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. Oil Shale Stressor

Exploration Activities

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 in-situ (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 in-situ 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 in-situ 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 in-situ heating if those future technologies are developed (University of Utah 2011, p. 15; Vanden Berg and Birgenheier 2017, p.81). In-situ 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.

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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). Leasing is available for surface and subsurface mining in Utah and only subsurface mining in Colorado (BLM 2013, p. 18). 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).

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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 (Table 2; 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 (Table 2; 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. Future Condition Evaluation

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 - 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	1	1	1	2	6	1.2	**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.

	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	**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	23	3	1	3	3	3	13	2.6	**Good**	None	There are no identified stressors in this 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**
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 - 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 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 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	**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 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	**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 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 - 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%

	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	**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	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	1	1	1	2	6	1.2	**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 - 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	**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 DCA.
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 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. Scenario 1 maps are depicted in Figures 1 – 10; scenario 2 maps are depicted in Figures 11 – 20.

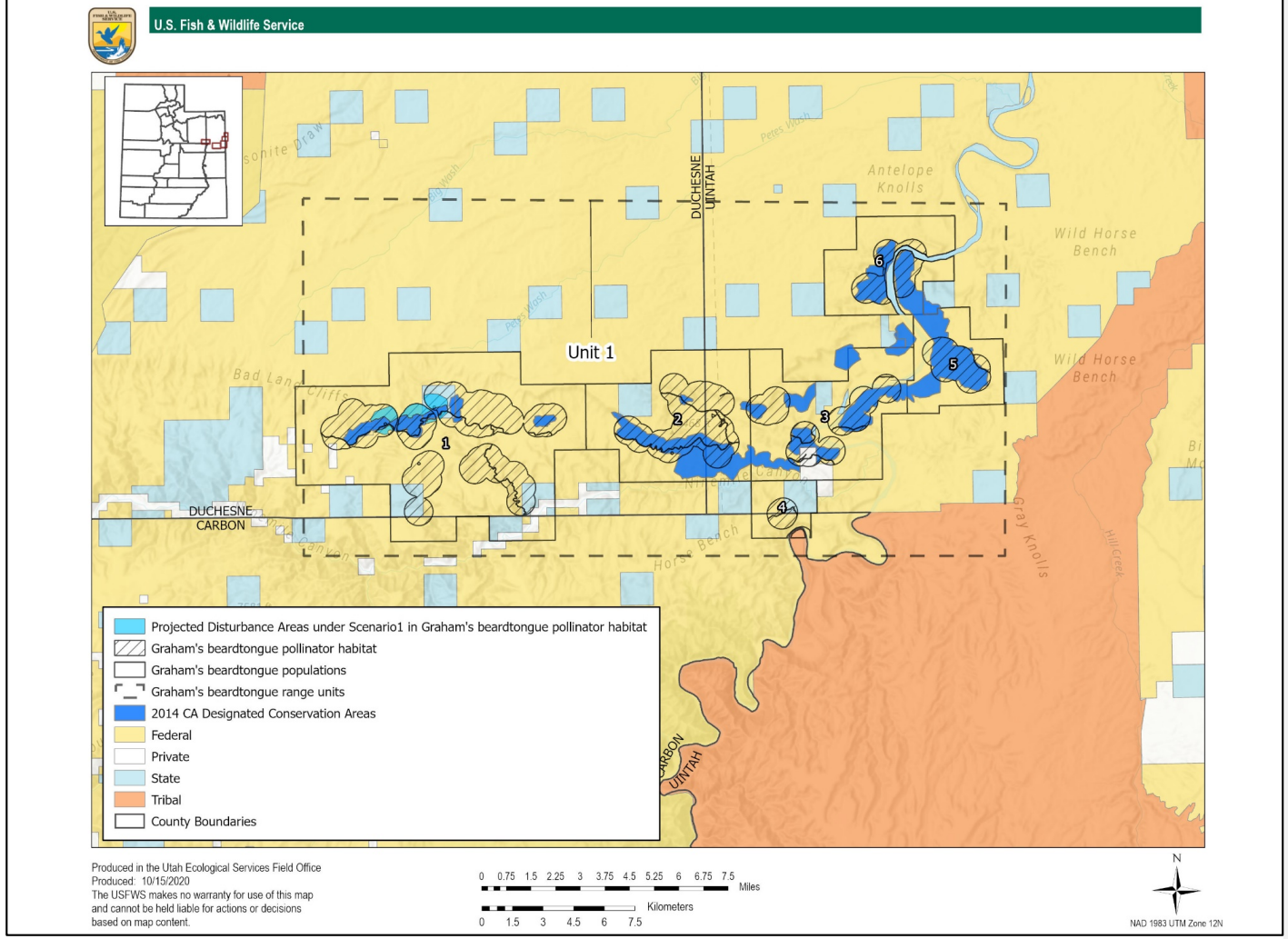
U.S. Fish & Wildlife Service
Unit 1
DUCHESNE
UINTAH
DUCHESNE
CARBON
CARBON
UINTAH
Antelope Knolls
Wild Horse Bench
Wild Horse Bench
Gray Knolls
Hill Creek
Bad Land Cliffs
Peters Wash
Horse Beach
1
2
3
4
5
6
Projected Disturbance Areas under Scenario1 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

Commented [JS3]: Hard to see projected disturbance area

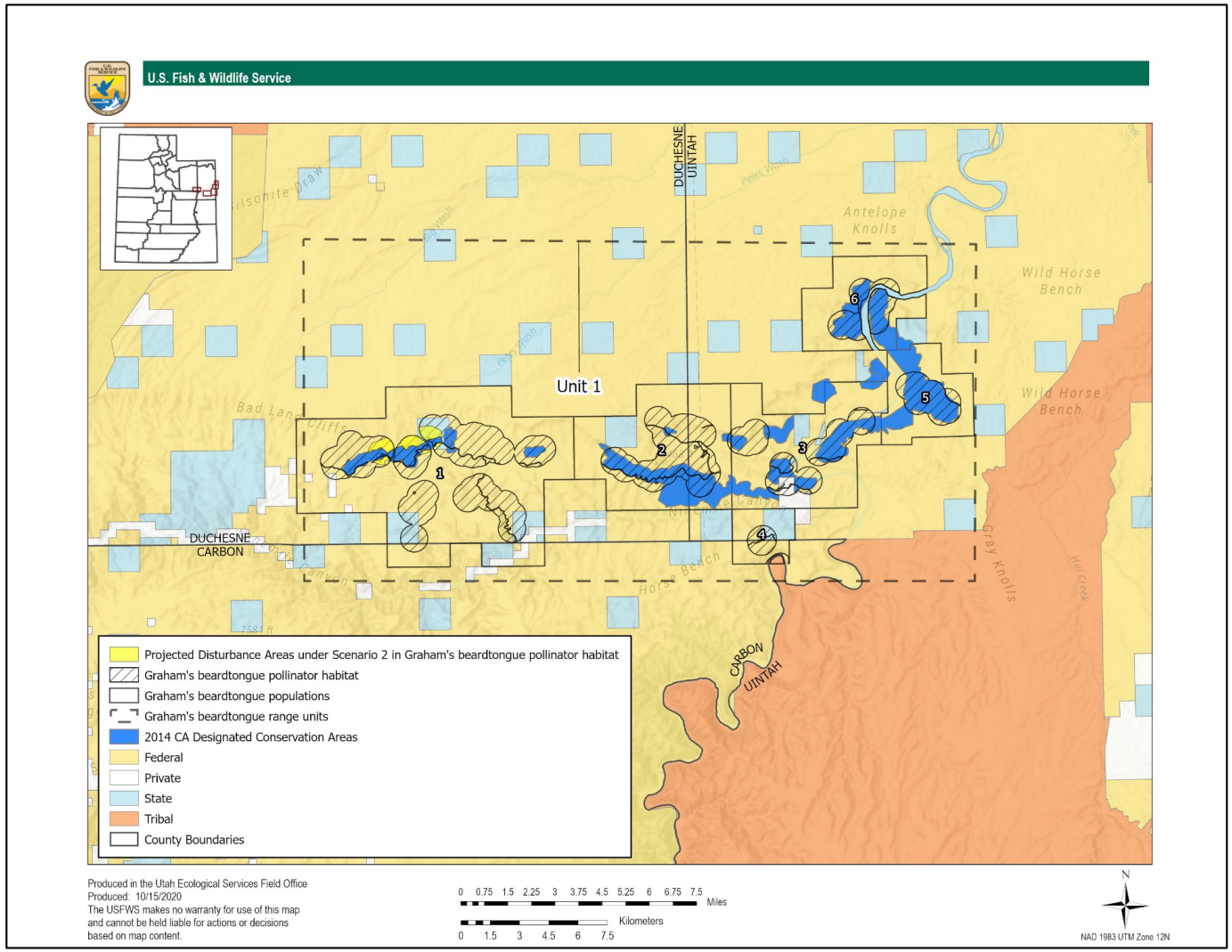

Figure 2. Graham's beardtongue populations 1 – 6 in range unit 1 and Future Scenario 2.

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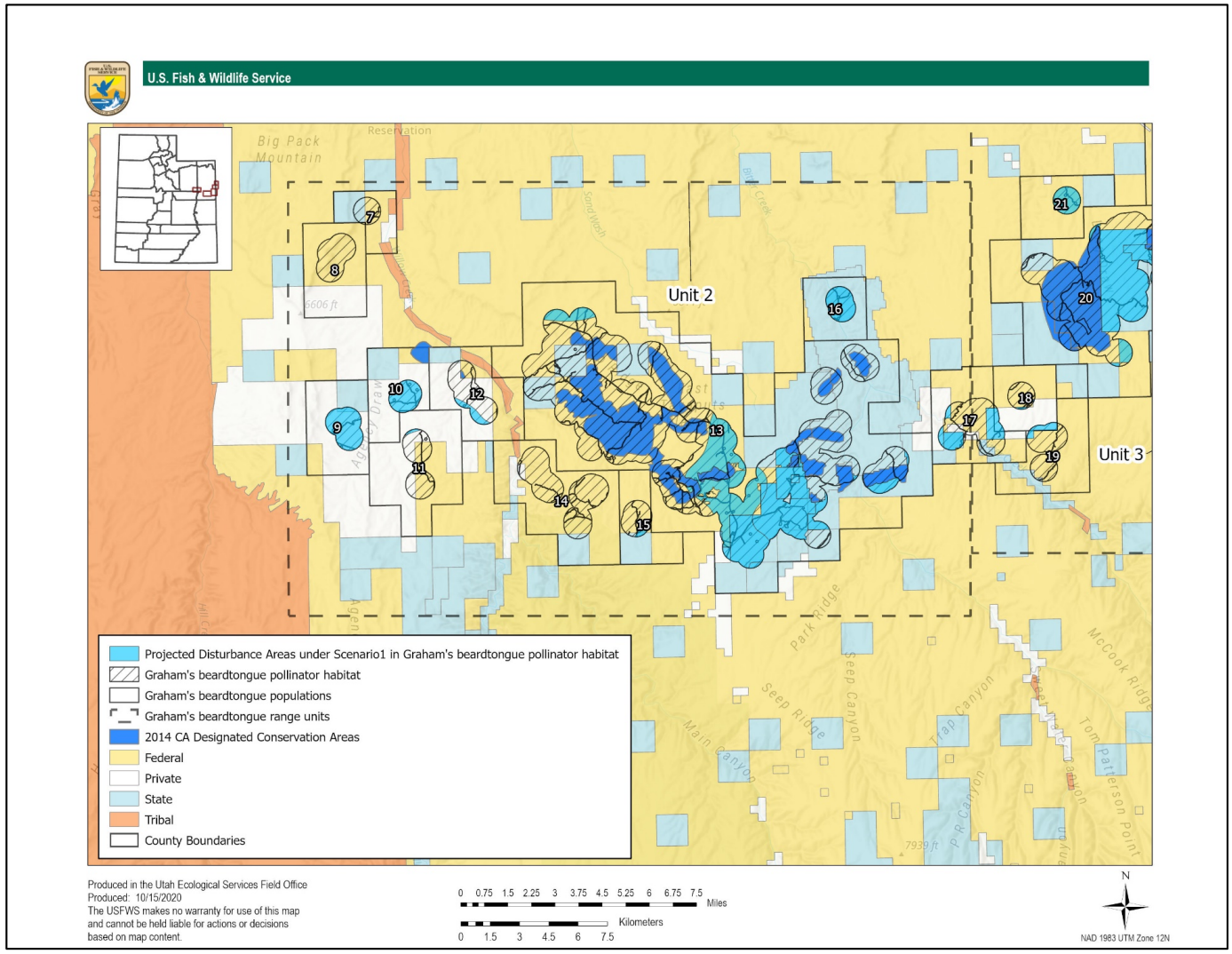


Figure 3. Graham's beardtongue populations 7 – 16 in range unit 2 and Future Scenario 1.

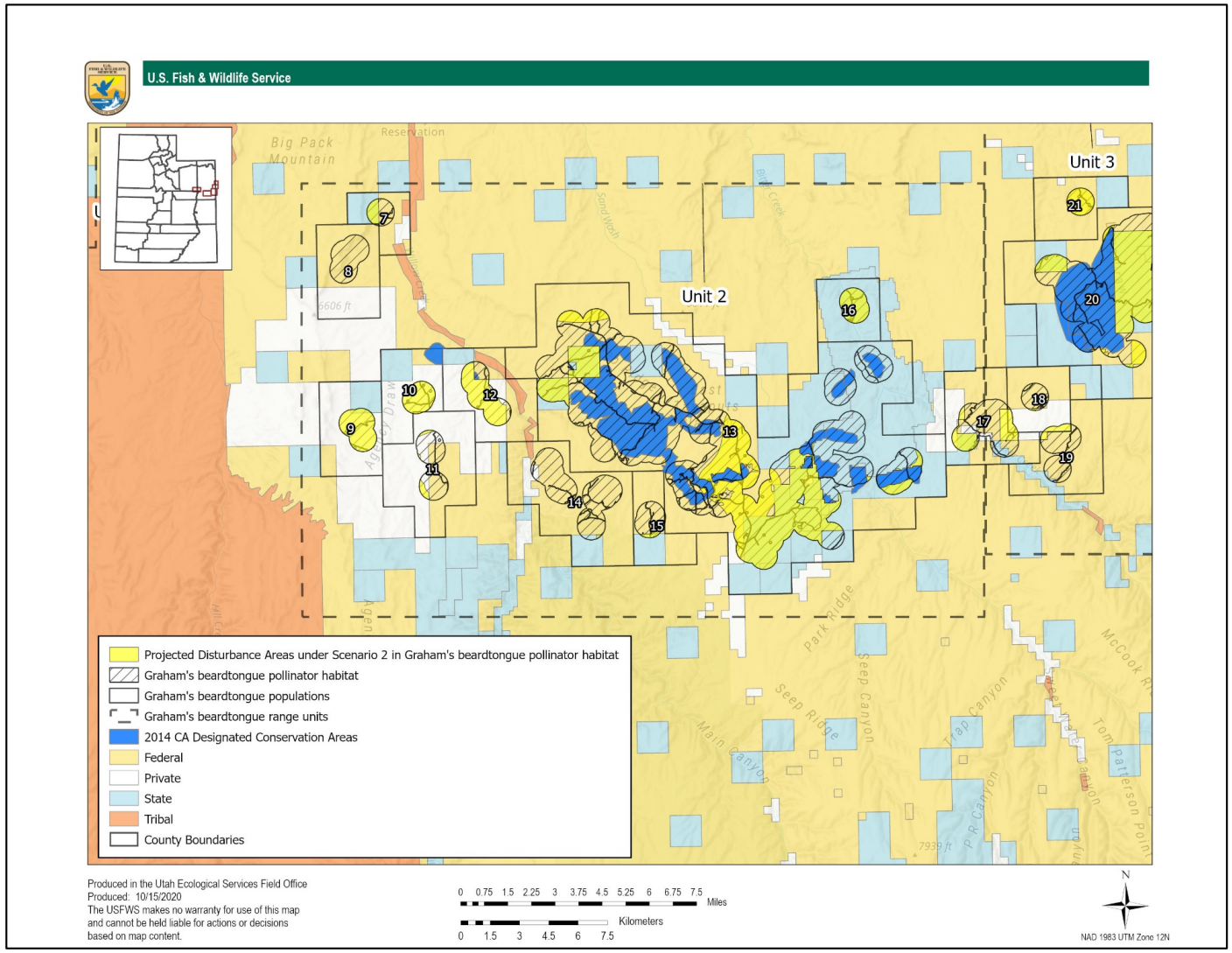

U.S. Fish & Wildlife Service
Big Pack Mountain
Reservation
Unit 2
Unit 3
Projected Disturbance Areas under Scenario 2 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5 Miles
0 1.5 3 4.5 6 7.5 Kilometers
N
NAD 1983 UTM Zone 12N

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

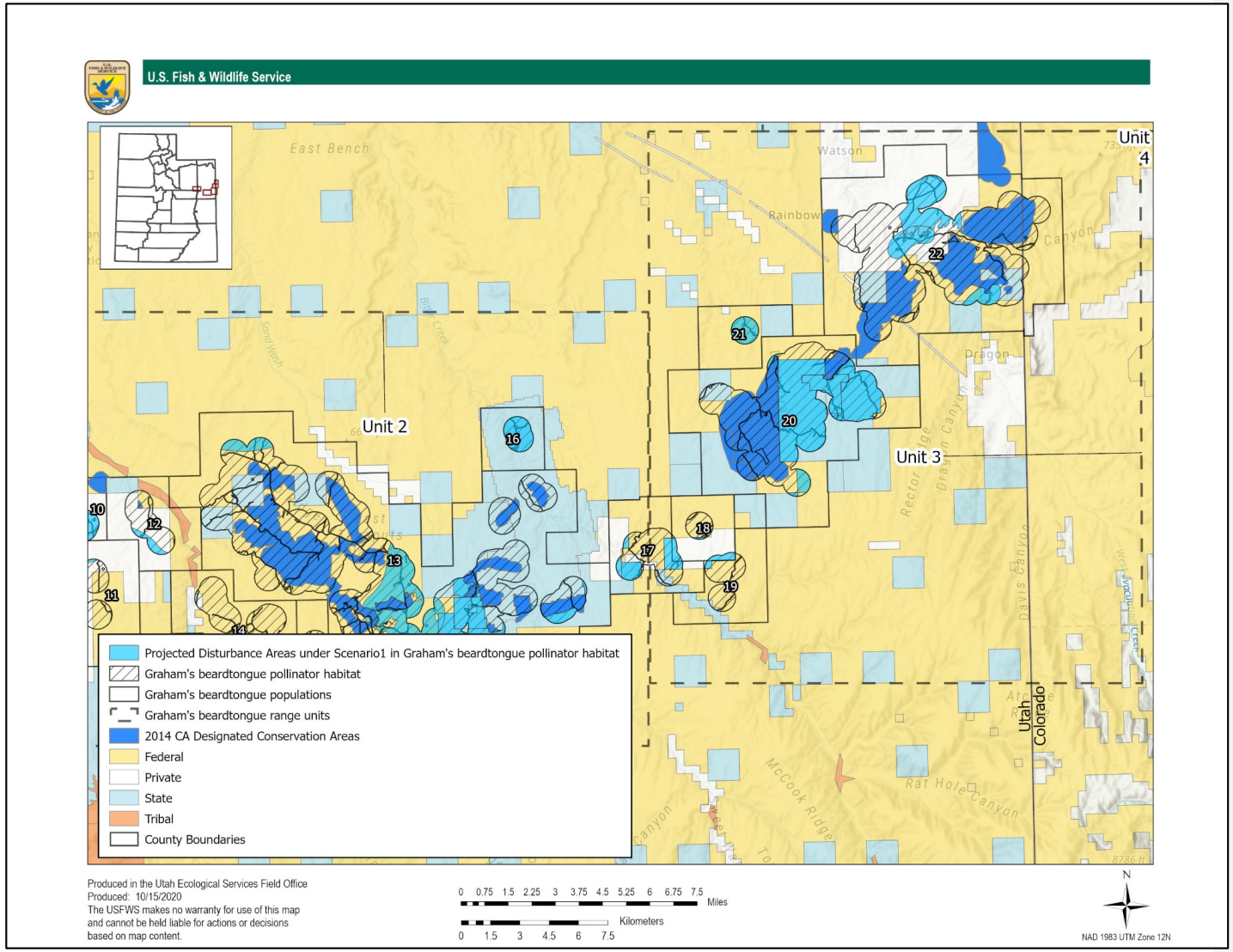

U.S. Fish & Wildlife Service
East Bench
Watson
Rainbow
Unit 4
Unit 2
Unit 3
Dragon
Utah
Colorado
McCook Ridge
Rat Hole Canyon
Projected Disturbance Areas under Scenario1 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map
and cannot be held liable for actions or decisions
based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

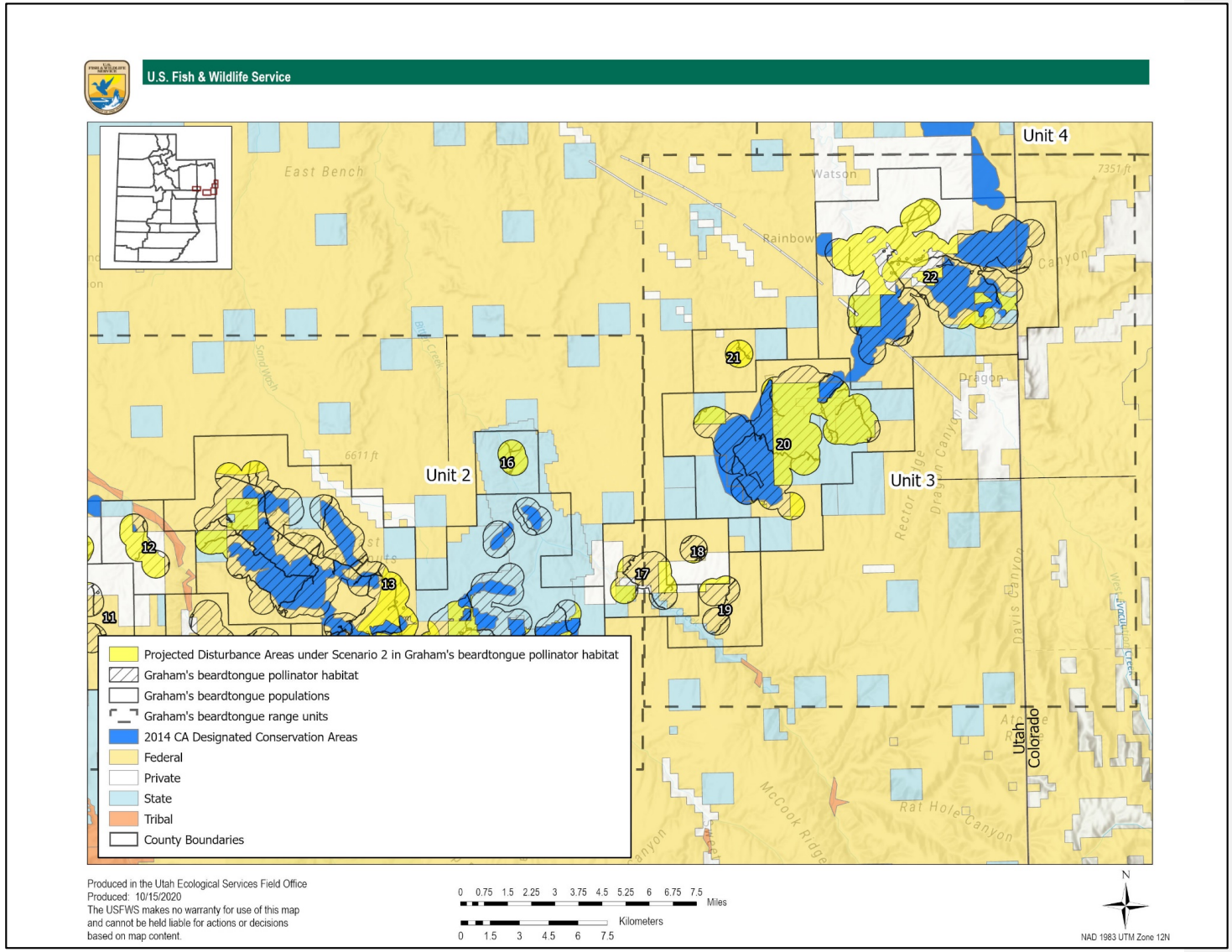

U.S. Fish & Wildlife Service
Unit 4
Unit 2
Unit 3
East Bench
Watson
Rainbow
Canyon
Pregon
Utah
Colorado
Projected Disturbance Areas under Scenario 2 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

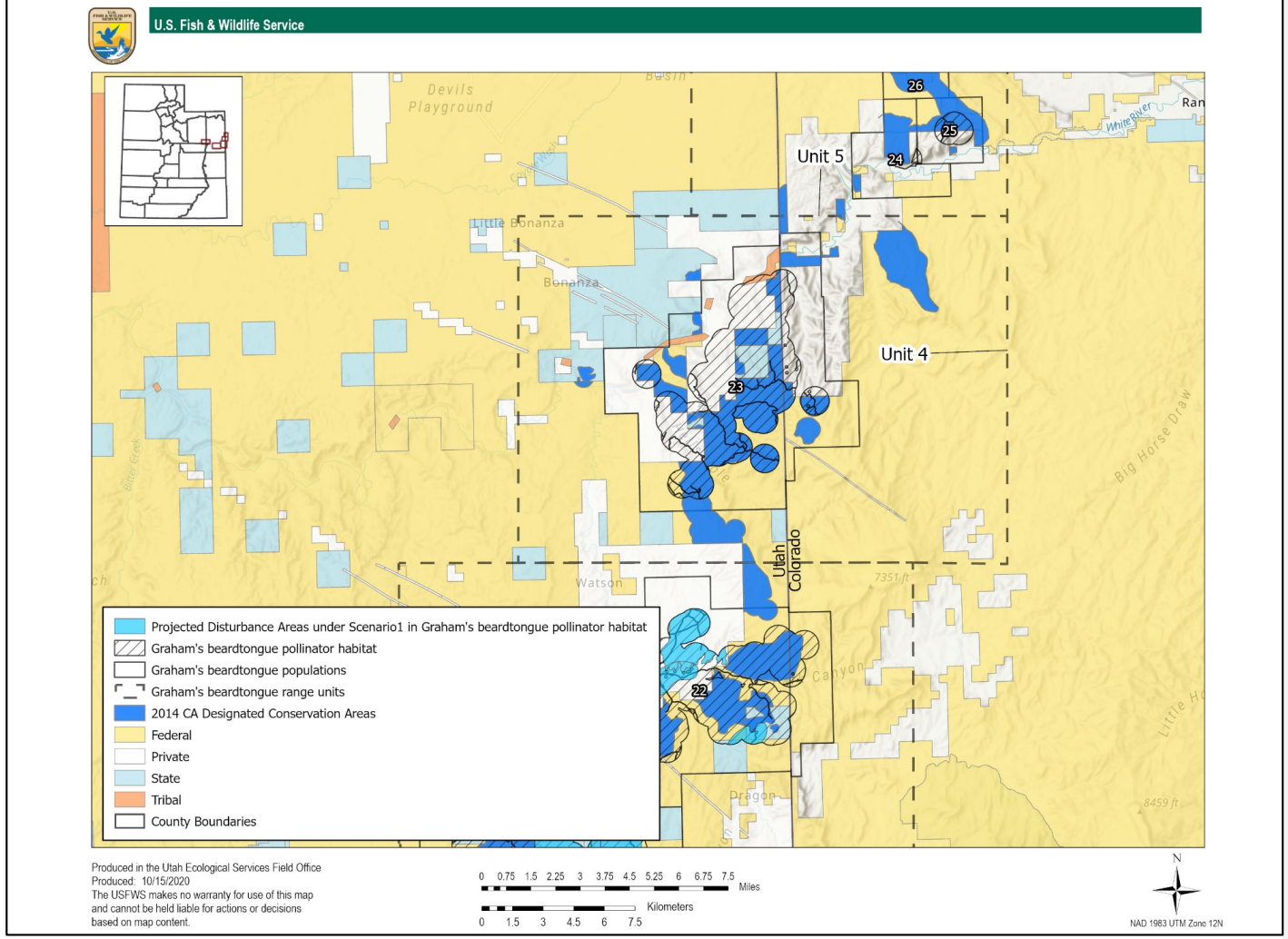
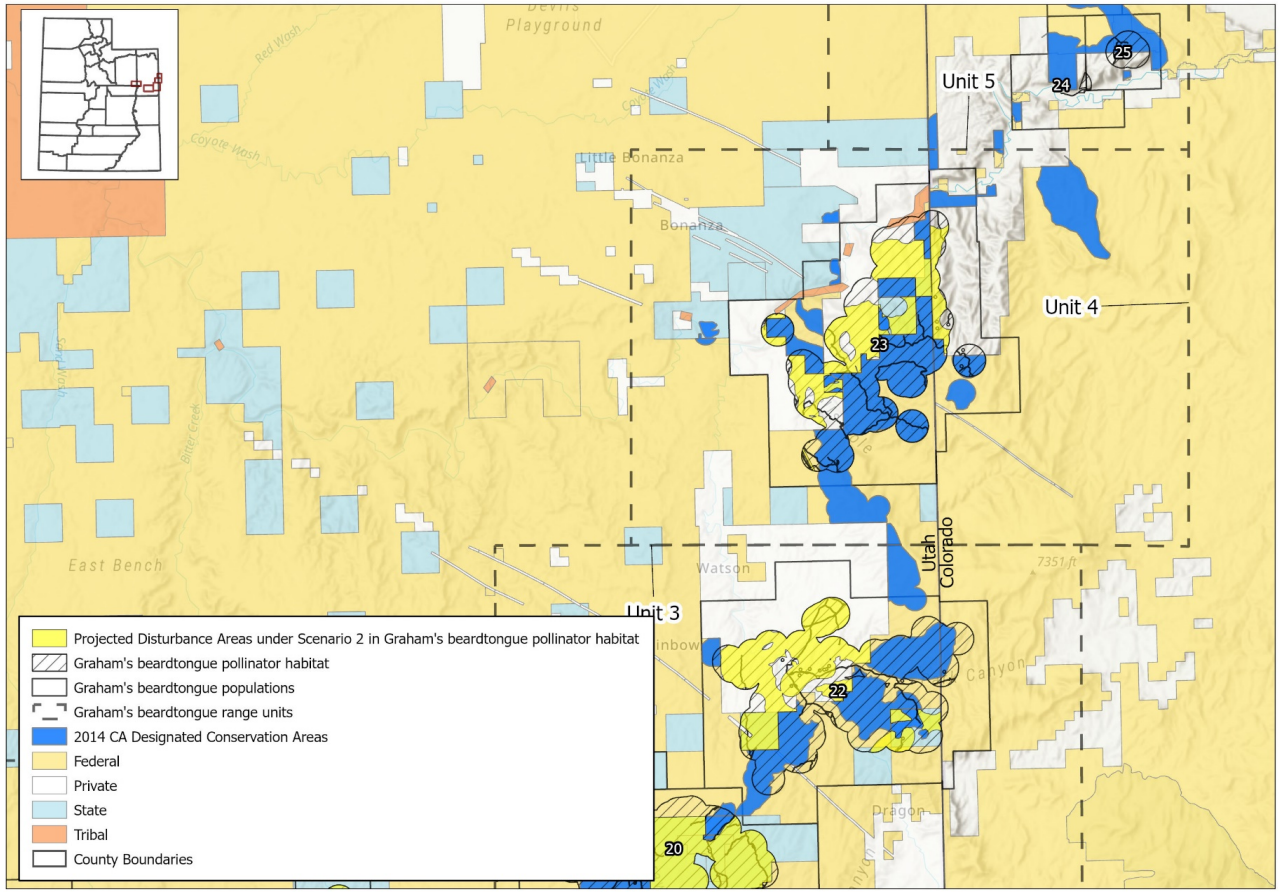

U.S. Fish & Wildlife Service
Devils Playground
Little Bonanza
Bonanza
Watson
Dragon
Canyon
Unit 5
Unit 4
26
25
24
23
22
Utah
Colorado
White River
Big Horse Draw
7351 ft
8459 ft
Projected Disturbance Areas under Scenario1 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

U.S. Fish & Wildlife Service



Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
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0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5 Miles

0 1.5 3 4.5 6 7.5 Kilometers

N

NAD 1983 UTM Zone 12N

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

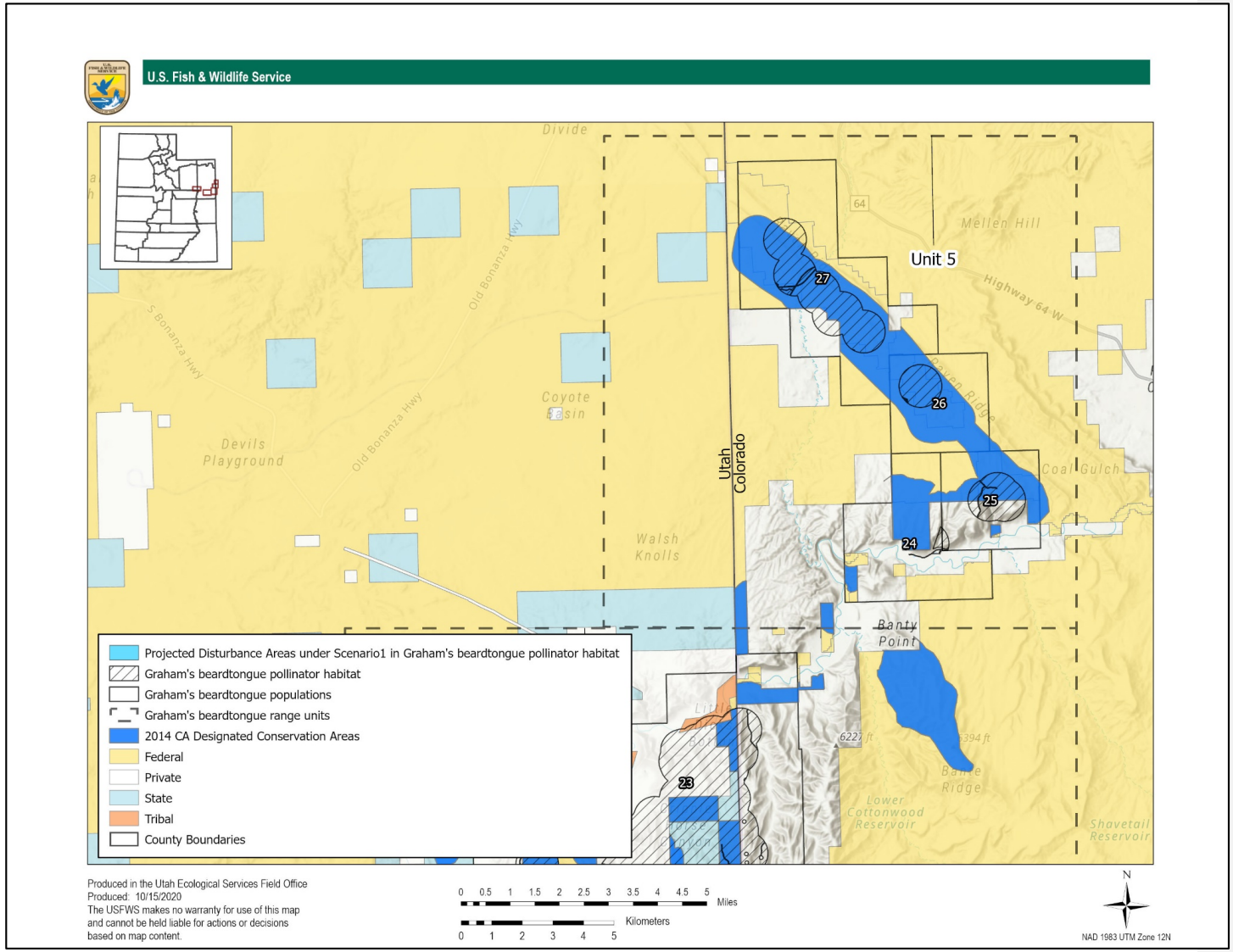

U.S. Fish & Wildlife Service
Unit 5
Utah
Colorado
Divide
Old Bonanza Hwy
S Bonanza Hwy
Devils Playground
Coyote Basin
Walsh Knolls
Mellen Hill
Highway 64 W
Coal Gulch
Banty Point
Lower Cottonwood Reservoir
Shavetail Reservoir
23
24
25
26
27
Projected Disturbance Areas under Scenario1 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 Miles
0 1 2 3 4 5 Kilometers
N
NAD 1983 UTM Zone 12N

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

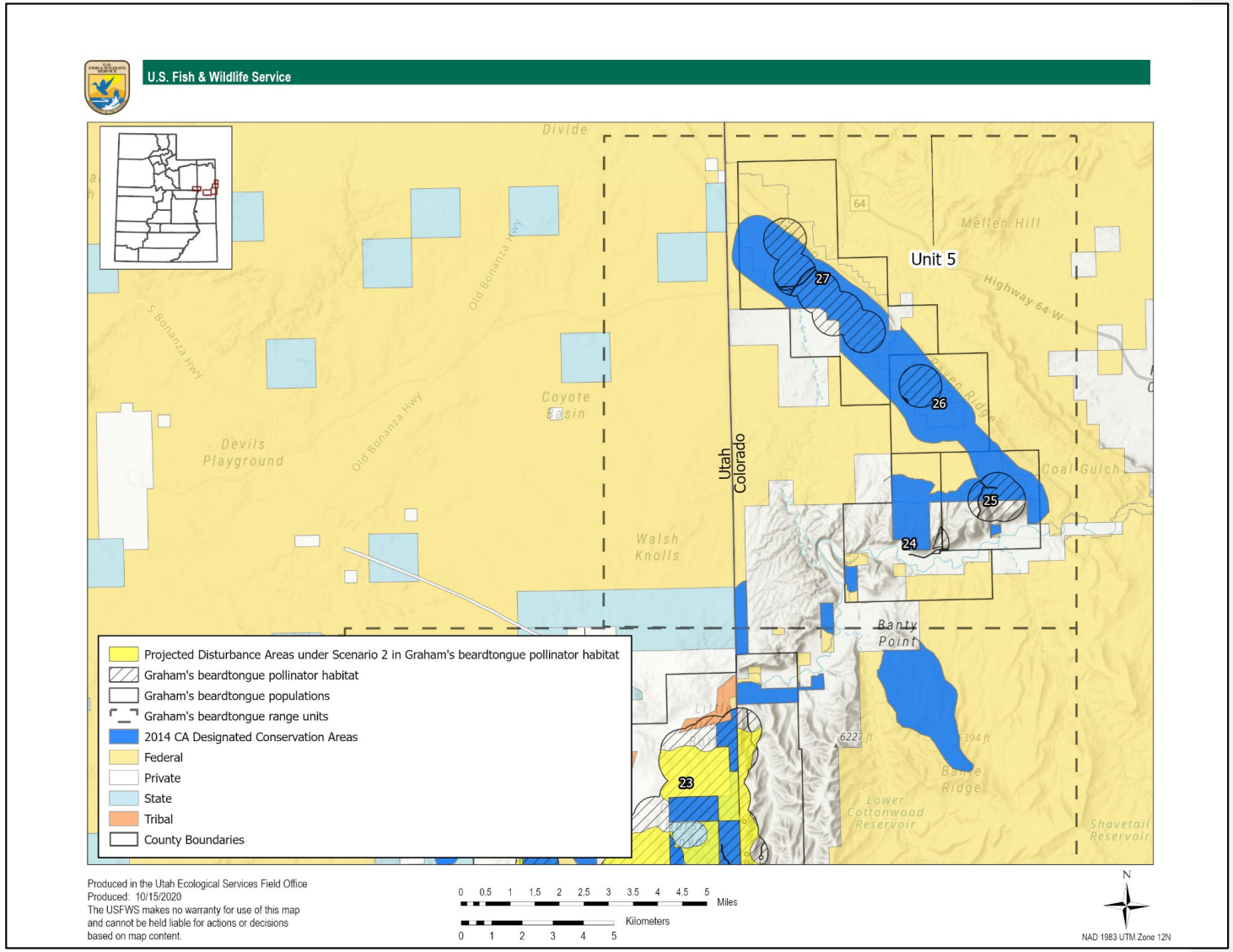

U.S. Fish & Wildlife Service
Unit 5
Utah
Colorado
Divide
Old Bonanza Hwy
S Bonanza Hwy
Devils Playground
Coyote Basin
Walsh Knolls
Mellen Hill
Highway 64 W
Coal Gulch
Banty Point
Lower Cottonwood Reservoir
Shavetail Reservoir
Battle Ridge
23
24
25
26
27
Projected Disturbance Areas under Scenario 2 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 Miles
0 1 2 3 4 5 Kilometers
N
NAD 1983 UTM Zone 12N

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

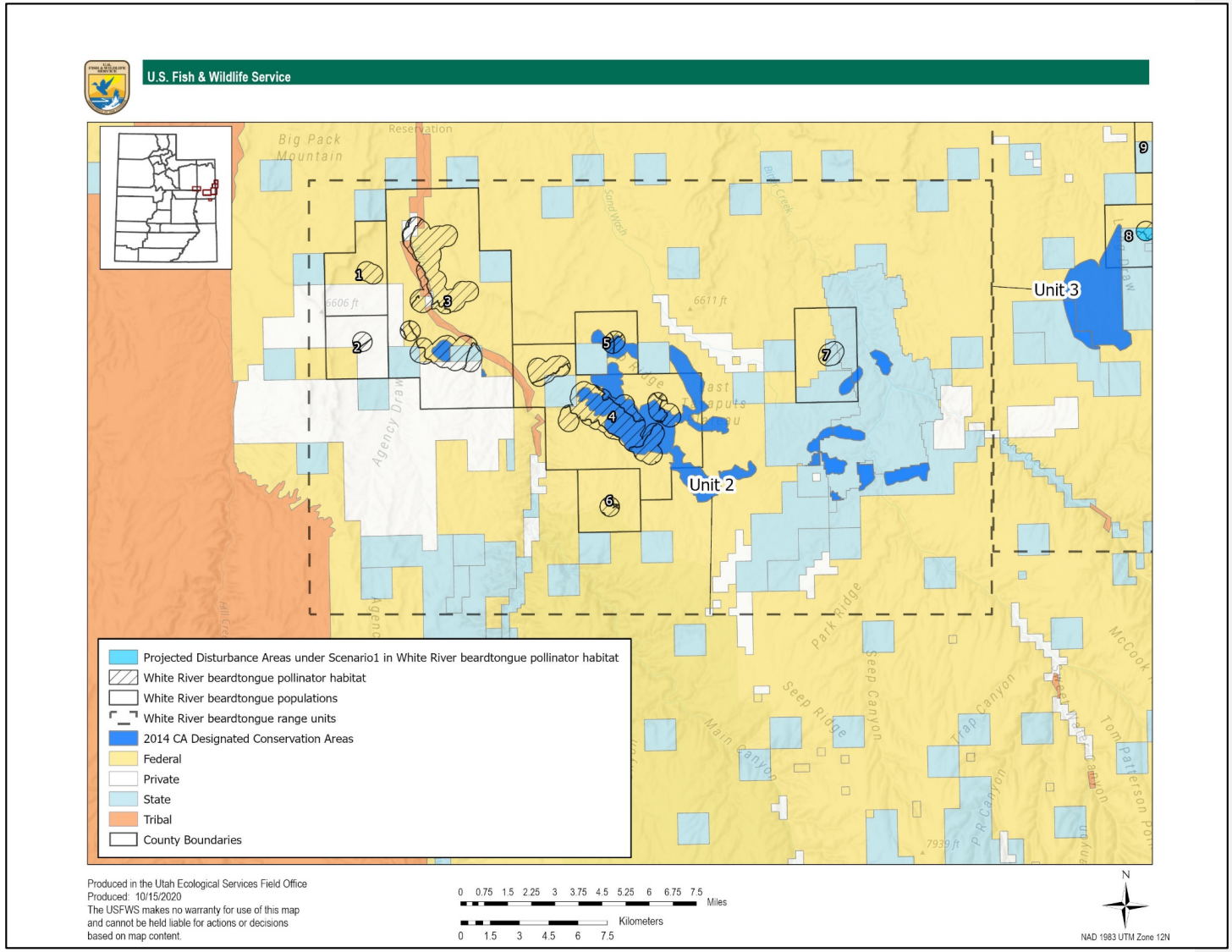

U.S. Fish & Wildlife Service
Big Pack Mountain
Reservation
Unit 2
Unit 3
Agency Draw
Park Ridge
Seep Ridge
Seep Canyon
Trap Canyon
Main Canyon
P-R Canyon
Tom Patterson Canyon
McCook Ridge
6606 ft
6611 ft
7939 ft
Projected Disturbance Areas under Scenario1 in White River beardtongue pollinator habitat
White River beardtongue pollinator habitat
White River beardtongue populations
White River beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

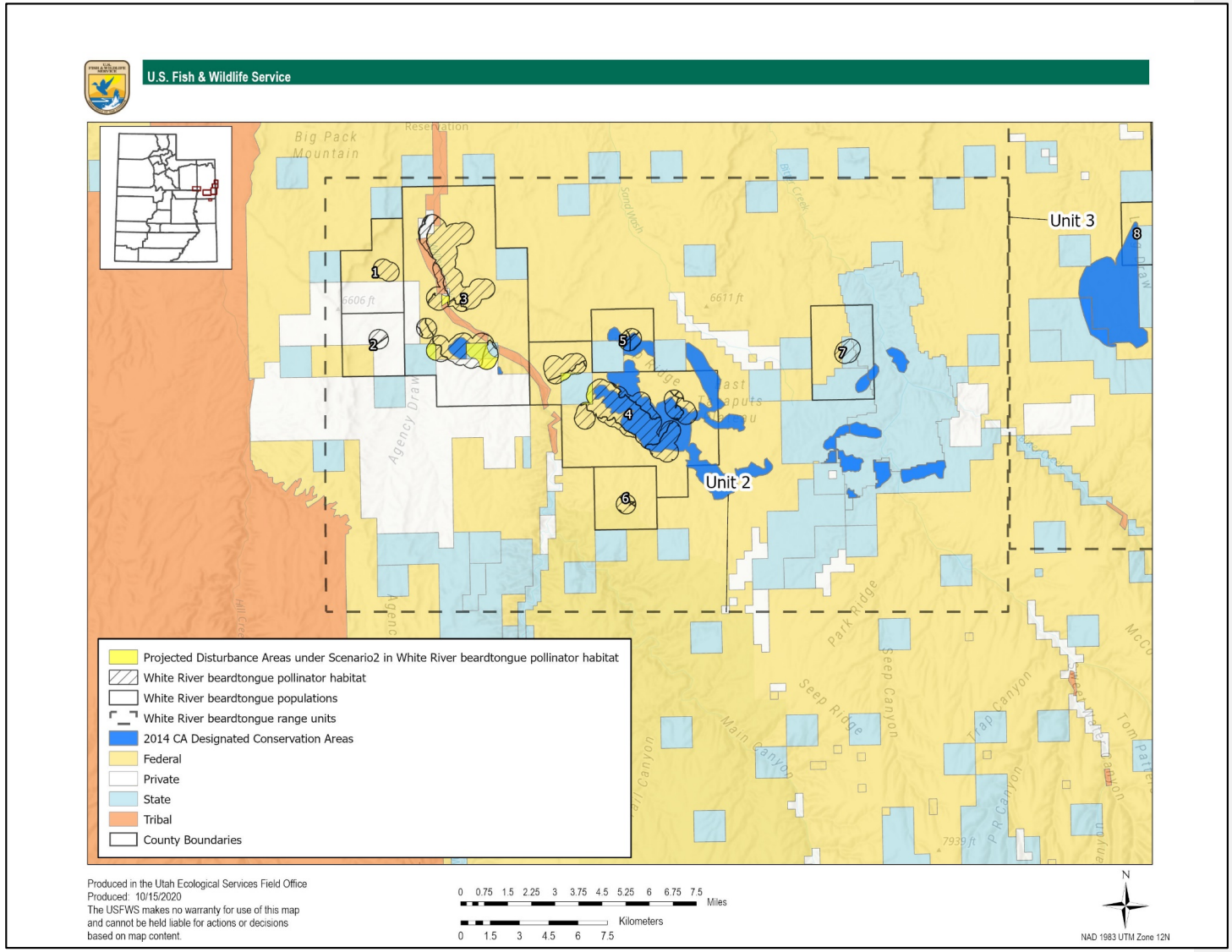

U.S. Fish & Wildlife Service
Big Pack Mountain
Unit 3
Unit 2
1
2
3
4
5
6
7
8
6606 ft
6611 ft
7939 ft
Agency Draw
Park Ridge
Seep Canyon
Seep Ridge
Main Canyon
Trap Canyon
P R Canyon
Projected Disturbance Areas under Scenario2 in White River beardtongue pollinator habitat
White River beardtongue pollinator habitat
White River beardtongue populations
White River beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

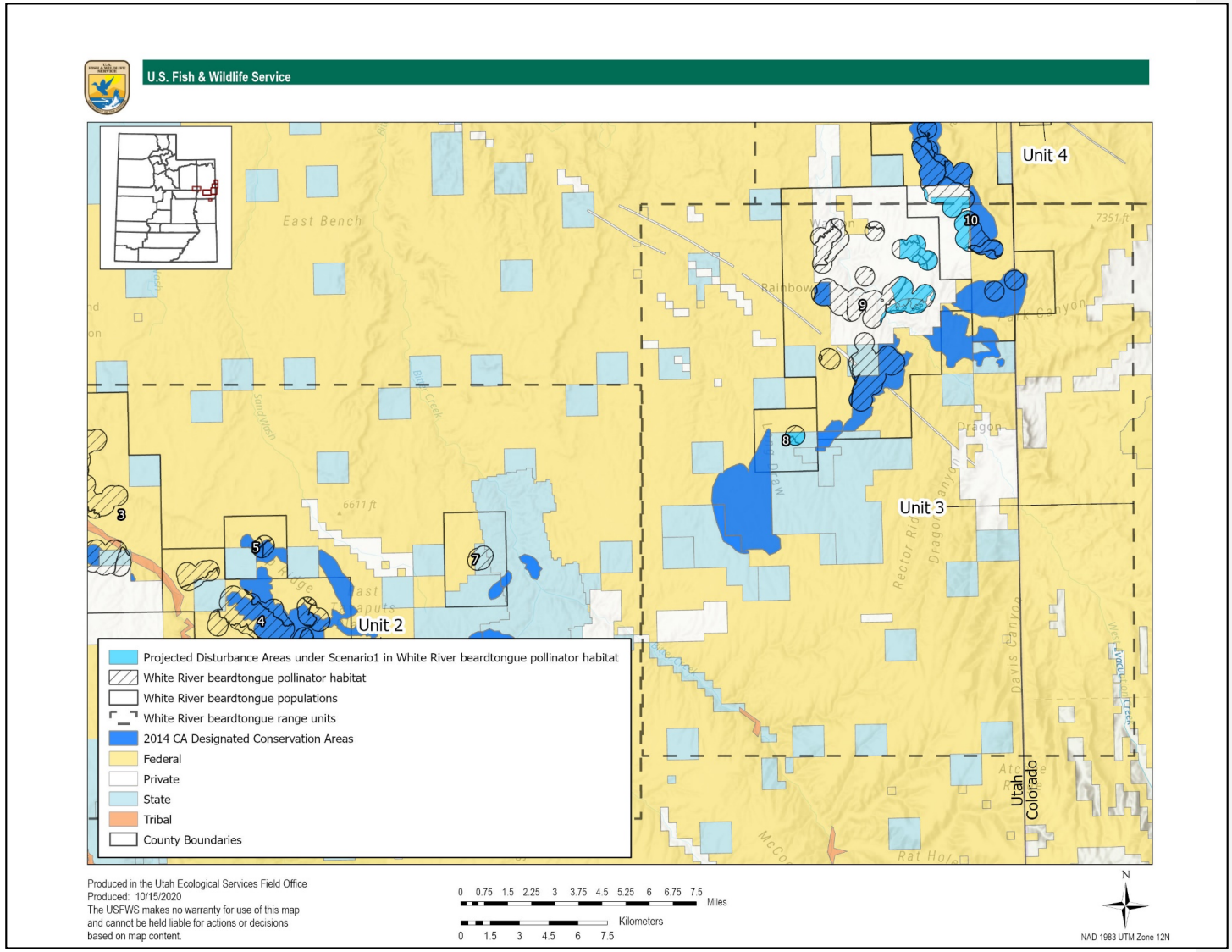
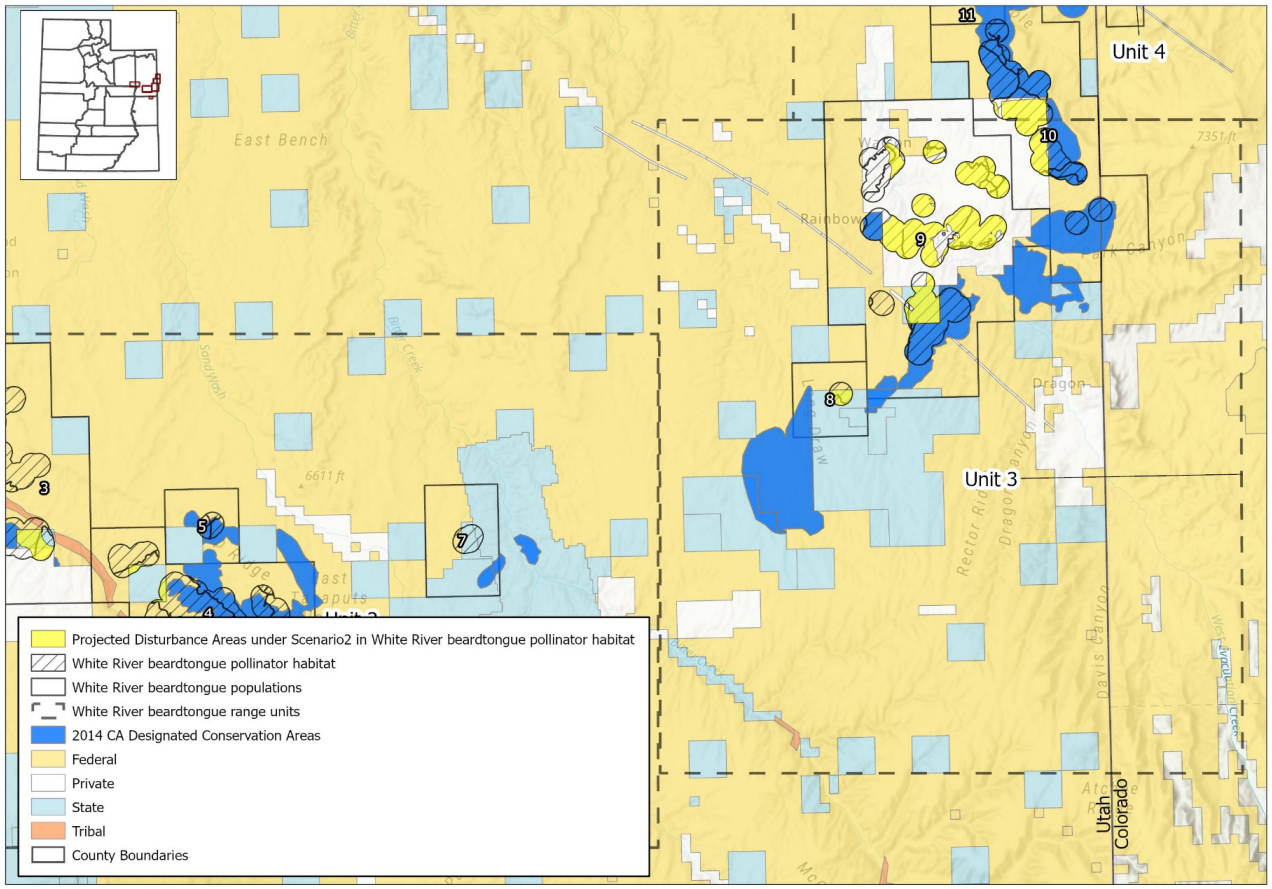

U.S. Fish & Wildlife Service
Unit 4
Unit 3
Unit 2
East Bench
Rainbow
Dragon
Sand Wash
Bitter Creek
Davis Canyon
Utah
Colorado
10
9
8
7
5
4
3
6611 ft
7351 ft
Projected Disturbance Areas under Scenario1 in White River beardtongue pollinator habitat
White River beardtongue pollinator habitat
White River beardtongue populations
White River beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

U.S. Fish & Wildlife Service



Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
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0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5 Miles

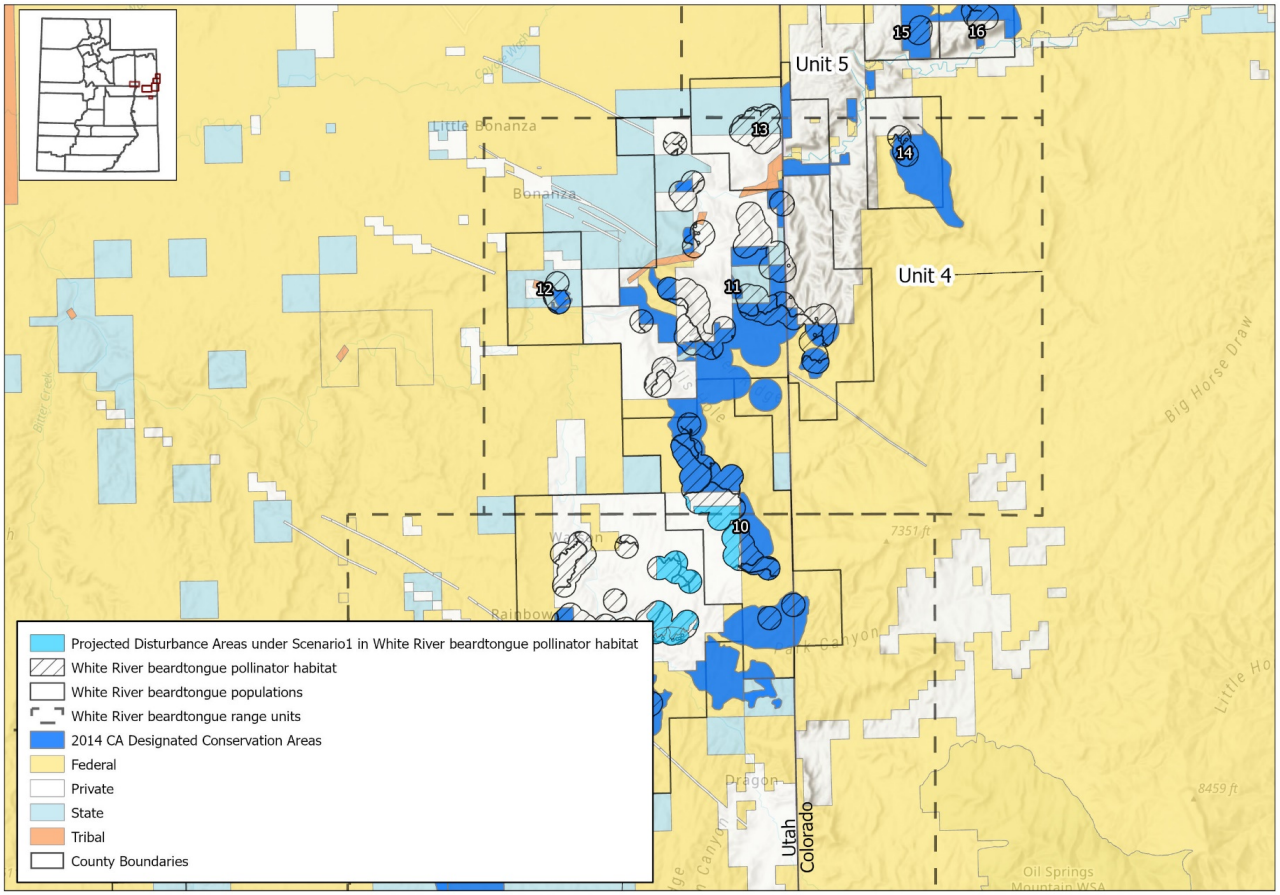
0 1.5 3 4.5 6 7.5 Kilometers

N

NAD 1983 UTM Zone 12N

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

U.S. Fish & Wildlife Service



Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
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0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5 Miles

0 1.5 3 4.5 6 7.5 Kilometers

N

NAD 1983 UTM Zone 12N

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

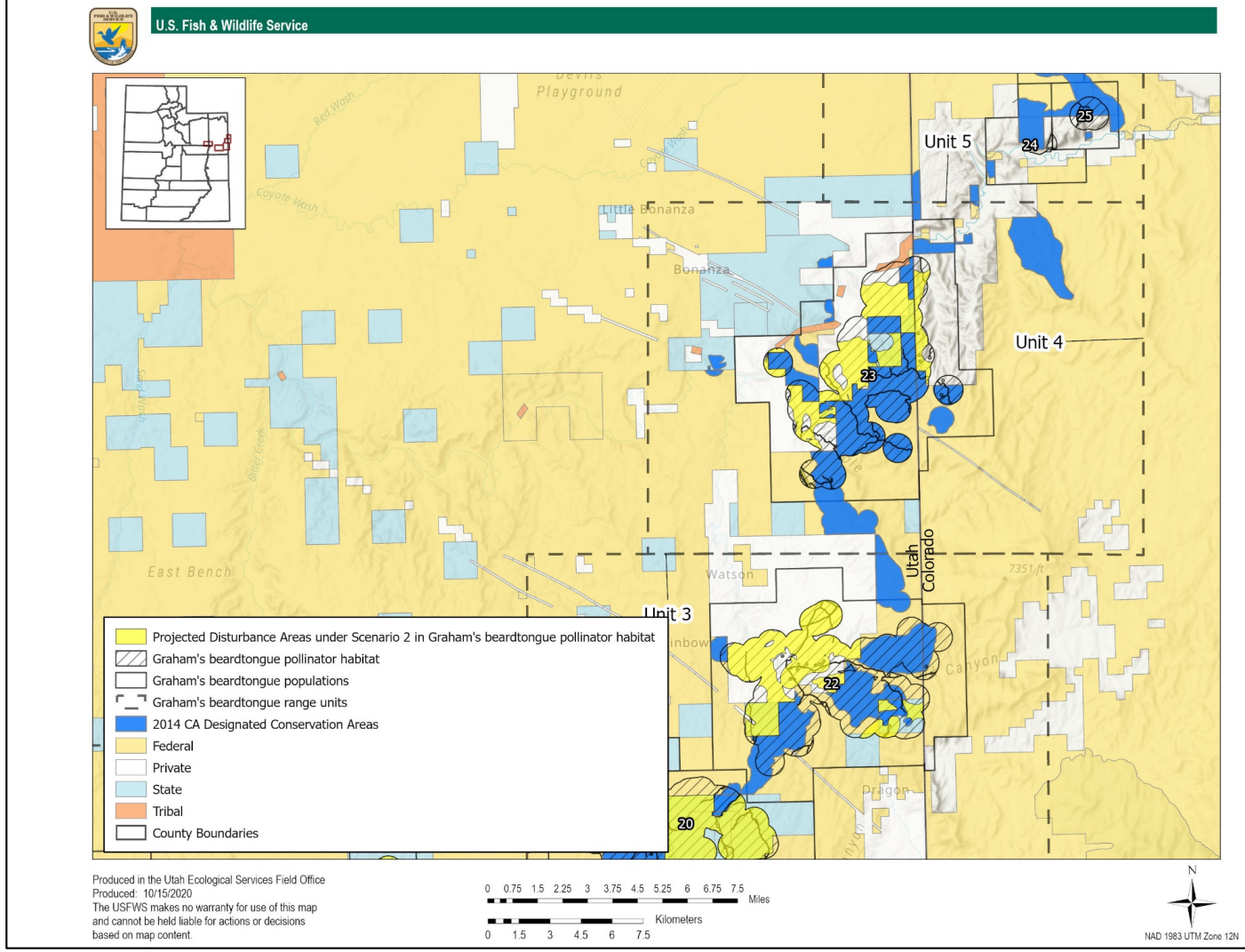

U.S. Fish & Wildlife Service
Unit 5
Unit 4
Unit 3
25
24
23
22
20
Utah
Colorado
Devils Playground
Red Wash
Coyote Wash
Little Bonanza
Bonanza
East Bench
Watson
Bitter Creek
7351 ft
Canyon
Dragon
Projected Disturbance Areas under Scenario 2 in Graham's beardtongue pollinator habitat
Graham's beardtongue pollinator habitat
Graham's beardtongue populations
Graham's beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.75 1.5 2.25 3 3.75 4.5 5.25 6 6.75 7.5
Miles
0 1.5 3 4.5 6 7.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

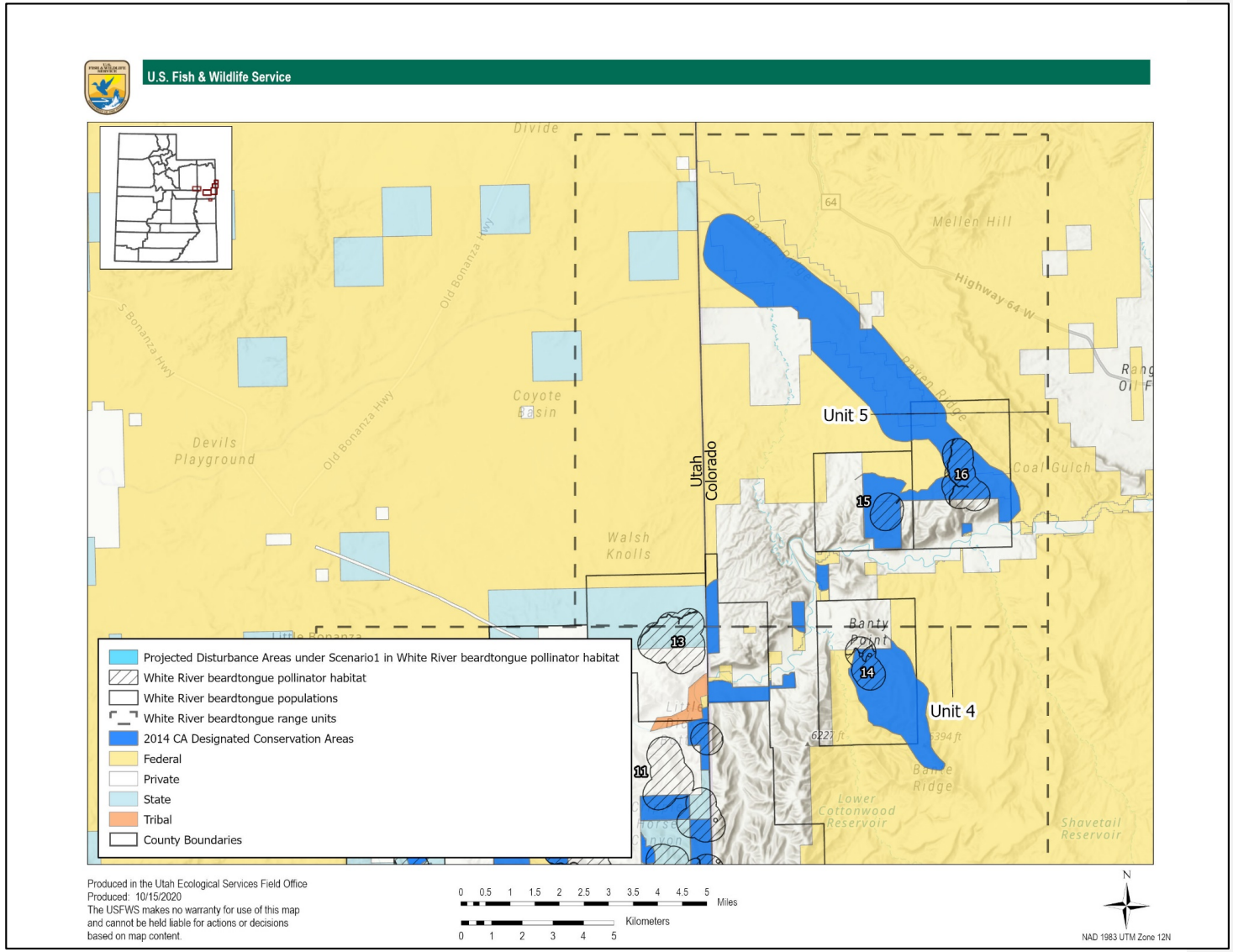
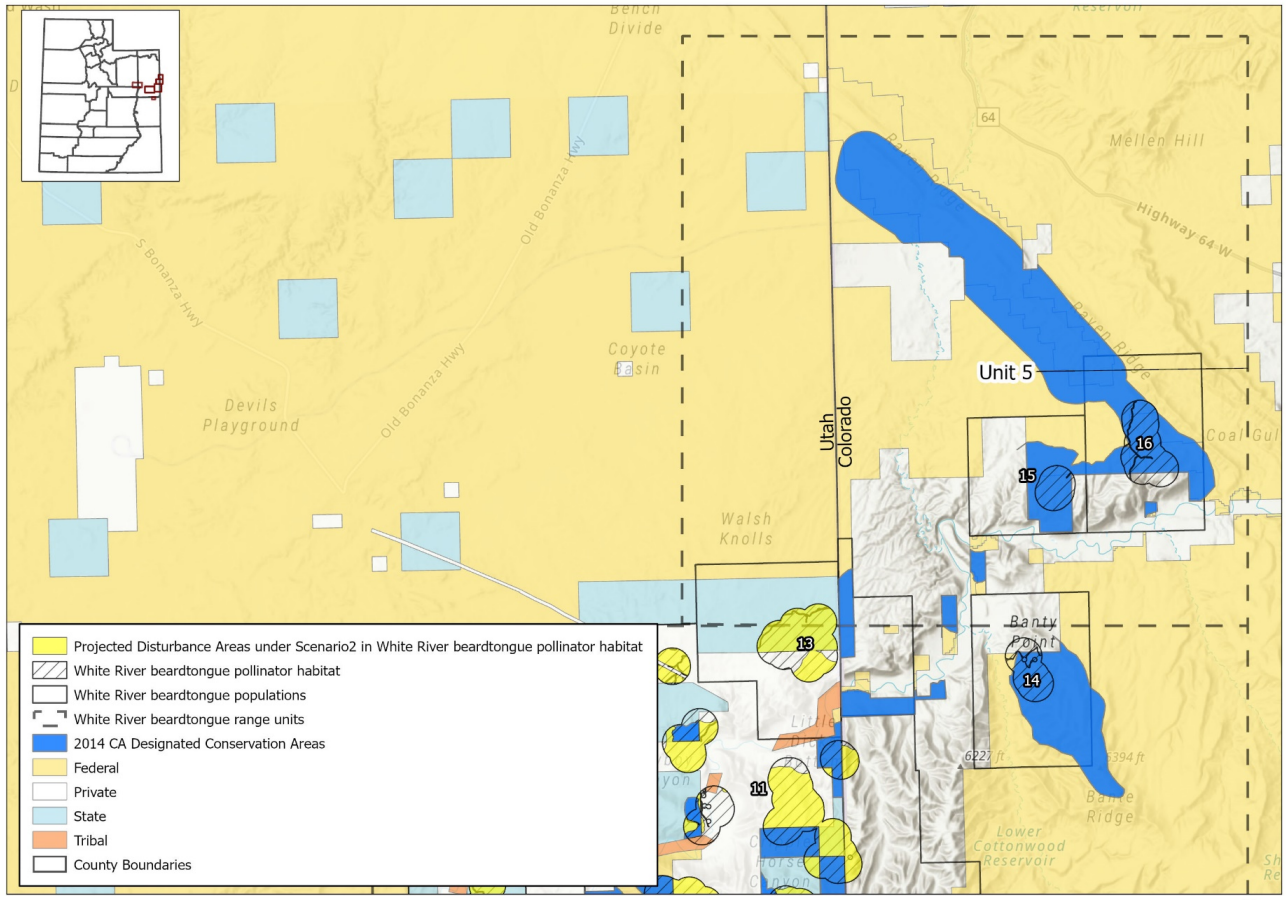

U.S. Fish & Wildlife Service
Divide
Old Bonanza Hwy
S Bonanza Hwy
Old Bonanza Hwy
Coyote Basin
Devils Playground
Walsh Knolls
Utah
Colorado
Mellen Hill
64
Highway 64 W
Unit 5
Unit 4
16
15
14
13
11
Coal Gulch
Banty Point
Lower Cottonwood Reservoir
Shavetail Reservoir
Projected Disturbance Areas under Scenario1 in White River beardtongue pollinator habitat
White River beardtongue pollinator habitat
White River beardtongue populations
White River beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
Tribal
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
Miles
0 1 2 3 4 5
Kilometers
N
NAD 1983 UTM Zone 12N

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

U.S. Fish & Wildlife Service



Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 Miles

0 1 2 3 4 5 Kilometers

N

NAD 1983 UTM Zone 12N

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

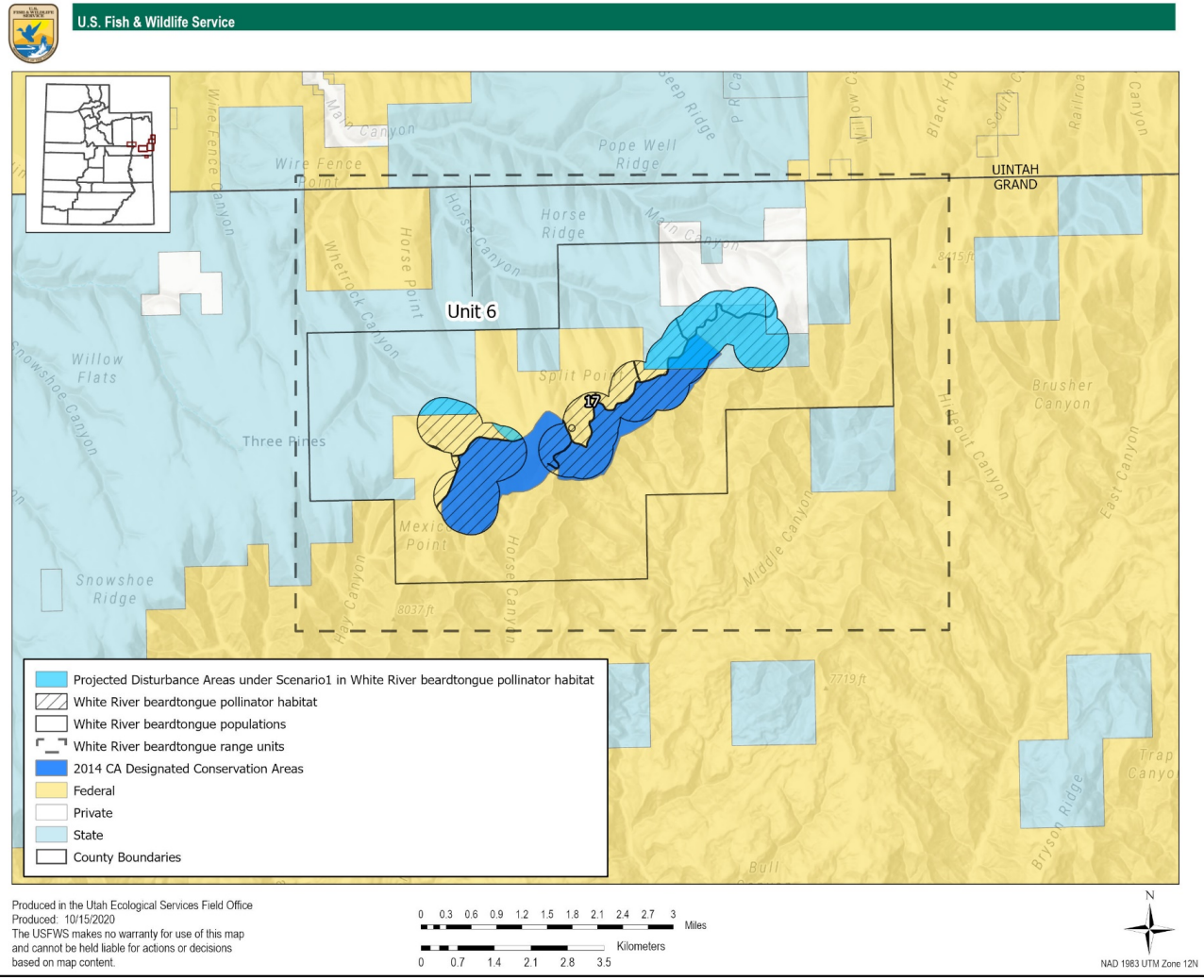

U.S. Fish & Wildlife Service
UINTAH
GRAND
Unit 6
Wire Fence Point
Horse Ridge
Horse Point
Pope Well Ridge
Willow Flats
Three Pines
Snowshoe Ridge
Brusher Canyon
Middle Canyon
Bryson Ridge
Trap Canyo
Bull
8037 ft
7719 ft
8415 ft
Projected Disturbance Areas under Scenario1 in White River beardtongue pollinator habitat
White River beardtongue pollinator habitat
White River beardtongue populations
White River beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3
Miles
0 0.7 1.4 2.1 2.8 3.5
Kilometers
N
NAD 1983 UTM Zone 12N

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

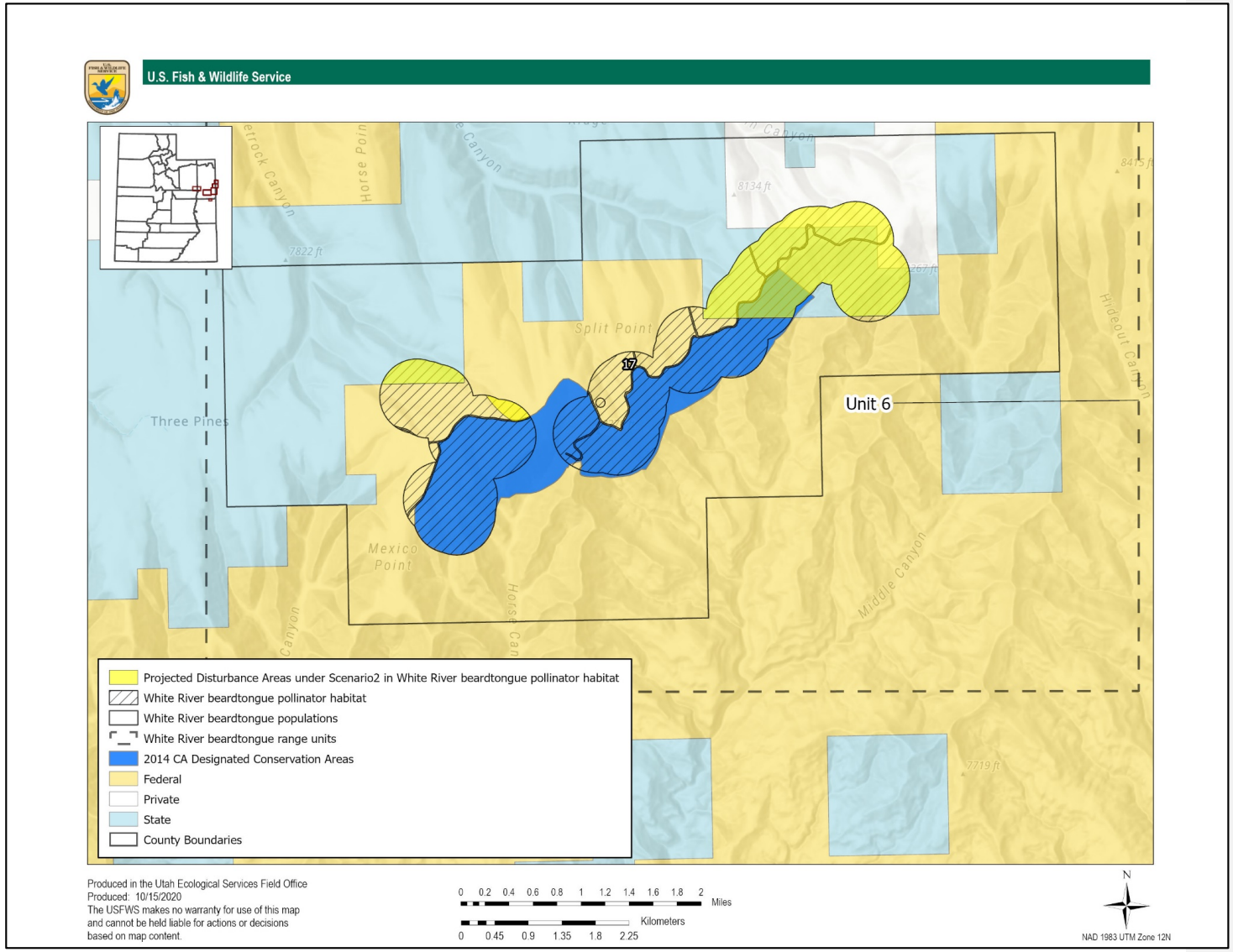

U.S. Fish & Wildlife Service
Unit 6
Split Point
Three Pines
Mexico Point
Middle Canyon
Hideout Canyon
Horse Point
8134 ft
7822 ft
7719 ft
17
Projected Disturbance Areas under Scenario2 in White River beardtongue pollinator habitat
White River beardtongue pollinator habitat
White River beardtongue populations
White River beardtongue range units
2014 CA Designated Conservation Areas
Federal
Private
State
County Boundaries
Produced in the Utah Ecological Services Field Office
Produced: 10/15/2020
The USFWS makes no warranty for use of this map and cannot be held liable for actions or decisions based on map content.
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2
Miles
0 0.45 0.9 1.35 1.8 2.25
Kilometers
N
NAD 1983 UTM Zone 12N

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**

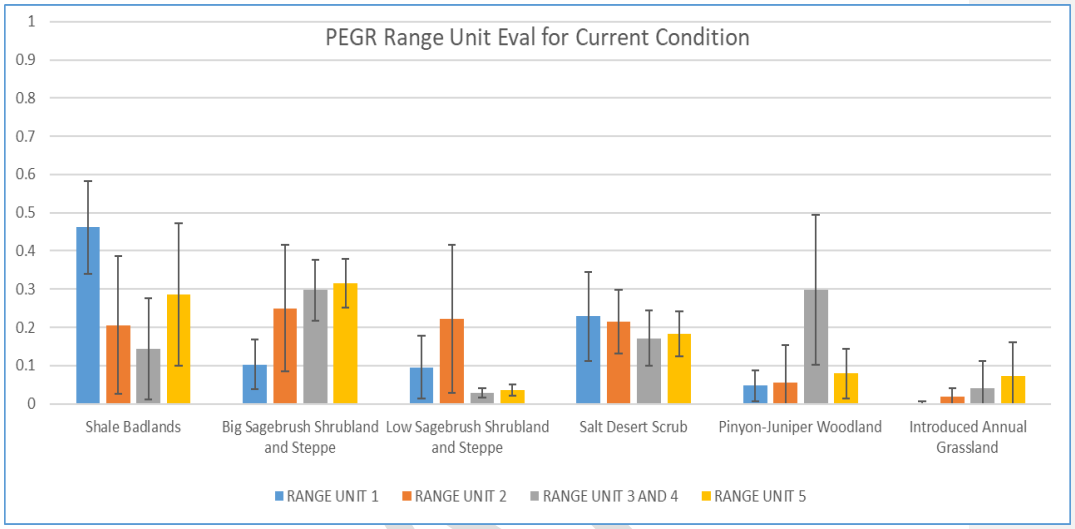
Table 11. White River beardtongue population size (demographic surrogate) evaluation.

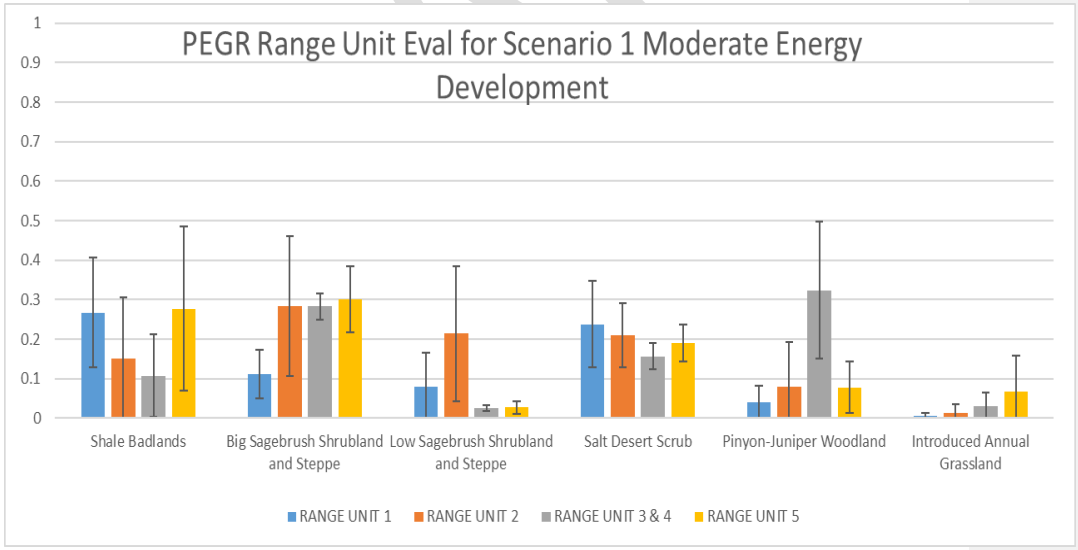
Range Unit	Population	Current Condition and Size[2]	Scenario 1 Condition and Size	Scenario 2 Condition and Size
2. SEEP RIDGE	1	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	2	**Moderate (S)**	**Moderate (S)**	**Moderate (S)**
	3	**Good (L)**	**Good (L)**	**Good (L)**
	4	**Good (L)**	**Good (L)**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

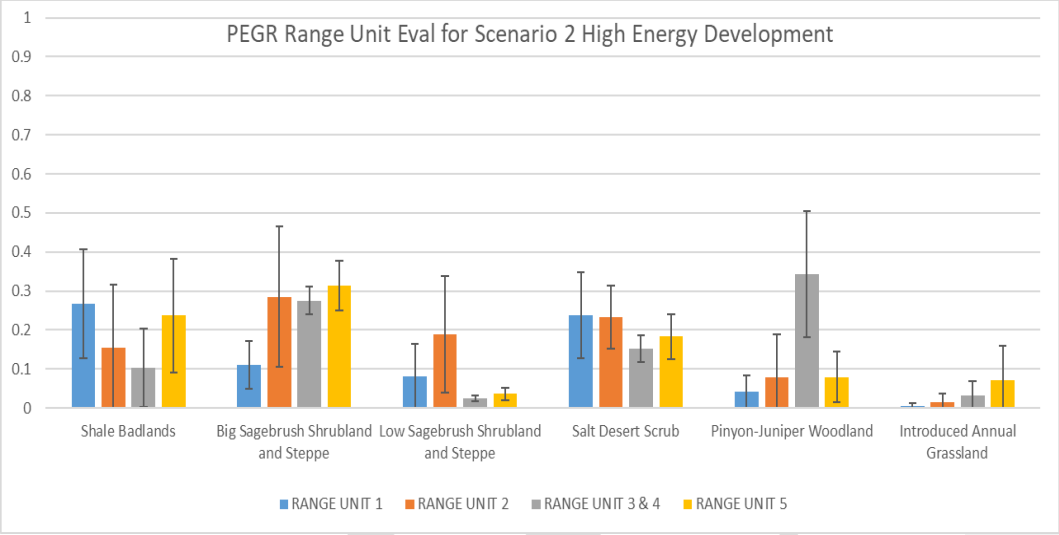
[2] Population size categories – large (L), medium (M), and small (S) are based on extinction risk over 50 years. Large populations have less than 5% extinction risk; medium populations have 6 – 10% extinction risk; and small populations have greater than 10% extinction risk (USFWS 2020a, pp. 71 – 72).

3. EVACUATION CREEK	8	**Low (S)**	**Extirpated**	**Extirpated**
	9	**Good (L)**	**Moderate (L)**	**Moderate (S)**
4. WHITE RIVER	10	**Good (L)**	**Good (L)**	**Good (L)**
	11	**Good (L)**	**Good (L)**	**Moderate (L)**
	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**

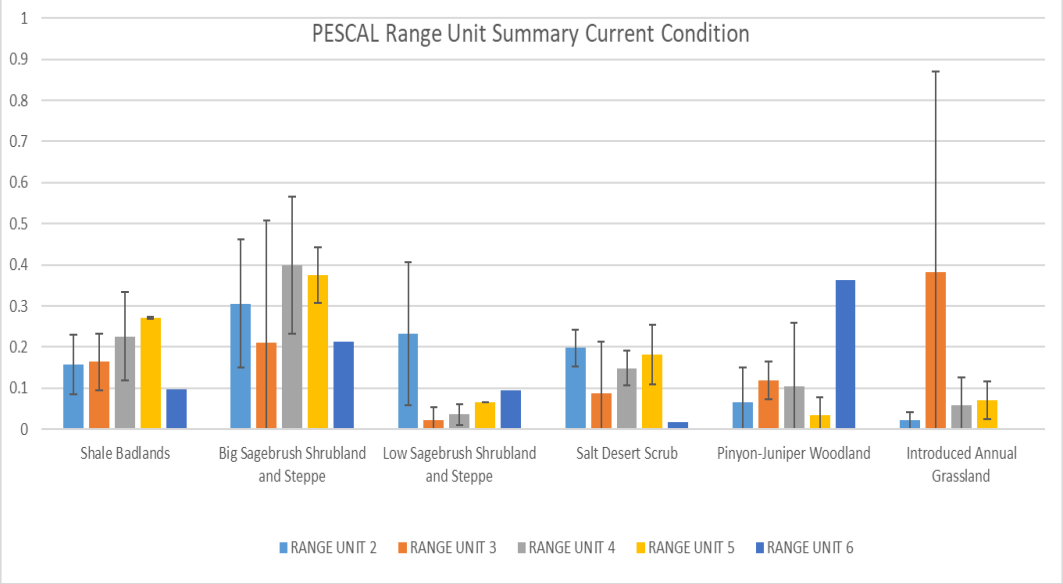
Graham's beardtongue ecological settings (ecological surrogate) evaluation.

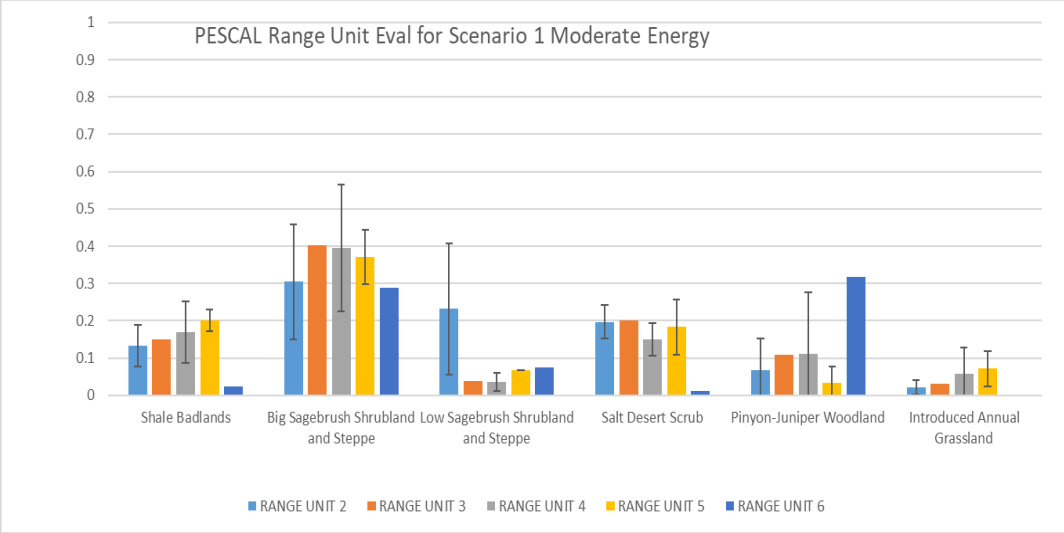


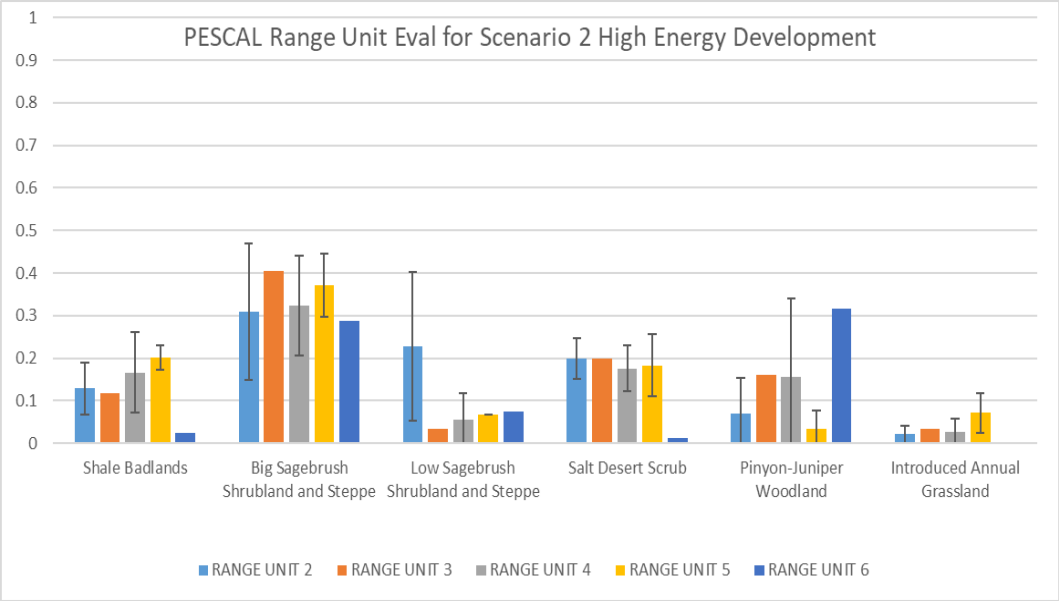




White River beardtongue ecological settings (ecological surrogate) evaluation.




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. For some reason, I could not merge due to missing files.

Commented [JS5]: Did you use this shapefile or not?

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