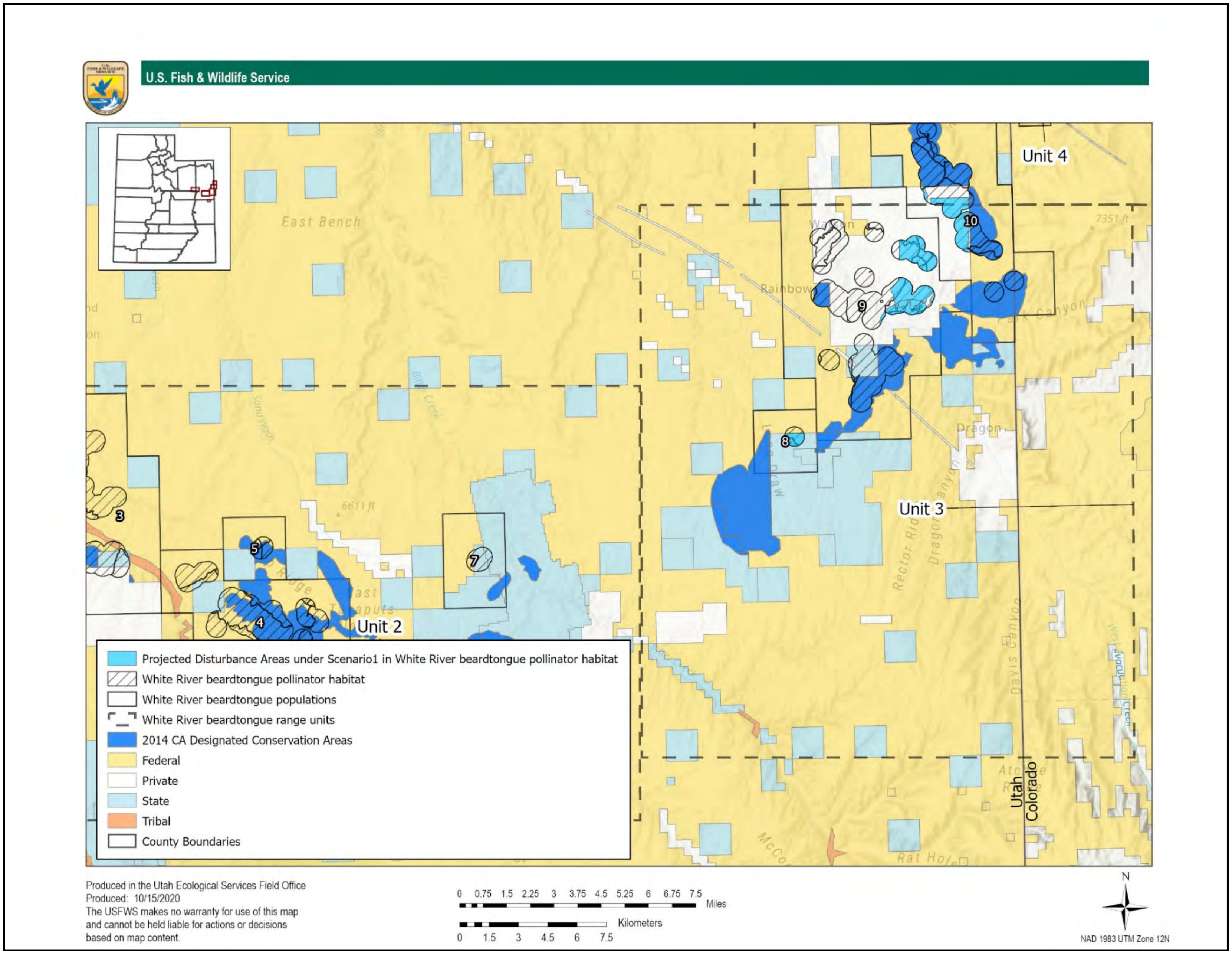


Figure 13. White River beardtongue populations 8 – 10 in range unit 3 and Future Scenario 1.

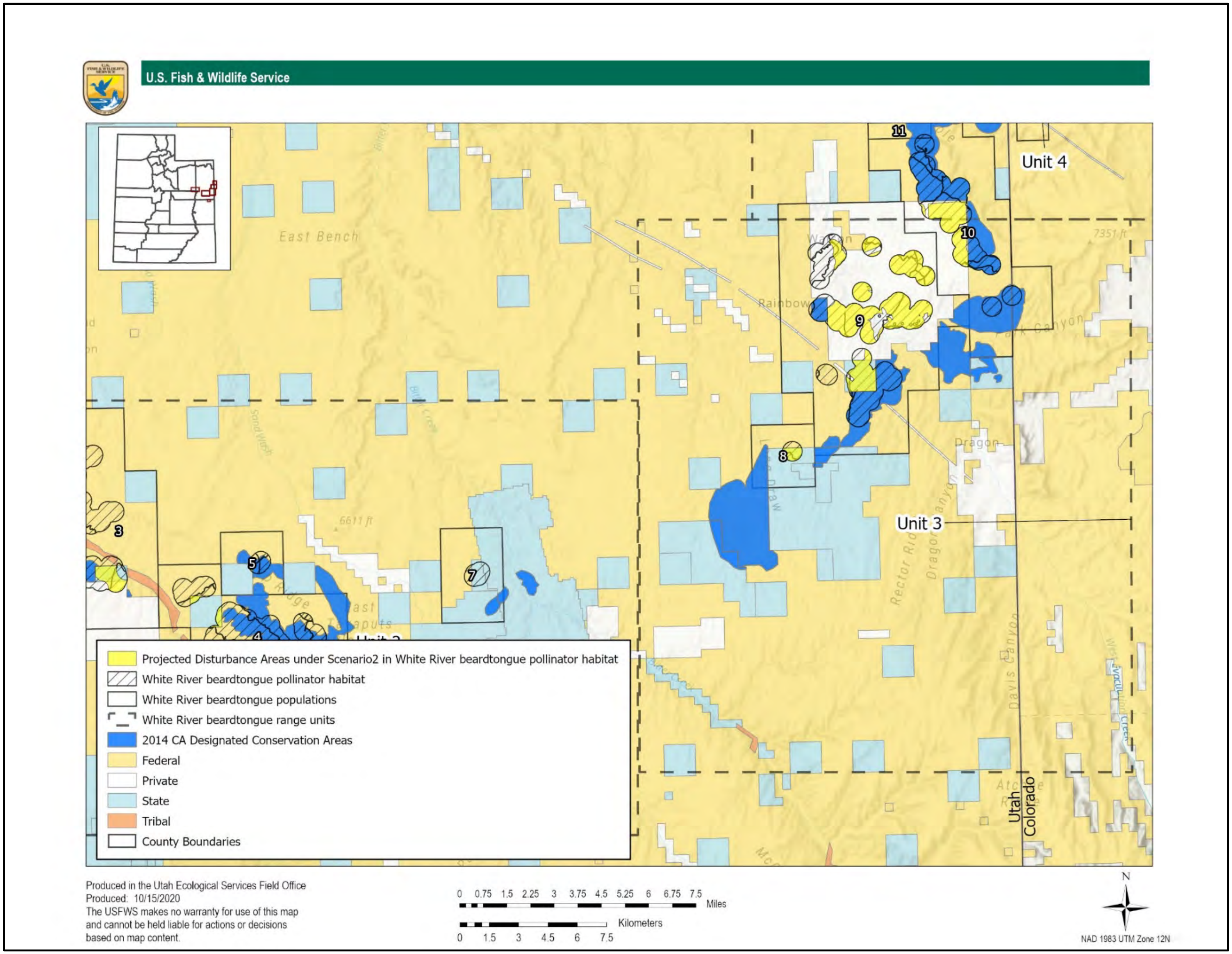


Figure 14. White River beardtongue populations 8 – 10 in range unit 3 and Future Scenario 2.

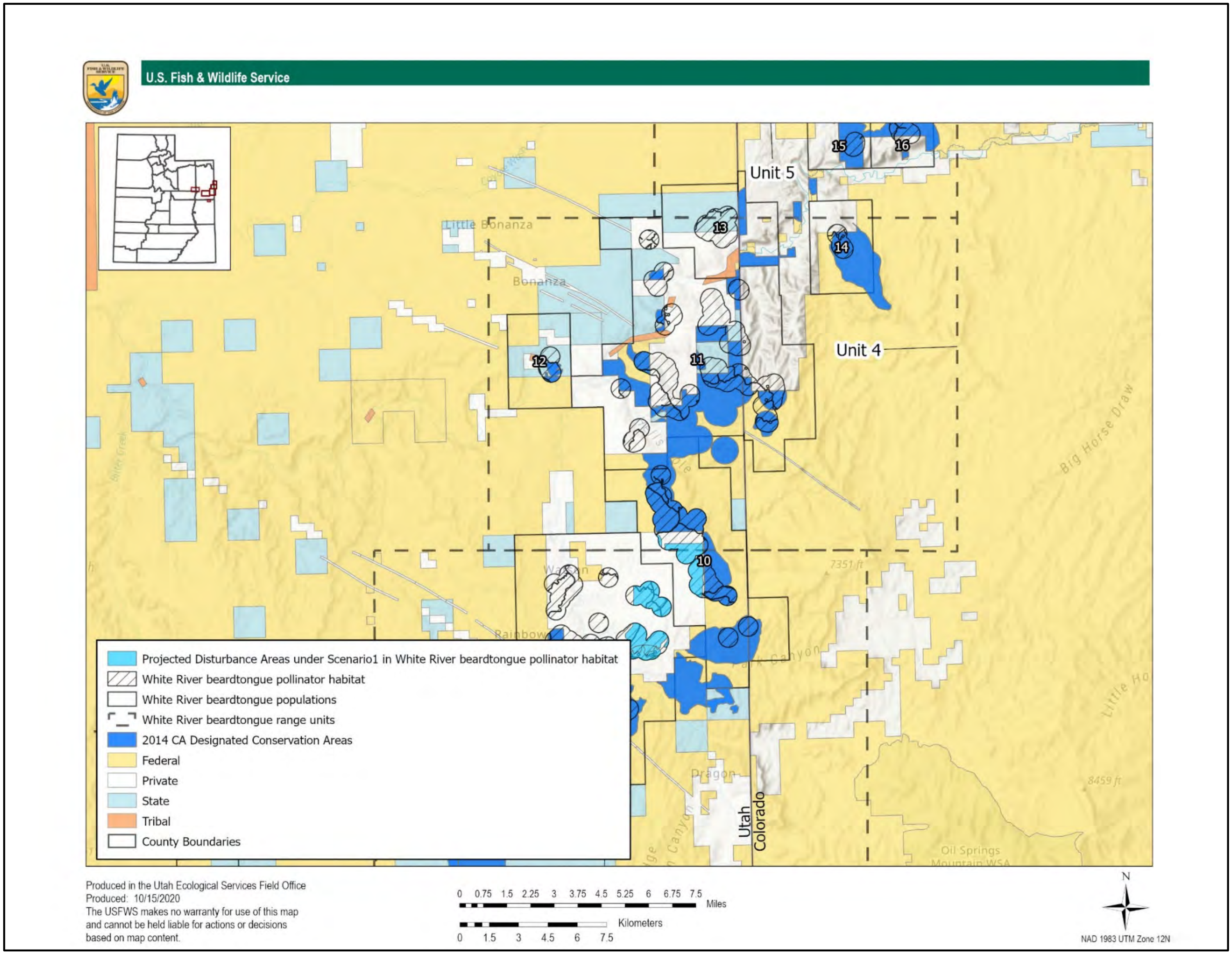


Figure 15. White River beardtongue populations 11 – 14 in range unit 4 and Future Scenario 1.

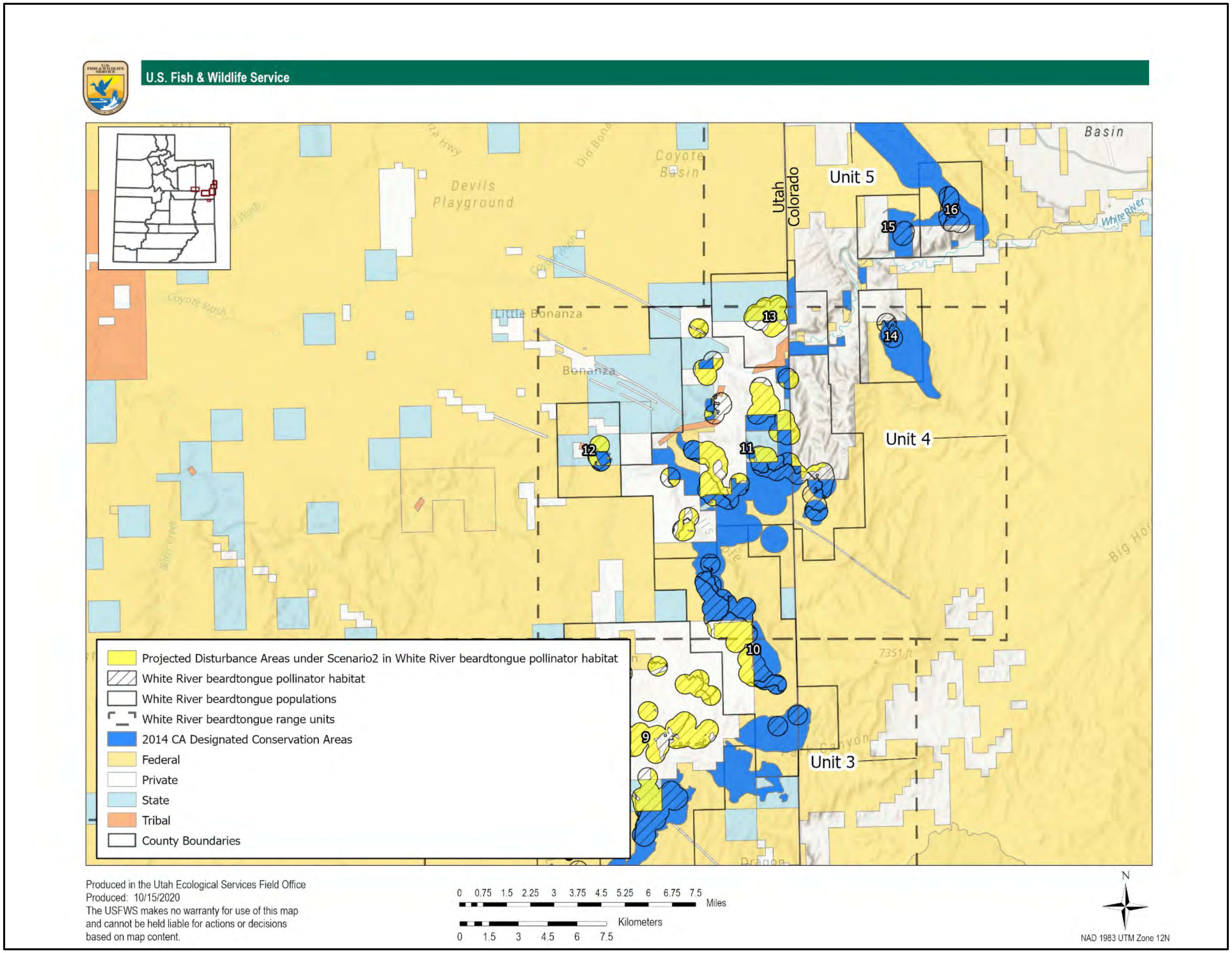


Figure 16. White River beardtongue populations 11 – 14 in range unit 4 and Future Scenario 2.

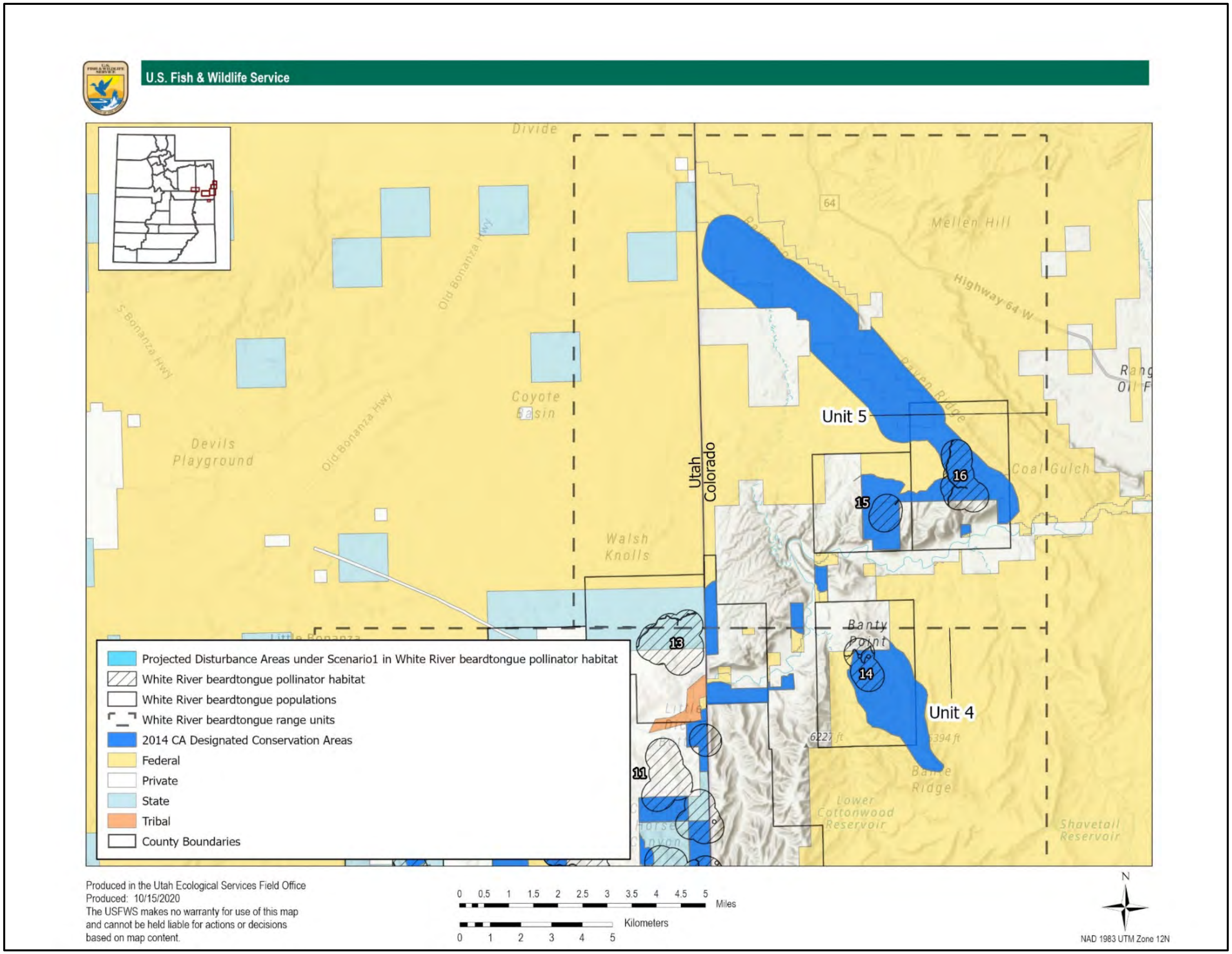


Figure 17. White River beardtongue populations 15 – 16 in range unit 5 and Future Scenario 1.

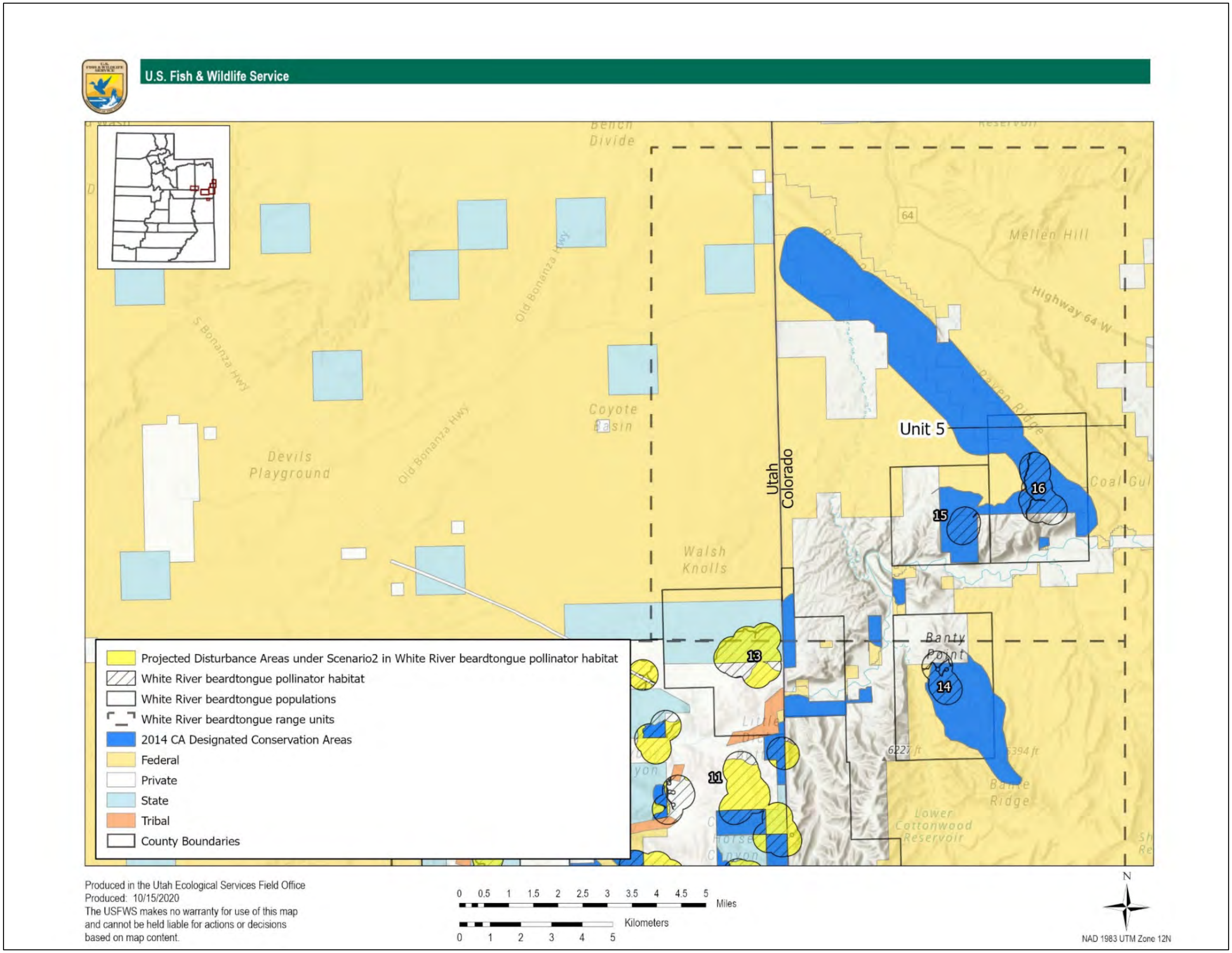


Figure 18. White River beardtongue populations 15 – 16 in range unit 5 and Future Scenario 2.

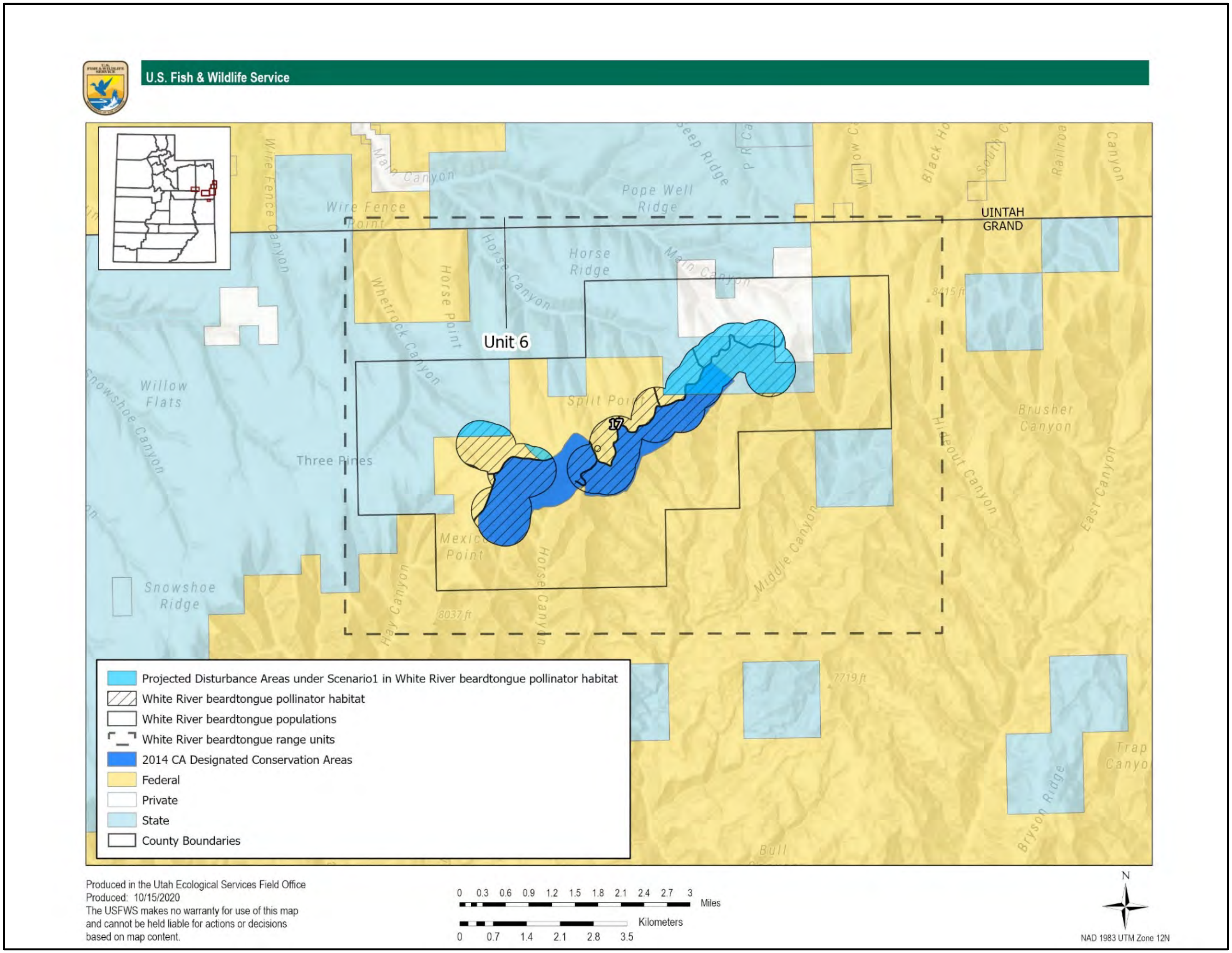


Figure 19. White River beardtongue population 17 in range unit 6 and Future Scenario 1.

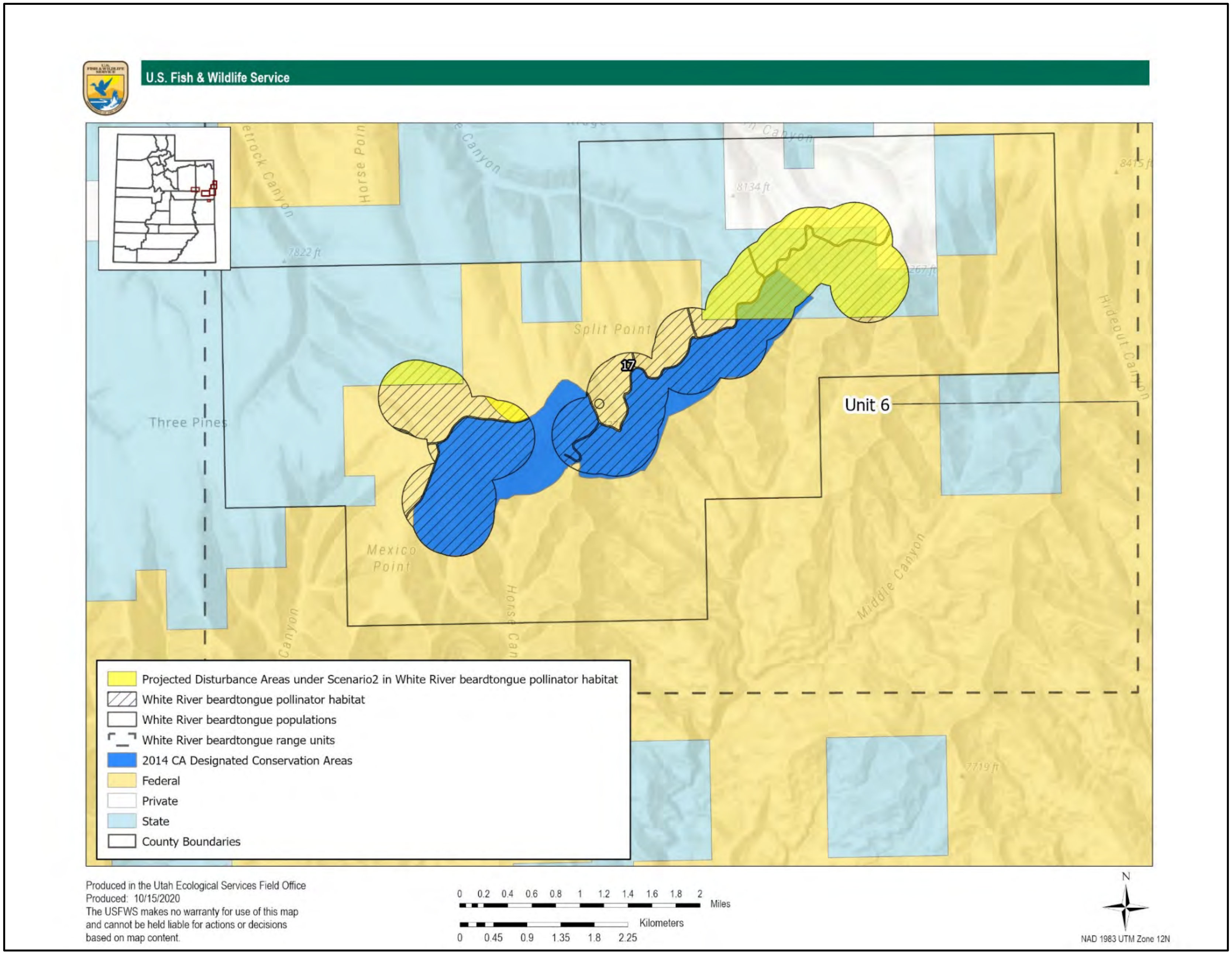


Figure 20. White River beardtongue population 17 in range unit 6 and Future Scenario 2.

5. Representation Evaluation

To assess future representation, we evaluated the projected demographic (population size) and ecological (ecological settings) surrogates of genetic diversity relative to the current condition. For more information about our methodology and results of the current condition representation evaluation, please see the Biological Report (USFWS 2020a, p. 71).

Table 10. Graham's beardtongue population size (demographic surrogate) evaluation.

Range Unit	Population	Current Condition and Size[1]	Scenario 1 Condition and Size	Scenario 2 Condition and Size
1. SAND WASH	1	Good (L)	Good (L)	Good (L)
	2	Good (L)	Good (L)	Good (L)
	3	Good (L)	Good (L)	Good (L)
	4	Moderate (S)	Moderate (S)	Moderate (S)
	5	Good (L)	Good (L)	Good (L)
	6	Good (L)	Good (L)	Good (L)
2. SEEP RIDGE	7	Moderate (S)	Moderate (S)	Low (S)
	8	Moderate (S)	Moderate (S)	Moderate (S)
	9	Moderate (S)	Extirpated	Extirpated
	10	Good (L)	Extirpated	Extirpated
	11	Moderate (L)	Moderate (L)	Moderate (L)
	12	Moderate (S)	Low (S)	Low (S)
	13	Good (L)	Good (L)	Good (L)
	14	Good (L)	Good (L)	Good (L)
	15	Good (L)	Good (L)	Moderate (L)
	16	Moderate (S)	Extirpated	Extirpated
3. EVACUATION CREEK	17	Good (L)	Moderate (L)	Moderate (L)
	18	Moderate (S)	Moderate (S)	Moderate (S)

[1] Population size categories – large (L), medium (M), and small (S) are based on extinction risk over 50 years. Large populations have less than 5% extinction risk; medium populations have 6 – 10% extinction risk; and small populations have greater than 10% extinction risk (USFWS 2020a, pp. 71 – 72).

	19	**Moderate (S)**	**Low (S)**	**Low (S)**
	20	**Good (L)**	**Good (L)**	**Good (L)**
	21	**Moderate (S)**	**Low (S)**	**Low (S)**
	22	**Good (L)**	**Good (L)**	**Good (L)**
4. WHITE RIVER	23	**Good (L)**	**Good (L)**	**Good (L)**
5. RAVEN RIDGE	24	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	25	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	26	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	27	**Good (L)**	**Good (L)**	**Good (L)**
# Large pops		**15**	**14**	**14**
# Med pops				
# Small pops		**12**	**10**	**10**

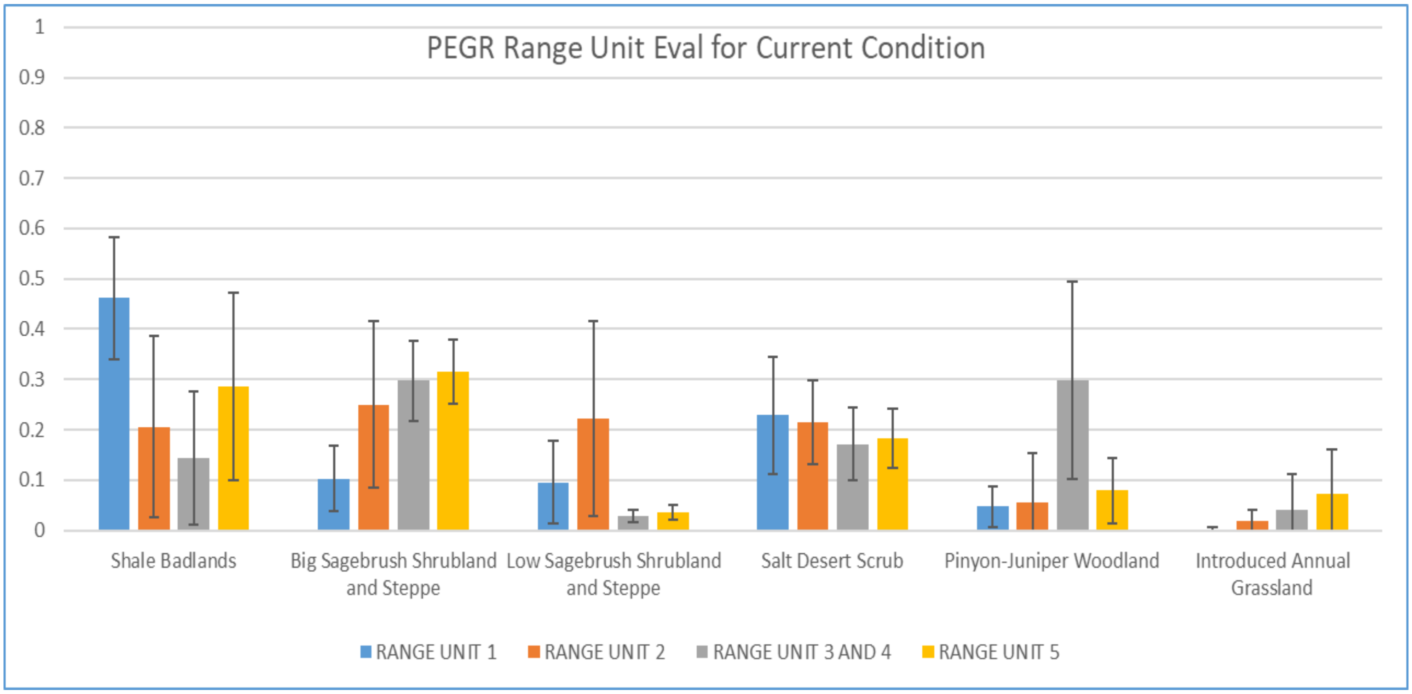
Table 11. White River beardtongue population size (demographic surrogate) evaluation.

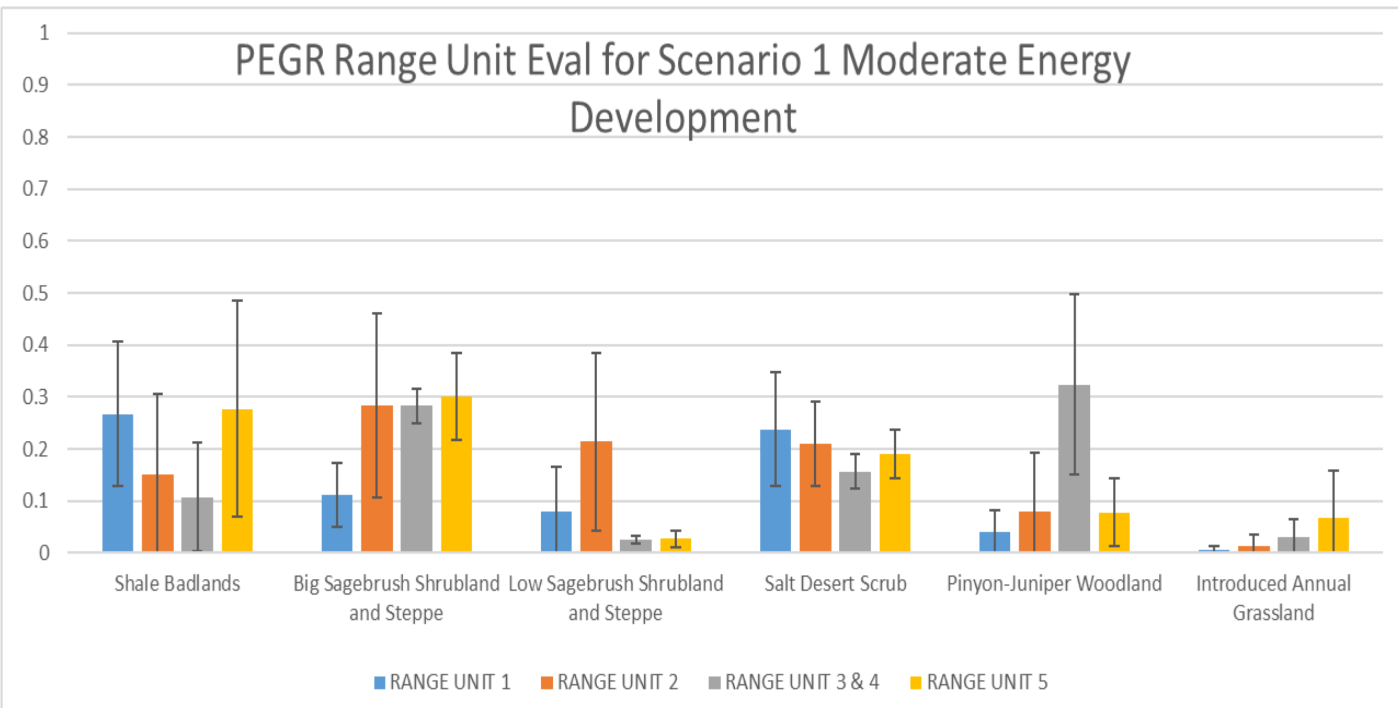
Range Unit	Population	Current Condition and Size[2]	Scenario 1 Condition and Size	Scenario 2 Condition and Size
2. SEEP RIDGE	1	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	2	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	3	**Good (L)**	**Good (L)**	**Good (L)**
	4	**Good (L)**	**Good (L)**	**Good (L)**
	5	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	6	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	7	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**

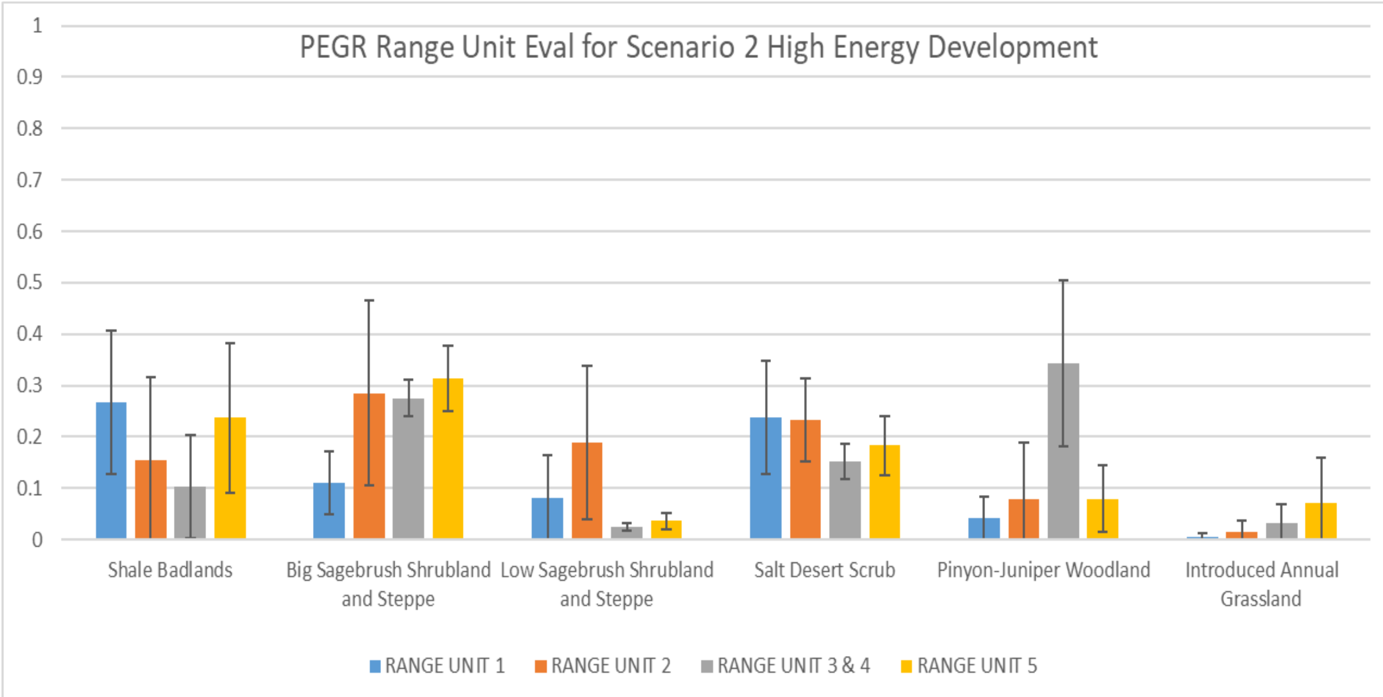
[2] Population size categories – large (L), medium (M), and small (S) are based on extinction risk over 50 years. Large populations have less than 5% extinction risk; medium populations have 6 – 10% extinction risk; and small populations have greater than 10% extinction risk (USFWS 2020a, pp. 71 – 72).

3. EVACUATION CREEK	8	**Low (S)**	**Extirpated**	**Extirpated**
	9	**Good (L)**	**Moderate (L)**	**Moderate (S)**
	10	**Good (L)**	**Good (L)**	**Good (L)**
	11	**Good (L)**	**Good (L)**	**Moderate (L)**
4. WHITE RIVER	12	**Moderate (L)**	**Moderate (L)**	**Moderate (L)**
	13	**Moderate (L)**	**Moderate (L)**	**Extirpated**
	14	**Moderate (L)**	**Moderate (L)**	**Moderate (L)**
5. RAVEN RIDGE	15	**Moderate (L)**	**Moderate (L)**	**Moderate (L)**
	16	**Good (L)**	**Good (L)**	**Good (L)**
6. BOOK CLIFFS	17	**Good (L)**	**Good (L)**	**Good (L)**
# Large pops		**11**	**11**	**10**
# Med pops				
# Small pops		**6**	**5**	**5**

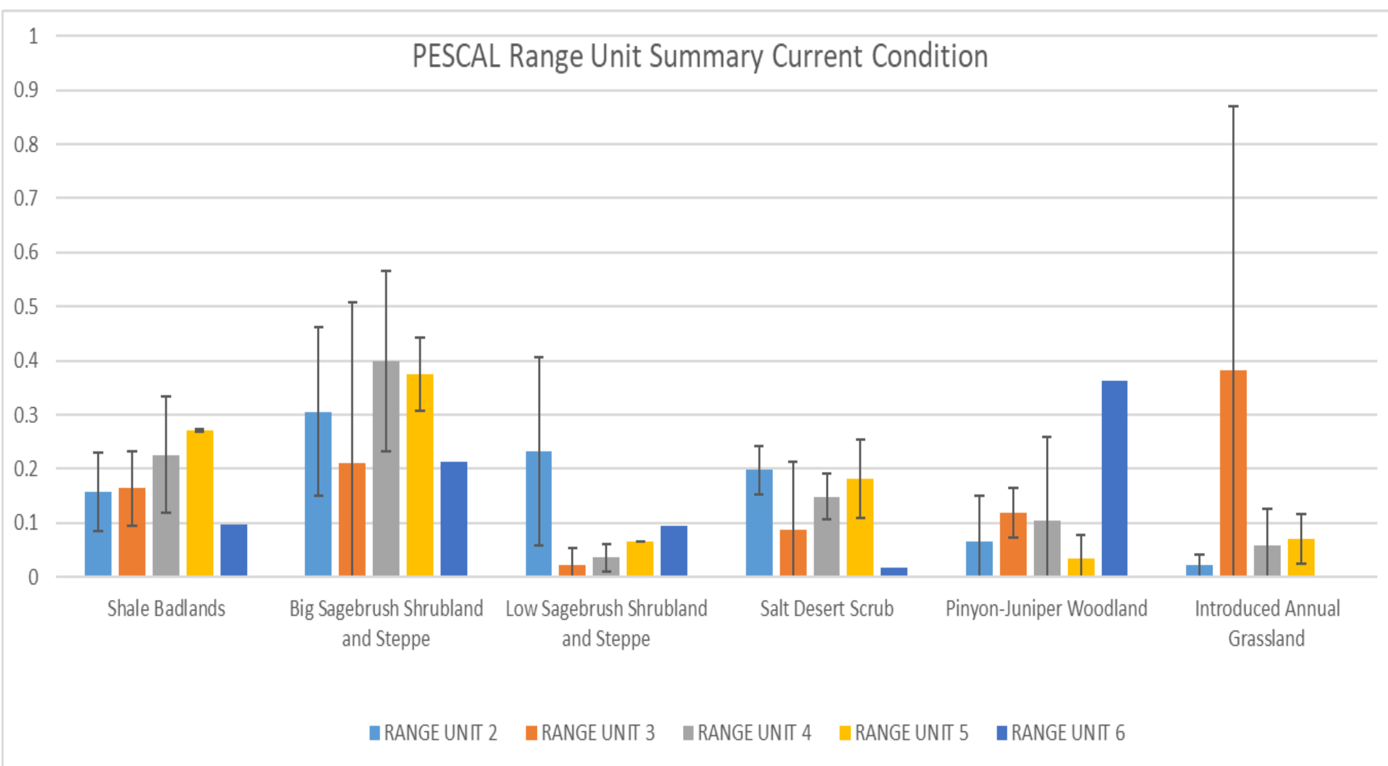
Graham's beardtongue ecological settings (ecological surrogate) evaluation.

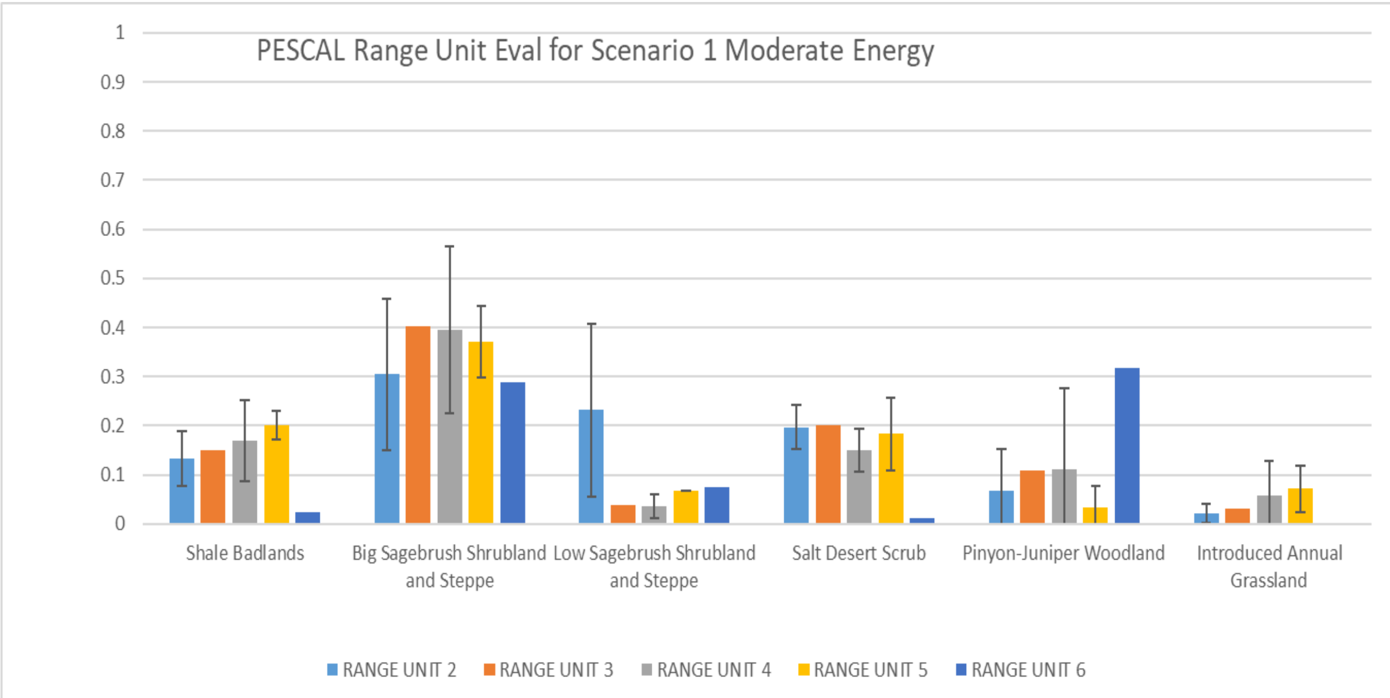


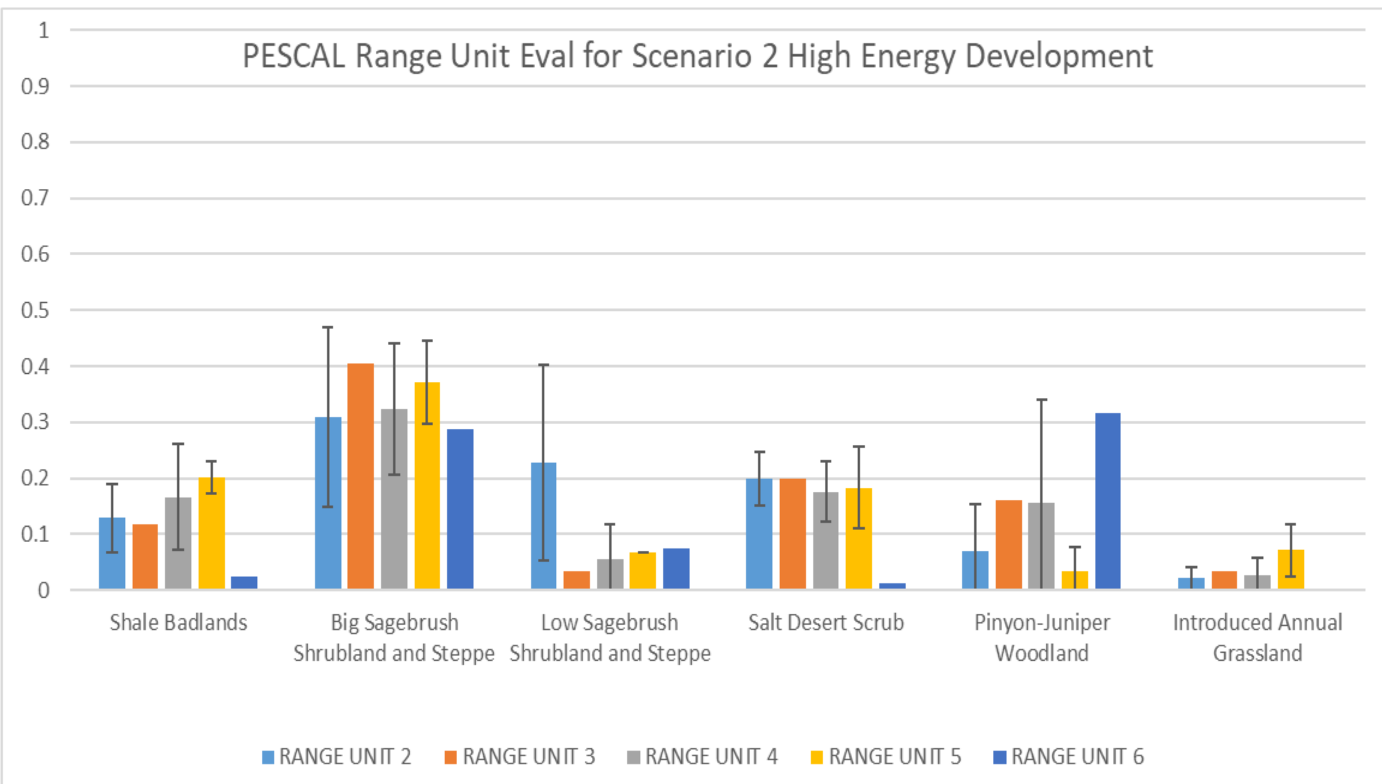




White River beardtongue ecological settings (ecological surrogate) evaluation.




PESCAL Range Unit Eval for Scenario 1 Moderate Energy
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Shale Badlands
Big Sagebrush Shrubland and Steppe
Low Sagebrush Shrubland and Steppe
Salt Desert Scrub
Pinyon-Juniper Woodland
Introduced Annual Grassland
RANGE UNIT 2
RANGE UNIT 3
RANGE UNIT 4
RANGE UNIT 5
RANGE UNIT 6


PESCAL Range Unit Eval for Scenario 2 High Energy Development
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Shale Badlands
Big Sagebrush Shrubland and Steppe
Low Sagebrush Shrubland and Steppe
Salt Desert Scrub
Pinyon-Juniper Woodland
Introduced Annual Grassland
RANGE UNIT 2
RANGE UNIT 3
RANGE UNIT 4
RANGE UNIT 5
RANGE UNIT 6

6. Workflow Summary

Below we summarize the GIS workflow for the stressor forecasts and the two future scenarios, 1 and 2.

Oil Shale Moderate Forecast

1. Seep ridge area and Holliday block on state lands and one private parcel that are leased likely oil shale exploration areas (SITLA_private_highdevelopmentpotential_2020_3). This area includes Red Leaf proposed new expansion area (4,000 ac).
2. Enefit private land (EAO_SouthBlock_highdevelopmentpotential_2020)

   Shapefile used for the oil shale moderate forecast: SITLA_private_highdevelopmentpotential_2020_Final.shp

3. Used the Red Leaf Ambient Air boundary (Red Leaf Ambient Air Boundary) shapefile to modify the perimeter to include this area by hand. (Note: I performed the modification by hand because I could not merge due to missing files).

Oil Shale High Forecast

1. Merged the following oil shale lease and permit areas:

   - SITLA active oil shale leases (SITLA_Active_OilShaleLeases_20180928)
   - UDOGM Mine Permit Boundaries (UDOGM_Penstemon_Permit_Boundaries_20180928)
   - BLM preferential lease parcel (os_pref) that includes the 160 ac RD&D parcel.
   - All 4 Enefit proposed ROWs (EAO_4ROWs_merged_040813.shp).
   - Enefit South Parcel (EAO_PrelimPlant_MineSiteArea_040813).

   Shapefile for oil shale lease and permit areas:
BLM_EAO_UDOGM_lease_permit_areas_merge_2

2. Used the following shapefiles to identify potential oil shale exploration areas:

   - Converted the Utah Geological Survey (UGS) oil shale overburden depth layer (cong_15gpt_200 shapefiles) to individual layers at the surface (contour of 0 is surface (i.e. mahogany ledge), -200ft depth, and -400ft depth. Then used the feature to polygon tool to convert them into polygons (cong_15gpt_200_mahogledge_poly; cong_15gpt_200_200ft_poly; cong_15gpt_200_400ft_poly). Merged all three polygons (con_15gpt_200_0to400ftdepth_poly).
   - Used the clip tool to separate the 25 gpt_isopatch_potential_economic_resource shapefiles using the Mahogany zone outcrop (con_15gpt_200_mahogledge_poly). (con_15gpt_200_mahogledge_poly_clip).

- Clipped the oil shale overburden depth layers – surface, 200ft, 400ft to the 25 gpt_isopatch_potential_economic_resource shapefiles using the Mahogany zone outcrop (con_15gpt_200_mahogledge_clip; con_15gpt_200_200ftdepth_clip; con_15gpt_200_400ftdepth_clip).
- Merged the polygon (con_15gpt_200_mahogledge_poly_clip) and polyline (con_15gpt_200_mahogledge_poly_clip) shapefiles to identify areas of potential oil shale surface mining. Buffered by 100m to estimate a surface disturbance area (potential_oilshale_ exploration_100mbuff). Buffer justification based on Michael Vanden Berg's opinion of the extent of oil shale operations around the resource.
- Clipped this layer to state and private lands and removed small parcels along Nine Mile canyon because Michael Vanden Berg said oil shale development in this area in not likely (likely_oilshale_exploration_100mbuff_privatestate_clip)

  Shapefile for potential oil shale exploration areas:
  likely_oilshale_exploration_100mbuff_privatestate_clip

3. Combined the two shapefiles with the areas of high development potential used for the moderate forecast: SITLA_private_highdevelopmentpotential_2020_Final.shp

   Shapefile used for oil shale high forecast: Future_oilshaleareas_high_forecast

Tar Sands Forecast

1. Used the UGS layer for surface or near surface exposure of tar sands (impregrk) and clipped to state and private land ownership (UT_CO_landownership_20181107 with definition query for state and private lands). New shapefile: UGS_tarsands_surface_deposits_privatestate_clip.shp.

2. Buffered this by 100m. New shapefile: Likely_tarsands_exploration_privatestate_clip_100mbuff.shp

3. Trimmed this to the PR Springs South area. New shapefile: tarsands_exploration_privatestate_clip_100mbuff_PRSsouth

4. Combined the new shapefile with areas under active tar sand lease (UT_SITLA_Contracts_Active_TarSand_20180928), Combined Hydrocarbon Lease (CHL_Leases) and Conversion Applications for Combined Hydrocarbon Lease (P_R_Springs_ConversionApplications_6_1_2020_).
   New shapefile: tar_sand_union_20200806

Shapefile used for the tar sand forecast: tar_sand_union_20200806

Traditional Oil and Gas Forecast

1. Used the UGS delineated oil and gas fields (UB_OilGasFields_2018).

Shapefile used for the traditional oil and gas forecast: UB_OilGasFields_2018

2014 CA Designated Conservation Areas

1. Used the latest 2014 CA conservation area files and removed the interim and private conservation areas (CAs_Final2019_05_15_designated_thru2034)

Shapefile used for the 2014 CA designated conservation areas: CAs_Final2019_05_15_designated_thru2034

BLM Lands with Surface Disturbance Restrictions

1. Identified areas on BLM lands with high likelihood of no surface disturbance
    - BLM areas that are closed to leasing, or has the following stipulations: No Lease, No Surface Occupancy (BLM_Oil_Gas_Lease_Cat_NSO.shp; CO_BLM_NSO_Stip)
    - BLM ACEC's in the Price FO (BLMPriceFO_acec_approved_rmp; Unit 1 for Graham's) and White River FO (BLM_CO_ACEC; Unit 5 for Graham's)
    - In Colorado, the beardtongues likely receive indirect protections on slopes between 35 – 50 degrees. This protection would apply on a project-specific and site-specific basis. (WRFO_slope_degree_35orgreater)
    - In Utah, the beardtongues likely receive indirect protections on steep slopes (40 degrees or greater). In most of these situations, other alternative development locations will be selected. This protection would apply on a project-specific and site-specific basis. (VFO_partial_slopepoly_over40degree.shp)

2. Merged these areas into the following shapefile: BLM_surface_restrictions_NSO_slope_ACEC

Shapefile used for the BLM surface disturbance restrictions: BLM_surface_restrictions_NSO_slope_ACEC

Future Scenario 1: Moderate Energy Development

1. Used the masterpoint files (PEGR_compiled_pts_20181127_elev_eo_CAs_FINAL2019_05_15_JOIN; PEAL_compiled_pts_20181127_elev_eo_CAs_FINAL2019_05_15_JOIN) to summarize plant abundance inside and outside of conservation areas by population. Used these masterpoint files and the landownership layer (UT_CO_Landownership_20181107) to summarize plant abundance on BLM lands outside of conservation areas.

2. Used the pollinator habitat files that include current disturbance (PEGRbuff_disturbance_union_eo4_explode_clip2; PESCALbuff_disturbance_union_eo4_explode_clip2) to evaluate changes to pollinator habitat area.

3. Combined the oil shale high development potential areas (SITLA_private_highdevelopmentpotential_2020_Final), traditional oil and gas (UGS_OilGasFields), and tar sand stressors into one shapefile (Future_energy_extent_Moderate).

4. Removed all designated conservation areas (BLM, state, private) for protections through 2034 (CAs_Final2019_05_15_designated_thru2034) using the erase tool.

   New shapefile: Future_moderate_energy_CAs_thru2034_erase

5. Removed areas on BLM lands with surface disturbance restrictions (BLM_surface_restrictions_NSO_slope_ACEC) using the erase tool.

   New shapefile: Future_moderate_energy_CAs_thru2034_BLMstips

   Shapefile used for the moderate energy scenario:
   Future_moderate_energy_CAs_thru2034_BLMstips
   Renamed to: Scenario1_stressor_extent_Final

6. Used the erase tool to remove areas where stressors occur (Future_moderate_energy_CAs_thru2034_BLMstips) from the masterpoint files and the pollinator habitat area to identify future plant abundance:

   New shapefiles:

   - PEGRpts_ plant_remain_2034_Mod;
   - PEALpts_plant_remain_2034_Mod;

   and future pollinator habitat:

   - PEGRbuff_ pollhabitat_remain_2034_Mod.
   - PEALbuff_ pollhabitat_remain_2034_Mod.

<u>Future Scenario 2: High Energy Development</u>

1. Used the masterpoint files (PEGR_compiled_pts_20181127_elev_eo_CAs_FINAL2019_05_15_JOIN; PEAL_compiled_pts_20181127_elev_eo_CAs_FINAL2019_05_15_JOIN) to summarize plant abundance inside and outside of conservation areas by population. Used these

masterpoint files and the landownership layer (UT_CO_Landownership_20181107) to summarize plant abundance on BLM lands outside of conservation areas.

2. Used the pollinator habitat files that include current disturbance (PEGRbuff_disturbance_union_eo4_explode_clip2; PESCALbuff_disturbance_union_eo4_explode_clip2) to evaluate changes to pollinator habitat area.

3. Combined the oil shale (Future_oilshaleareas_merge_Final), traditional oil and gas (UGS_OilGasFields), and tar sand stressors into one shapefile (Future_oilgas_shale_merge).

4. Removed all designated conservation areas (BLM, state, private) for protections through 2034 (CAs_Final2019_05_15_designated_thru2034) using the erase tool.

   New shapefiles: Future_oilgas_shale_merge_CAs_thru2034_erase.

5. Removed areas on BLM lands with surface disturbance restrictions (BLM_surface_restrictions_NSO_slope_ACEC) using the erase tool.

   New shapefiles: Future_oilgas_shale_merge_CAs_thru2034_BLMstips

Shapefile used for the high energy scenario: Scenario2_stressor_extent_Final

6. Used the erase tool to remove areas where stressors occur (Future_oilgas_shale_merge_CAs_thru2034_BLMstips) from the masterpoint files and the pollinator habitat area to identify future plant abundance:

   New shapefiles:
   - PEGRpts_ plant_remain_2034_High;
   - PESCALpts_plant_remain_2034_High;

   and future pollinator habitat:

   - PEGRbuff_ pollhabitat_remain_2034_4_High.
   - PESCALbuff_ pollhabitat_remain_2034_High.

   Updated pollinator habitat acreages (Acres column) using calculate geometry tool. ((Note, for some reason there is no pollinator habitat included for Graham's beardtongue population 24. I did the evaluation by hand looking at the relevant shapefiles, and also merged the population 24 pollinator habitat area to the existing: PEGRbuff_pollhabitat_remain_2029_High; and PEGRbuff_pollhabitat_remain_2034_High

7. Used the clip tool to identify areas where stressors occur (Future_oilgas_shale_merge_CAs_thru2029_BLMstips;

Future_oilgas_shale_merge_CAs_thru2034_BLMstips) from the masterpoint files and the pollinator habitat area. These areas are potential loss of plants.

- PESCALpts_plant_loss_2034_High;
- PESCALpts_plant_loss_2034_High;

And future pollinator habitat:

- PEGRbuff_pollhabitat_loss_2034_High
- PESCALbuff_pollhabitat_loss_2034_High

Updated pollinator habitat acreages (Acres column) using calculate geometry tool.

Future Occupied Habitat

Calculated remaining occupied habitat in 2034 by buffering remaining points (PEGRpts_ plant_remain_2034_High; PESCALpts_plant_remain_2034_High) by 300 ft, then clipping it to remaining habitat (PEGRbuff_ pollhabitat_remain_2034_4_High; PESCALbuff_ pollhabitat_remain_2034_High)

New shapefiles: PEGRpts_plant_remain_2034_High_300ftbuff;
PESCALpts_plant_remain_2034_High_300ftbuff;
PESCALpts_plant_remain_2034_Mod_300ftbuff;
PEGRpts_plant_remain_2034_Mod_300ftbuff

Updating the masterpoint dataset (December 8, 2020)

We received new information about the 2020 Graham's and White River beardtongues survey results from the Colorado Natural Heritage Program in early December 2020 (BLM_EORs_2020). The survey results indicate there are 3 new Graham's sites with 565 plants in population 22, and 1,039 fewer plants at a known White River site in population 10. I made a new version of the masterpoint file (penstemon_compiled_pts_20201211) from the original masterpoint file (penstemon_compiled_pts_20181127) and made the following changes:

Workflow

Graham's beardtongue

- For OBJECTID: 19 EO_ID column: 15634, I changed the 121 plants to 686 plants in the TOTPOP and Density_totpop columns. I also revised the COMMENTS column to state: Malone & Emerick 2015 (121 plants) plus Malone 2020 (565 plants), and the SOURCE column to state: CNHP_2020_BLM_EORs_2020
- Removed two rows, OBJECTID: 189 and 5416, that contained 201 Graham's plants in a SITLA Interim A area.

White River beardtongue

For OBJECTID: 4 EO_ID column:12233, I changed the 1,407 plants to 368 plants in the TOTPOP and Density_totpop columns. I also revised the COMMENTS column to state: Malone 2020 revisit of old plant estimate of 1407 plants from Franklin 2003: re: 1994, and the SOURCE column to state: CNHP_2020_BLM_EORs_2020

Results (See excel file entitled: Current Condition and Caps Analysis_20201211_update.xls)

Sum of Density_totpop	Column Labels	
Row Labels	Penstemon grahamii	Penstemon scariosus var. albifluvis
1	954	3
2	516	8
3	371	2278
4	46	8565
5	489	10
6	288	1
7	50	77
8	49	1
9	17	2050
10	266	5506
11	195	5639
12	22	1679
13	11441	1290
14	1263	393
15	459	384
16	33	617
17	370	1401
18	1	
19	9	
20	19735	
21	6	
22	11900	
23	7700	
24	6	
25	27	
26	1	
27	171	
Grand Total	**56385**	**29902**

Updating the future scenarios shapefiles (December 11, 2020)

Workflow

Graham's beardtongue

(1) Copied the final plant remain shapefiles for the moderate and high energy development scenarios for Graham's (PEGRpts_plant_remain 2034_Mod; PEGRpts_plant_remain 2034_High) and saved them as new shapefiles (PEGRpts_plant_remain 2034_Mod_Final; PEGRpts_plant_remain 2034_High_Final).

(2) For PEGRpts_plant_remain 2034_Mod_Final, I modified OBJECTID: 3682 EO_ID column: 15634, I changed the 121 plants to 686 plants in the TOTPOP and Density_totpop columns. I also revised the COMMENTS column to state: Malone & Emerick 2015 (121 plants) plus Malone 2020 (565 plants), and the SOURCE column to state: CNHP_2016_penstemon_abund_point and CNHP_2020_BLM_EORs_2020. (Note, 53 of these new plants are actually located in a BLM designated conservation area but this point is located outside of the BLM designated CA. Therefore, the tallies of the actual number of plants inside CAs differs from the shapefile).

(3) For PEGRpts_plant_remain 2034_High_Final, I modified OBJECTID: 3185 EO_ID column: 15634, I changed the 121 plants to 686 plants in the TOTPOP and Density_totpop columns. I also revised the COMMENTS column to state: Malone & Emerick 2015 (121 plants) plus Malone 2020 (565 plants), and the SOURCE column to state: CNHP_2016_penstemon_abund_point and CNHP_2020_BLM_EORs_2020. (Note, 53 of these new plants are actually located in a BLM designated conservation area but this point is located outside of the BLM designated CA. Therefore, the tallies of the actual number of plants inside CAs differs from the shapefile).

White River beardtongue

(1) Copied the final plant remain shapefiles for the moderate and high energy development scenarios for White River (PEALpts_plant_remain 2034_Mod; PESCALpts_plant_remain 2034_High) and saved them as new shapefiles (PEGRpts_plant_remain 2034_Mod_Final; PEGRpts_plant_remain 2034_High_Final).

(2) For PEALpts_plant_remain 2034_Mod_Final, I modified OBJECTID: 1212 EO_ID column:12233, I changed the 1,471 plants to 368 plants in the TOTPOP and Density_totpop columns. I also revised the COMMENTS column to state: Malone 2020 revisit of old plant estimate of 1407 plants from Franklin 2003: re: 1994, and the SOURCE column to state: CNHP_2020_BLM_EORs_2020

(3) For PESCALpts_plant_remain 2034_High_Final, I modified OBJECTID: 1036 EO_ID column:12233, I changed the 1,471 plants to 368 plants in the TOTPOP and Density_totpop columns. I also revised the COMMENTS column to state: Malone 2020 revisit of old plant estimate of 1407 plants from Franklin 2003: re: 1994, and the SOURCE column to state: CNHP_2020_BLM_EORs_2020

<u>Results (See excel file entitled: Energy Summary_Final.xls)</u>

Table 12. There are 37,350 Graham's beardtongue plants remaining under the moderate energy development scenario 1.

Graham's beardtongue plants that remain under the Moderate Energy Development Scenario

Row Labels	Sum of Density_totpop
1	931
2	516
3	371
4	46
5	489
6	288
7	50
8	49
11	195
12	22
13	7949
14	1263
15	459
17	206
18	1
19	9
20	5483
22	11118
23	7700
24	6
25	27
26	1
27	171
Grand Total	**37350**

Table 13. There are 29,686 White River beardtongue plants remaining under the moderate energy development scenario 1.

White River beardtongue plants that remain under the Moderate Energy Development Scenario

Row Labels	Sum of Density_totpop
1	3
2	8
3	2278
4	8565
5	10
6	1
7	77
9	1843
10	5498
11	5639
12	1679
13	1290
14	393
15	384
16	617
17	1401
Grand Total	**29686**

Table 14. There are 30,794 Graham's beardtongue plants remaining under the high energy development scenario 2.

Graham's beardtongue plants that remain under the High Energy Development Scenario	
Population	Number of Plants
Row Labels	**Sum of Density_totpop**
1	931
2	516
3	371
4	46
5	489
6	288
7	50
8	49
11	195
12	9
13	7657
14	1263
15	459
17	206
18	1
19	9
20	5287
22	8414
23	4349
24	6
25	27
26	1
27	171
Grand Total	**30794**

Table 15. There are 22,695 White River beardtongue plants remaining under the high energy development scenario 2.

White River beardtongue plants that remain under the High Energy Development Scenario	
Population	Number of Plants
Row Labels	**Sum of Density_totpop**
1	3
2	8
3	1712
4	8565
5	10
6	1
7	77
9	164
10	4678
11	3004
12	1678
14	393
15	384
16	617
17	1401
Grand Total	**22695**