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Blue Diamond Cholla Surveys

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Final Survey Report

Submitted to:

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Acronyms

Acronym	Definition
ac	acre
DCP	Desert Conservation Program
EO	Element occurrence
ft	feet
ha	hectares
Ironwood	Ironwood Consulting, Inc.
m	meter
NDNH	Nevada Division of Natural Heritage
SOW	Scope of Work

Executive Summary

This report provides the results from 2022 and 2023 field surveys for Blue Diamond cholla (*Cylindropuntia multigeniculata*) within Clark County, Nevada, completed by Ironwood Consulting, Inc. Results from 2022 surveys are summarized in this report, but were detailed in a previous report provided to the Desert Conservation Program. This report details surveys occurring between April 17 and 21, 2023 and October 17 and 27, 2023. The project goals were to (1) expand the known occurrence datasets for the species, (2) ground-truth the habitat suitability model, and (3) secure information about Blue Diamond cholla presence in areas at risk for development or disturbance by human activities.

Ironwood used a habitat suitability model provided by the Clark County Desert Conservation Program to identify general survey areas and optimize field efforts. Botany teams targeted these survey locations and used a combination of coarse- and fine-scale ground surveys to search for Blue Diamond cholla and incidental observations of other special status plants considered secondary or tertiary for the purposes of this project.

Ironwood field surveys for Blue Diamond cholla in 2022 and 2023 covered more than 67,377 total acres, including 41,908 acres of modeled habitat. Five survey areas were visited in 2022 with negative results (Ironwood 2023). The 2023 spring and fall field surveys focused on visiting the remaining survey areas and resulted in five new element occurrence records for Blue Diamond cholla and three incidental element occurrence records for halfring milkvetch (*Astragalus mohavensis* var. *hemigyrus*). The 2023 fieldwork also included a re-visit to the expansive Summit Pass Blue Diamond cholla occurrence that Ironwood first documented in 2021. These surveys expanded the previously delineated boundary of the occupied area at Summit Pass; approximately 34,000 individuals over 2,486 acres of occupied habitat were added to the known distribution of Blue Diamond cholla at this site alone. The resulting data from the 2023 surveys included: 1) new and updated element occurrence records, 2) habitat overview and diagnostic photos for the targeted species, and 3) GIS data for survey tracks, survey acreage, and occupied area. This data was provided to the Desert Conservation Program and the Nevada Division of Natural Heritage.

Ironwood surveys significantly expanded the known occupied habitat within Clark County, making it more common within the County than previously known. However, its global range is still limited to Clark County, Nevada, Mohave County, Arizona, and a single occurrence in La Paz County, Arizona. Recommendations include 1) additional surveys for undocumented occurrences in Lincoln County, Nevada, and western Arizona, 2) future research on short- and long-term impacts from wildfires and invasive annual plants, and 3) initiation of the conversation to change listing status of Blue Diamond cholla at the State and County levels. Each of these actions would help identify conservation implications and guide future management decisions for this plant.

1.1 Introduction

The Clark County Desert Conservation Program (DCP) contracted Ironwood Consulting, Inc. (Ironwood) to complete targeted surveys for the Blue Diamond cholla (*Cylindropuntia multigeniculata* [Clokey] Backb.) where habitat has been modeled but presence has not yet been verified. The project required focused field surveys that implemented a rigorous data collection protocol, using the existing habitat model to determine survey areas.

This annual survey report describes the approach that Ironwood used to meet the project objectives and survey results from the 2023 spring and fall seasons for Blue Diamond cholla and incidental encounters of other sensitive plants.

1.2 Background and Need for the Project

Through previous funding, the Desert Conservation Program (DCP) commissioned the development of species distribution models for five targeted rare plant taxa, including Blue Diamond cholla, to support management decisions and conservation of species vulnerable to habitat loss in the County. Few observations of Blue Diamond cholla existed compared to the area of suitable habitat predicted by the model. This suggested that, before these surveys, the majority of modeled habitat within Clark County remained un-surveyed. These targeted surveys were intended to refine the existing distribution quickly and efficiently, document observed habitat parameters, in addition to updating the known range of Blue Diamond cholla.

1.3 Management Actions Addressed by the Project

Improved knowledge of the species' distribution may be used to refine the existing habitat model, identify potential areas where conservation could occur, aid in locating new populations, and help land managers evaluate the status of sensitive species. Species with conservation status are protected under the Multiple Species Habitat Conservation Plan. The state protects species with a Critically Endangered and Threatened status in Nevada; the BLM sensitive species are managed and protected on BLM-administered lands.

1.4 Goals and Objectives of the Project

The goals of the project, as identified by the DCP, were to:

- Expand the known occurrence datasets for Blue Diamond cholla.
- Ground-truth the habitat suitability model for this species.
- Secure information about Blue Diamond cholla presence in areas at risk for development or disturbance by human activities.

2. Methods and Materials

Ironwood completed a project Work Plan (NDNH 2022b) and a Data Management Plan (Ironwood 2022a) that detailed the rare plant survey methods, including pre-field coordination, survey area selection, equipment and materials, data management protocols, injury and illness prevention plans, and contingency plans for unexpected events. Field methods, data management practices, and analysis methods are outlined below.

2.1 Survey Locations

The identification of general survey areas was completed in close coordination with the DCP and included 17 unique areas (Figure 2-1). Table 2-1 outlines the potential survey acreages of modeled habitat for Blue Diamond cholla at each survey area. Five of the areas were surveyed in 2022 with negative results (Ironwood 2023). The areas surveyed in 2022 were Bird Spring Range, Keystone Wash Prospects, Lost Cabin Spring, Manse, and Trout

Canyon North (22,894 total surveyed acres). The 2023 fieldwork focused on visiting the remaining twelve survey areas.

The general survey areas were determined using the habitat suitability model provided by the County (Nussear and Simandle 2019; USGS 2018). Priority survey areas were identified that met the following criteria:

- Habitat was modeled as marginal, suitable, and optimal.
- Habitat was located within 2.5 miles (mi) of mapped roads.
- Habitat was located more than 0.5 mi from a recorded Blue Diamond cholla occurrence.

Table 2-1. Survey acreages for general surveyed areas and modeled suitable habitat for Blue Diamond cholla.

General Survey Area Name	Clark County General Location	Modeled Suitability Rating			Total Area (acres)
		Marginal (0.677 – 0.783)	Suitable (0.784 - 0.871)	Optimal (0.872- 0.100)	
Azure Ridge North	southeast	503.9	1,323.8	769.0	2,905.3
Bird Spring Range	south-central	1,436.3	2,582.2	1,140.8	6,004.1
Christmas Tree Pass	south	2,597.3	1,316.9	-	4,744.6
Indian Ridge	west-central	396.6	121.2	-	1,199.6
Jumbo	southeast	523.6	762.1	729.7	2,327.4
Keystone Wash Prospects	southwest	905.4	2,420.9	1,252.1	4,795.5
Lost Cabin Spring	southwest	1,180.6	137.1	-	1,952.6
Lucy Gray Mountains	south-central	902.2	885.0	1,486.8	3,655.9
Manse	southwest	953.9	2,372.2	200.9	3,656.0
McCullough Mtns North	south-central	994.3	382.7	-	1,817.4
McCullough Mtns South	south-central	1,518.8	2,319.9	254.5	4,160.7
Mormon Mountains	north	780.1	377.2	455.2	2,555.7
Peak 1902/Peak 1859	west-central	474.9	198.7	-	1,105.6
Railroad Spring	south-central	1,047.5	1,301.3	-	2,739.3
Summit Pass	southeast	238.8	669.3	1,342.0	2,295.9
Trout Canyon North	southwest	850.9	651.2	124.2	1,802.2
Wamp Spring	north-central	1,050.9	480.5	-	2,215.9
Total Area of General Survey Areas					**49,933.6**

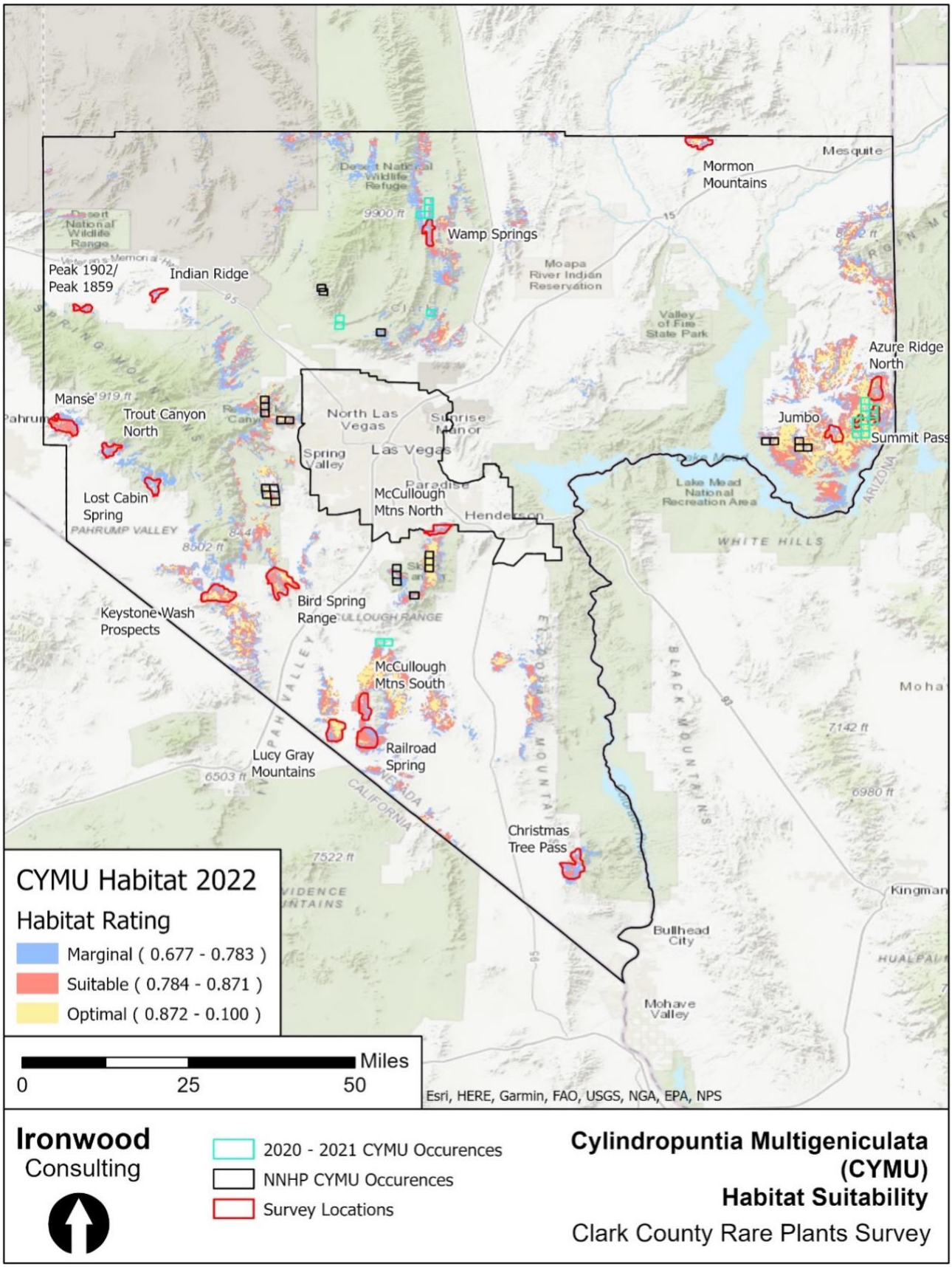

Figure 2-1. General field survey area locations with modeled habitat suitability for Blue Diamond cholla.

2.2 Field Survey Equipment

The following necessary materials, vehicles, and equipment were used to fulfill the contract:

- Recreational GPS units and data collection devices (typically 5-meter [m] accuracy) – Each crew (three to five botanists) used a recreational GPS unit, or an iPad/iPhone integrated GPS with a Bluetooth-enabled data collection device to input field data into a pre-designed data dictionary.
- Data collection interface – ESRI Field Maps and Survey123 were used as data collection interfaces on tablets in the field for spatial all data collection.
- Miscellaneous field equipment, including plant presses and other collection equipment (for species that do not have State of Nevada endangered or federal status), hand lenses, data sheets, maps (electronic and paper), compasses, safety gear (e.g., first aid kits and InReach devices), and other field equipment.
- Ironwood created and maintained a project binder containing the project work plan, data management plan, and all other relevant information (maps, figures, protocols, contact information, worker injury and illness prevention plan). The binder was distributed to the field crews for reference and guidance for the project protocol, safety, and methods.

2.3 Field Data Collection

All data were recorded electronically on the application interface designed for the project using ESRI Field Maps and Survey123. Data was uploaded to the cloud server in real time or at the end of the workday if cellular service was not available at a site and backed-up each evening. All photos were saved, labeled, and backed up each evening. If necessary, technical adjustments to the data collection interface were made to ensure data quality and efficiency. Paper datasheets were provided as a backup data collection method and included all fields outlined in the data dictionary.

In general, field data collection included a combination coarse-scaled surveys that assessed the quality of habitat in an area and focused surveys that more thoroughly covered high quality habitat areas for the presence/absence of the target species, per BLM survey guidance provided by the County in the Scope of Work (SOW). A typical survey of a site, including data collection, would include:

- During all surveys, the botanist team collected tracks on a 5-m accuracy GPS (Garmin or similar) unit or via Field Maps to document the survey site coverage and acreage.
- The botanist team began each survey by assessing the site for overall habitat characteristics and quality.
- Assessment of a site at a coarse scale utilized intuitive controlled survey methods outlined in the BLM guidance (see 8.Appendix A). The botanist team determined habitat quality using survey intervals of up to 300 m in areas where habitat for Blue Diamond cholla was not present or habitat quality was poor. Blue Diamond cholla is a relatively large plant with a distinct visual signature and detectable at a distance using binoculars.
- In areas where habitat quality for Blue Diamond cholla was moderate or high, the botanist team conducted more focused surveys with smaller survey intervals.

- If a Blue Diamond cholla individual or population was observed, the botanist team would conduct a focused search of the area for individuals, marking individuals with a pin flag. After the population boundaries were determined, data would be collected for this new Element Occurrence record using a Survey123 form.
- For Blue Diamond cholla individual or population occurrences, the boundaries of the population area would be mapped, using Field Maps to document the occurrence.
- A list of associated species at each Blue Diamond cholla occurrence would be collected using a Survey123 form that included data fields matching the Nevada Division of Natural Heritage (NDNH) site inventory form.
- Populations were generally considered to be all individuals separated by less than a half-mile radius.
- All data was saved and uploaded immediately to the ESRI ArcGIS Online server. If cellular signals were not available, data was uploaded once cellular service returned.

Taxonomic sources for identifying species included *A Flora of Nevada* (Kartesz 1987), *Flora of North America (*Flora of North American Editorial Committee 1993+), and *The Jepson Desert Manual: Vascular Plants of Southeastern California* (Baldwin et al. 2012; Welsh et al. 2015). The NDNH's Information, Tracking Lists, Survey Report Forms and Other Forms website was referenced for species information and floristic survey protocols (NDNH 2023).

2.4 Data Management and Quality Control

2.4.1 Spatial Data

Data for observed occurrences of the target species were collected using ESRI Field Maps and Survey123. All spatial data collected on ESRI Field Maps was accessed through ArcGIS Online. All data was saved as feature layers and packaged as a geodatabase, with metadata and feature attributes included and labeled according to NDNH data standards (NDNH 2023).

2.4.2 Survey Coverage Tracks

The field team collected GPS tracks throughout the entire survey to enable acreage calculations totaling at least 16,200, per the SOW. Each botanist collected tracks on a recreational grade GPS unit and/or using Field Maps so that survey coverage could be assessed. Tracks showed completed survey areas and survey coverage. Since Blue Diamond cholla is visible from several hundred meters when using binoculars, the survey tracks were buffered by 300 m because this area was effectively surveyed along the traverse; the total sum area within the buffer was reported as surveyed. Binoculars were also used to survey steep hillsides that were otherwise inaccessible without technical equipment.

2.4.3 Tabular Data

Tabular data also included photos and metadata. All tabular data, unless determined otherwise, was saved in Excel format. This includes all fields necessary so that the data is broadly useful, including dates, UTMs, descriptions, associated files, data type, observer, survey site, species, etc. Tabular data was compiled after the field data collection was completed, from both digital and paper data forms.

2.4.4 Data Accuracy and Quality

To ensure data was collected accurately, all botanists and botany technicians were trained in data collection methodology. For each crew, a botanist or botany technician was assigned the role of data collection lead. This person was tasked with assuring that each data field was populated accurately and completely.

Data was reviewed in the field at the end of each field day by the Project Manager and/or Assistant Project Manager to ensure completeness, accuracy, and quality. Inaccurate or incomplete data was rectified within 24 hours of original data collection. The GIS/Data Lead also reviewed data collected by Field Maps (and/or Survey123) to assure that all fields were filled out correctly and there were no errors. If data errors were detected, the GIS/Data Lead contacted the PM and/or Assistant PM and the data was corrected within 24 hours and re-reviewed by the GIS/Data Lead.

The Project Manager and/or Assistant PM were in the field for all data collection to ensure that the workplan was followed and data documentation followed standardized procedures approved by the County.

3. Results

3.1 Survey Sites, Habitat, and Acreages

Surveys took place between April 17-21, 2023, and October 17-27, 2023. Ironwood botanists surveyed in teams of three to five and covered 44,483 total acres (ac) across 12 of the 17 general survey areas and at the opportunistic survey area Gann/Walker Spring (Table 3-1, Table 3-2, and Table 3-3). A total of 67,377 ac were surveyed during 2022 and 2023. Maps of the 2023 surveyed areas with general survey sites delineated are seen in Appendix B. Representative photographs of the survey sites and Blue Diamond cholla are included in Appendix C.

In 2023, a total of 29,233 ac surveyed were included in the habitat model, with 10,555, 10,990, and 7,687 total ac surveyed in marginal, suitable, and optimal habitat (as described by the model), respectively. A total of 23,460 ac were surveyed in areas outside the general survey area polygons. These areas were visually identified in the field by Blue Diamond cholla experts (Marc Baker and Michelle Cloud-Hughes) as possible habitat.

Table 3-1. Surveyed acreage inside and outside of general survey area polygons.

General Survey Area	Acres Surveyed		
	Inside	Outside	Total
Azure Ridge North	930	1,444	2,374
Christmas Tree Pass	2,915	502	3,416
Gann/Walker Spring*	-	119	119
Indian Ridge	1,078	1,044	2,122
Lucy Grey Mountains	3,398	1,526	4,924
McCullough Mtns North	1,108	755	1,863
McCullough Mtns South	3,043	1,509	4,552
Mormon Mountains	2,133	1,616	3,749
Peak 1902/Peak 1859	845	406	1,251
Railroad Springs	1,411	1,439	2,850

General Survey Area	Acres Surveyed		
	Inside	Outside	Total
Summit Pass and Jumbo	3,135	4,277	7,412
Wamp Spring	1,028	8,823	9,851
Total	**21,023**	**23,460**	**44,483**

* Opportunistic survey area.

Table 3-2. Surveyed acreage at general survey areas by habitat model rating.

General Survey Area	Surveyed Acres by Habitat Model Rating			Total
	Marginal	Suitable	Optimal	
Azure Ridge North	284	551	1,321	2,156
Christmas Tree Pass	1,515	961	-	2,475
Gann/Walker Spring*	36	15	68	119
Indian Ridge	342	112	-	453
Lucy Grey Mountains	1,156	1,034	1,558	3,748
McCullough Mtns North	1,040	6	-	1,045
McCullough Mtns South	1,565	2,163	257	3,984
Mormon Mountains	649	342	432	1,423
Peak 1902/Peak 1859	352	171	-	523
Railroad Springs	688	1,597	29	2,314
Summit Pass and Jumbo	763	2,058	3,712	6,533
Wamp Spring	2,167	1,981	311	4,459
Total	**10,555**	**10,990**	**7,687**	**29,233**

* Opportunistic survey area.

Table 3-3. Acreage of modeled suitable habitat surveyed inside and outside general survey area polygons.

General Survey Area	Surveyed Acreage Inside				Surveyed Acreage Outside				Total
	Marginal	Suitable	Optimal	Unmodeled	Marginal	Suitable	Optimal	Unmodeled	
Azure Ridge North	74	366	425	65	210	186	895	152	2,374
Christmas Tree Pass	1,440	926	-	549	75	35	-	393	3,416
Gann/Walker Spring*	-	-	-	-	36	15	68	-	119
Indian Ridge	342	111	-	625	-	-	-	1,044	2,122
Lucy Grey Mountains	826	843	1,412	317	330	191	146	859	4,924
McCullough Mtns North	823	-	-	285	217	6	-	533	1,863
McCullough Mtns South	1,148	1,599	248	48	416	564	8	520	4,552
Mormon Mountains	616	323	402	792	34	18	30	1,534	3,749
Peak 1902/Peak 1859	340	168	-	337	12	2	-	391	1,251

General Survey Area	Surveyed Acreage Inside				Surveyed Acreage Outside				Total
	Marginal	Suitable	Optimal	Unmodeled	Marginal	Suitable	Optimal	Unmodeled	
Railroad Springs	491	843	-	77	197	754	29	459	2,850
Summit Pass and Jumbo	375	952	1,569	239	388	1,106	2,143	640	7,412
Wamp Spring	484	288	-	256	1,683	1,693	311	5,136	9,851
Total	**6,957**	**6,420**	**4,056**	**3,590**	**3,598**	**4,570**	**3,631**	**11,661**	**44,483**

* Opportunistic survey area.

3.2 Blue Diamond Cholla (*Cylindropuntia multigeniculata*) Occurrences

Blue Diamond cholla was found at Jumbo, Summit Pass, and Wamp Spring general survey areas and at the opportunistic survey area, Gann/Walker Spring (Table 3-4, and Figures B-3, B-11, B-12, and B-13 in 8.Appendix B). The total occupied area included 5,153 ac and an estimated 52,068 individuals. Blue Diamond cholla was first documented in 2021 at Summit Pass survey area with an estimated 14,000+ individuals, but the occupied habitat and estimated number of individuals were expanded during 2023 surveys. This increased the estimated number of individuals at this site by 34,000 plants; 2486.3 occupied acres were added to the known distribution of Blue Diamond cholla at this site in 2023. Due to the extensive size of the occupied area at Wamp Spring and Summit Pass, the field team focused on identifying the boundaries of the occupied habitat. The total number of individuals within the occupied habitat at each location was a conservative estimate based on surveyor tallies and extrapolation using average density in occupied areas. The mean elevation range across occurrences was 787 to 1,573 m (2,582 to 5,160 ft). Common associated species included blackbrush (*Coleogyne ramosissima*), cat claw acacia (*Senegalia greggii*), creosote (*Larrea tridentata*), ephedra (*Ephedra* spp.), Mojave yucca (*Yucca schidigera*), and red brome (*Bromus rubens*).

The overall quality of each occurrence varied from fair to good. The main variables impacting habitat quality were evidence of wildfire and significant presence of annual invasive plants. Less common variables included impacts (e.g., trampling and presence of annual invasive plants) likely attributable to wild burro and livestock.

Table 3-4. The 2023 survey occurrence summary for Blue Diamond cholla (*Cylindropuntia multigeniculata*).

Taxon	Project-specific Internal EO No.	Survey Area	Modeled Habitat Suitability	Area Occupied (ac)	No. Individuals	Overall Occurrence Quality	Mean Elevation (m)	Within 0.5 mi of Existing EO?
Blue Diamond cholla (*Cylindropuntia multigeniculata*)	2015	Wamp Spring	Not Modeled, Marginal, Suitable, Optimal	884.8	4,000+	Fair - Good	1,573	No
	2031	Gann/Walker Spring	Marginal	0.003	2	Fair	818	No
	2085	Gann/Walker Spring	Marginal	2.8	3	Fair	901	No
	4007	Summit Pass	Not Modeled, Suitable, Optimal	3,487.8	48,000+	Good	890	Yes
	6000	Jumbo	Optimal	776.3	62	Good	1,002	No

Taxon	Project-specific Internal EO No.	Survey Area	Modeled Habitat Suitability	Area Occupied (ac)	No. Individuals	Overall Occurrence Quality	Mean Elevation (m)	Within 0.5 mi of Existing EO?
	7020	Gann/Walker Spring	Optimal	1.9	1	Fair	787	No
Summary			**Not Modeled - Optimal**	**5,153.6**	**52,068+**	**Fair – Good**	**995**	

3.3 Incidental Rare Plant Occurrences

Halfring milkvetch (*Astragalus mohavensis* var. *hemigyrus*) was found opportunistically while surveying for Blue Diamond cholla at the Indian Ridge survey area and three EO records were produced (Table 3-5, Figure B-4 in 8.Appendix B). There was no habitat model provided by the DCP for this taxon. The total occupied area included 0.4 ac and a total of 61 individuals. The mean elevation range across occurrences was 1,375 to 1,530 m (4,511 to 5,020 ft). Common associated species included desert mallow (*Sphaeralcea ambigua*), red brome (*Bromus rubens*), and shadscale (*Atriplex confertifolia*).

The overall quality of each occurrence varied from fair to good. The main variable impacting habitat quality was the presence of the annual invasive red brome within occupied habitat.

Table 3-5. The 2023 survey occurrence summary for halfring milkvetch (*Astragalus mohavensis* var. *hemigyrus*).

Taxon	Project-specific Internal EO No.	Survey Area	Area Occupied (ac)	No. Individuals	Overall Occurrence Quality	Mean Elevation (m)
Halfring milkvetch (*Astragalus mohavensis* var. *hemigyrus)*	1018	Indian Ridge	0.2	42	Good	1,527
	1019	Indian Ridge	0.2	18	Fair	1,530
	4059	Indian Ridge	0.0002	1	Good	1,375
Summary			**0.4**	**61**	**Fair-Good**	**1,477**

4. Discussion

4.1 Expanded Range of Blue Diamond Cholla

Ironwood's survey efforts have expanded the known range of Blue Diamond cholla across Clark County, pushing the existing distribution both north and east. The northern extent of the known range now occurs just 16 km south of Lincoln County, NV. The easternmost extent was extended to just a few km from the Arizona border. Two of the occurrences newly documented by Ironwood since 2021 that occur near the Clark County boundary are expansive both in population size and population extent. This suggests there is potential for the discovery of additional occurrences in under-surveyed habitat across both state and county lines. While Blue Diamond cholla has been documented across a handful of occurrences in west-central and northwest Arizona, Clark County harbors the majority of known occurrences and populations.

4.2 Hybridization and Morphological Variation in Blue Diamond Cholla

Plants with intermediate morphology between Blue Diamond cholla and buckhorn cholla (*Cylindropuntia acanthocarpa*) are frequently observed where the two taxa co-occur. These putative hybrids are similar morphologically to silver cholla (*Cylindropuntia echinocarpa;* Baker and Cloud-Hughes 2014). Despite the resemblance of hybrid individuals to silver cholla, no morphological intermediates between Blue Diamond cholla and silver cholla have been documented.

The spiny fruit character in Blue Diamond cholla varies geographically, where fruit generally transition from non-spiny to spiny moving from west to east (Baker 2016). Plants lacking spines on the fruit occur in the Desert National Wildlife Refuge and Blue Diamond populations while plants with the spiniest fruit occur in Gold Butte National Monument and Arizona (Photo C-1 and Photo C-7). Populations with intermediate fruit types typically occur in the region between. It is unclear whether the variation in fruit morphology is the result of past hybridization, recent adaptation to arid conditions, or an evolutionary divergence of populations over time. Blue Diamond cholla cacti with spineless fruit are most likely to be confused with Whipple cholla (*Cylindropuntia whipplei*), while plants with spiny fruit can be mistaken for silver cholla. Therefore, care must be taken to use a combination of morphological characters when making a positive identification of Blue Diamond cholla where range overlap occurs.

4.3 Potential Threats to Blue Diamond Cholla

Road construction and mining have been historically cited as having prominent impacts to Blue Diamond cholla populations (NatureServe Explorer 2024). Additional threats include gypsum mining and illegal horticultural collection, but most documented occurrences are on federally protected lands and in remote areas, suggesting these are not pervasive threats.

Wildfire and competition with annual invasive plants were the most frequently cited threats to Blue Diamond cholla occurrences documented during Ironwood's rare plant surveys for the DCP between 2020 and 2023. Wildfires have impacted populations within the Desert National Wildlife Refuge (2006 Vegas fire) and Gold Butte National Monument (2005 Tramp and Fork fires) across extensive areas of occupied habitat.

In recent decades, fire size and frequency have reached unprecedented levels in the southwestern United States resulting, in part, from the increased presence and density of invasive annual plants and the invasive annual grass/fire feedback cycle (Shryock et al. 2015). Annual invasive plants produce fine fuel loading capable of sustaining large-scale wildfires, particularly during years of high rainfall. The populations of perennial plants not adapted to fire can subsequently be diminished or eliminated. While Shryock et al. (2014) found that forbs and grasses were consistently more abundant in burned areas post-fire, cacti were consistently reduced by fire. Additional traits that may limit post-fire regeneration in cacti are that they typically do not survive direct fire impacts due to tissue desiccation, they typically do not have persistent seed banks, and their seeds experience relatively high mortality rates during fires (Shryock et al. 2014; Esque et al. 2010). Parmenter(2008) found that juvenile cholla had especially high mortality rates post-fire. Because cacti are not generally known to have persistent soil-stored seed banks, their reproductive potential mainly exists in their live canopies.
This combination of traits may leave Blue Diamond cholla populations susceptible to significant losses from medium- to high-intensity wildfires and/or repeatedly burned areas with short fire intervals.

Ironwood botanists anecdotally observed some recovery (recruitment) of Blue Diamond cholla in burned habitat within the survey areas. Also notable was the observed occupation of often mature Blue Diamond cholla in habitat refugia such as cliff bands and rocky areas that were apparently unburned or burned under low-severity conditions. Future research to study the short- and long-term effects of fire and competition with invasive annual plants and their habitat would provide clarity about whether the current fire regime is a significant threat. This research, in combination with additional surveys across county and state lines for undocumented populations, would also help clarify conservation implications and guide future management decisions for Blue Diamond cholla.

Blue Diamond cholla was listed as "critically endangered and threatened with extinction" in the State of Nevada in 2001. Four years later a status report was written to help the U.S. Fish and Wildlife Service determine if offering protections under the Endangered Species Act was warranted (Baker 2005). The status report stated the known population estimate at 56,500 individuals range-wide. We report nearly that number (38,068+) of additional plants now known to science due to our field efforts in 2023 - it should be stressed that we consider our estimates to be conservative. This new information should guide the process of reassessing whether the species is yet in need of State of Nevada and Clark County Multiple Species Habitat Conservation Plan protections. De-listing or downgrading of listing level could be warranted when all data is compiled and reviewed by a rare plant technical committee.

5. Conclusion

Ironwood field surveys for Blue Diamond cholla in 2022 and 2023 covered more than 67,377 total acres, which included 41,908 acres of modeled habitat. These field surveys have significantly contributed to the known distribution of Blue Diamond cholla in Clark County, Nevada, by documenting five EO records that added more than 38,000 previously undocumented plants across more than 4,152 acres of occupied area. These survey results contribute both positive and negative survey data to the DCP and NDNH and can be used to refine the existing habitat suitability model and inform resource management decisions.

6. Recommendations

Future research on short- and long-term fire and invasive annual plant impacts to Blue Diamond cholla would help guide future management and conservation decisions impacting this plant. Future research could include establishing long-term monitoring plots within occupied habitat in both burned and adjacent unburned areas. The burned habitat in the Desert National Wildlife Refuge and Gold Butte National Monument are two candidate locations for establishing plots. Tracking variables such as germination, census of Blue Diamond cholla individuals, age structure, and plant cover (including invasive annuals) over time would help fill in knowledge gaps about the impacts and level of resilience this cactus has to fire and increased presence of annual invasives.

Ironwood surveys significantly expanded the documented habitat within Clark County, making it more common within the County that previously known. However, its global range is limited to Clark County, Nevada; the western edge of Mohave County, Arizona; and a single occurrence in La Paz County, Arizona. While there is potential for discovery of undocumented occurrences in Lincoln County, Nevada and western Arizona, Clark

County harbors most of the occupied habitat and total population. We recommend a formal review of all Blue Diamond cholla occurrence records by a rare plant technical committee to determine if its State and County listing status is currently appropriate.

7. List of Preparers and Contributors

7.1 Clark County Desert Conservation Program

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Appendix A: BLM and NDNH Rare Plant Survey Field Methodologies

BLM Rare Plant Sampling Methods

Botanical surveys should be conducted in a manner that will locate any special status or locally significant plants or plant communities that may be present. Specifically, botanical surveys should be:

- Conducted in the field at the proper times of year when special status and locally significant plants are both evident and identifiable. When special status plants are known to occur in the type of habitat present in the project area, nearby accessible occurrences of the plants (reference sites) should be observed to determine that the plants are identifiable at the time of survey.
- Floristic in nature. A floristic survey requires that every plant observed be identified to species, subspecies, or variety, as applicable. To properly characterize the site, a complete list of plants observed on the site shall be included in every botanical survey report. In addition, a sufficient number of visits spaced throughout the growing season is necessary to prepare an accurate inventory of all plants that exist on the site. The number of visits and the timing between visits must be determined by geographic location, the plant communities present, and the weather patterns of the year(s) in which the surveys are conducted.
- Conducted in a manner that is consistent with conservation ethics and accepted plant collection and documentation techniques4,5. Collections (voucher specimens) of special status and locally significant plants should be made, unless such actions would jeopardize the continued existence of the population. A single sheet should be collected and deposited at a recognized public herbarium for future reference. All collections shall be made in accordance with applicable state and federal permit requirements. Photography may be used to document plant identification only when the population cannot withstand the collection of voucher specimens.
- Conducted using systematic field techniques in all habitats of the site to ensure thorough coverage of potential impact areas. All habitats within the project site must be surveyed thoroughly to properly inventory and document the plants present. The level of effort required per given area and habitat is dependent upon the vegetation and its overall diversity and structural complexity.
- Well documented. When a special status plant (or rare plant community) is located, a California Native Species (or Community) Field Survey Form or equivalent written form, accompanied by a copy of the appropriate portion of a 7.5-minute topographic map with the occurrence mapped, shall be completed, included within the survey report, and separately submitted to the California Natural Diversity Database. Population boundaries should be mapped as accurately as possible. The number of individuals in each population should be counted or estimated, as appropriate.

Field Survey – Methodology

Field surveys will be floristic in nature; i.e., the contractor identifies every plant taxon observed in the project area to the taxonomic level necessary to determine rarity and listing status. Surveys will be conducted so they will ensure a high likelihood of locating all the plant taxa in the project area. The survey must be focused solely on plants – an individual should not combine multiple survey elements (e.g., tortoise, other wildlife, etc.). Depending on the size of the project area and the heterogeneity of the habitats within the project area, surveys will involve one or a combination of the following survey methods:

Complete Survey

A complete survey is a 100% visual examination of the project area (Figure A- 1) using transects. The length of the transect and distance between transects might change as the topography changes throughout the project area. Transects should be spaced so all of the area between transects is visible and so the smallest rare plant expected to occur is visible. The surveyor (1) compiles a species list while traversing the project area and keeps track of the plant community or habitat type where each taxon occurs; (2) maps the locations of all rare taxa encountered using a GPS unit; and (3) fills out a NNHP Nevada Native Species Site Survey Report (http://heritage.nv.gov/sites/default/files/other_docs/surv_pdf2013.pdf) for each location of each rare taxon encountered.

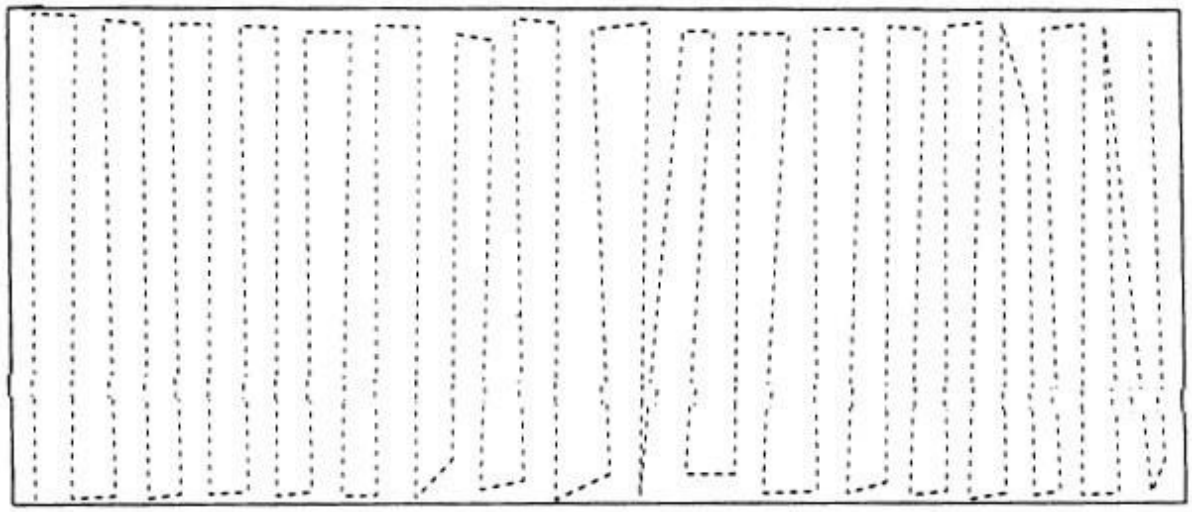

Figure A- 1. Complete survey.

Intuitive Controlled Survey

An intuitive controlled survey is a complete survey of habitats with the highest potential for supporting rare plant populations and a less intensive survey of all other habitats present. This type of survey can only be accomplished by botanists familiar with the habitats of all the plant species that may reasonably be expected to occur in the project area. The botanist traverses through the project area enough to see a representative cross section of all the major plant habitats and topographic features. During the survey, the botanist compiles a species list of all plant taxa seen en route and keeps track of the plant community or habitat type where each taxon occurs. The surveyor maps the locations of all rare taxa encountered using a GPS unit and fills out a NNHD Nevada Native Species Site Survey Report (http://heritage.nv.gov/sites/default/files/other_docs/surv_pdf2013.pdf) for each location of each rare taxon encountered. When the surveyor arrives at an area of “high potential” habitat, s/he surveys that area completely as described above and shown in Figure A- 1. High potential habitat areas include areas defined in a pre-field review of potential rare plants and habitat and other habitats where a rare species appears during the course of initial field work traversing the project area. Areas within the project area that are not the focus of a complete survey must be surveyed sufficiently so the botanist and BLM reasonably believe that few if any additional species would be added to the complete species list for the project area. The report must justify why the botanist did not consider these areas to have a high potential for supporting rare plant species and thus did not subject the area to a complete survey.

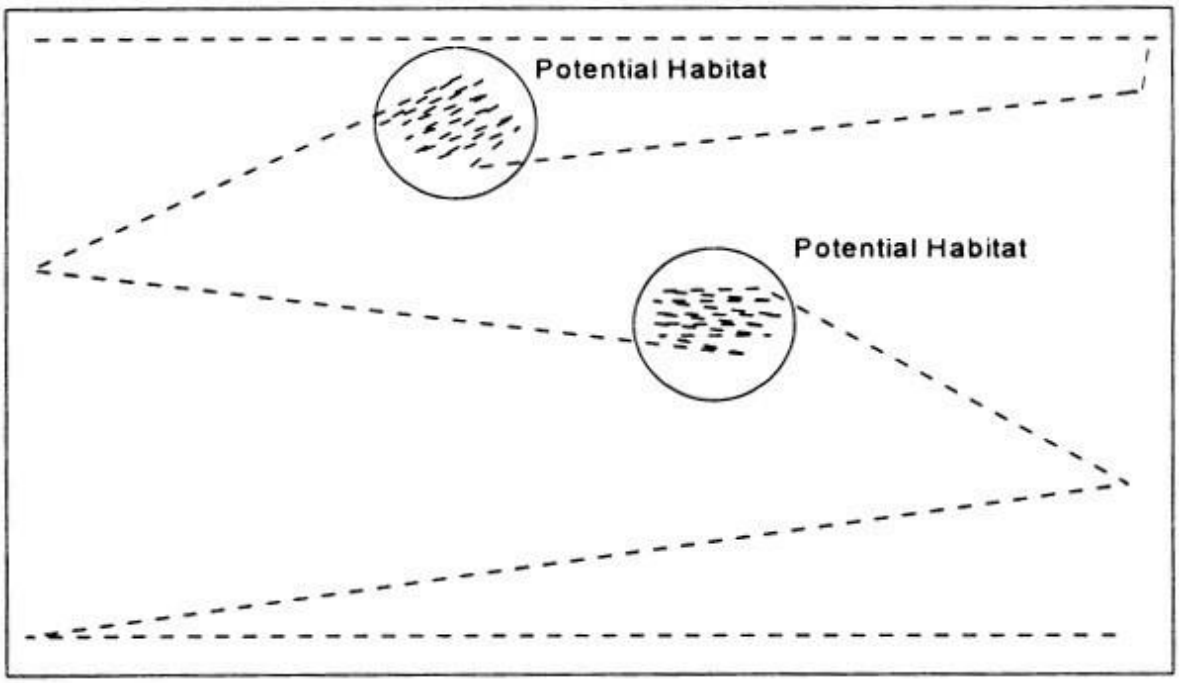

Figure A- 2. Intuitive Controlled Survey.

Documenting the Results of Surveys

The results of special status plant inventories should be well documented. This documentation must include, as a minimum, the completion and submission of Field Survey Forms and shapefiles/geodatabases of all special status plants found by BLM personnel or consultants.

Occurrences are defined as being separated from other plant locations by 0.25 mile. These forms are submitted to the BLM Southern Nevada District Office Botanist.

Most special status plant inventories of public lands conducted to assess the impacts of a project are performed by consultants hired by project proponents. These inventories must meet or exceed the intensity level required for the project by BLM. Personnel conducting the inventory must meet the qualifications outlined in this document. For BLM to adequately determine the quality of third-party inventories, the following information must appear in a detailed report to BLM from the consultant or project proponent.

- Project description:
  - Detailed map of the project location and study area.
  - Direct and indirect actions that may impact the special status plant communities.
  - Acreage of proposed disturbance and buffer area acreage of anticipated indirect impacts.
- Plant communities:

  A written description of the biological setting, including descriptions of the plant communities found in the project area and a vegetation map. Plant communities should be described and mapped to at least the alliance level using the vegetation classification system of the Nevada Natural Heritage Program (Heritage). A list and description of the alliances currently recognized by Heritage can be found at: http://heritage.nv.gov/node/174.

- Pre-project review:
  - Describe the intensity of the review process.
  - Identify which known populations were visited, which flora were used to identify the species, what experts were consulted, and which herbaria were visited.
  - If soil surveys were used to determine suitable habitat, include those references.
  - Identify which reference populations were visited, the timing of those visits, if rainfall patterns and temperatures were identified for the area from the nearest available weather station, and if any other climatic conditions were taken into account.
  - Identify which resources were used to identify target special status plants in the project area.
- Survey methodology:
  - A detailed description of the inventory methodology, including techniques and intensity of the inventory.
  - Distance(s) between transects throughout the study area, and how those distances were justified.
  - The methodology of special status plant identification (in the field or in a lab) and if the plant was sent to a specialist to be identified, which characteristics distinguished the plant from look-alikes in the area).
  - Maps showing areas searched. This will also include areas searched but no special status plants found (negative survey data).
  - Identify type of GPS unit used.
- Survey timing:
  - How inventory timing was determined.
  - Exact dates of all the surveys and which special status plants were identified on those dates.
  - Timing of visits to reference populations.
- Survey results:
  - The type and number of special status plants identified.
  - Phenological stage(s) the special-status plant was in when identified.
  - Habitat, soil type, vegetation type, and associated species of the special status plant
  - Population boundaries.
  - Condition of the population (disease, predation, etc.).
  - Current threats to the population (off-road vehicles, erosion, non-native species, etc.).
- Discussion:

  The assessments of the health, population size, and protective status of any special status plants found. A discussion of any range extensions discovered as a result of the survey. A discussion of the significance of any special-status plant occurrences found, with consideration of other nearby occurrences and the distribution of the species as a whole.

- Contractor qualifications:
  - The name(s) and qualifications of the persons conducting the surveys.

  - Include a copy of the email or letter for contractor approval for each surveyor.
- References:
  - List of references cited.
  - Persons contacted.
  - Herbaria or reference sites visited.
- Data:
  - Copies of field data forms.
  - Photos.
  - Maps (special status plant locations, survey areas, vegetation maps).
  - Shapefiles (special status plants, negative survey areas, total area surveyed).
  - Plant vouchers.
  - Any site-specific additional information required by contractor.
  - Voucher specimens of special-status plants should be collected if necessary to conclusively document the occurrence of the species and if the collection will not adversely affect the health of the population at the site. Collection of federally listed plants on federal lands requires a permit from the Fish and Wildlife Service. If voucher specimens are collected, they should be deposited in major recognized herbaria for future reference.
  - Photographs should be taken of the areas inventoried, of all special status plants found (including of identifying characteristics of special-status plants, or look-alikes), and of the habitat associated with each special status plant occurrence.

Data Collection – Data Submission

Data should be collected using a Mapping Grade GPS Receiver with an accuracy of < 3 meters Horizontal Root Mean Squared (HRMS).

All positions should be logged according to the following specifications:

- Maximum PDOP of 6.
- Minimum of 5 Satellites.
- Minimum elevation mask of 15 degrees.
- Datum: NAD83.
- Coordinate System: UTM Zone 11.
- ESRI compliant formats (Geodatabase, Coverage or Shapefile).

Metadata must be included with the data. The following must be included in the metadata:

- Project Name.
- Purpose – Summary of the intentions with which the data set was developed.
- Abstract Information – Brief narrative summary of the data set.
- Location – What area(s) does your data cover? i.e., list statewide, regions, city, county.

- Developer – Who collected the data?
- Data Dictionary – A data dictionary must be used for all projects. The dictionary should include the data that is requested on the Heritage forms. This ensures that the botanist is collecting (electronically) the same data as is requested by DFG. This also ensures that all inventories are collecting the same level/standard of data. An example of the data dictionary and metadata standard can be found at http://heritage.nv.gov/gis under "Species Data: Sample of At-risk Species Occurrence Records."

Qualifications of Personnel Conducting Inventories

All persons conducting special status plant inventories MUST be approved by the contracting agency prior to surveys taking place.

All personnel conducting special status plant inventories must have the following:

- Strong backgrounds in plant taxonomy and plant ecology
- Strong background in field sampling design and methods
- Knowledge of the floras of the survey area including the special status plant species
- Familiarity with natural communities of the area
- Familiarity with state and federal laws and agency policies that pertain to rare plant protection

These qualifications help ensure that all special status plants in the survey area will be located, including taxa that BLM or project proponents did not predict at the start of the inventory. All survey efforts must be coordinated with the BLM botanist. Approvals for changes to protocols or other survey methodology must be approved in writing by the BLM botanist.

Nevada Division of Natural Heritage Standard Field Survey – Methods

Pre-Survey Preparation

- Select species of interest:
  - If the project does not specify which plants to survey for, search a large surrounding area to identify any species that may be present in the survey area. Use county species lists to identify species that may be present.
  - If the project does specify particular plants, keep in mind other rare plants that may be found in the same location as the target species and be familiar enough with them to identify them if encountered.
- Review species file:

  Prior to beginning field surveys, review the species file to familiarize yourself with the biology of the target species. All surveyors should particularly note the following:

  - Key identifying features. This usually flowers and fruits but may include leaves, stems, bulbs, or other parts.

  - Phenology as it corresponds to those features. For example, if flowers are needed to positively identify the plant, when does the plant normally bloom?
  - Distinctive habitat features. If the plants are found on a particular soil type or in association with particular vegetation this should be noted and used in section 1.c.ii.

- Review reported locations

  Thoroughly review information regarding previously documented locations prior to field visits. The quality of data varies from very old herbarium records with very inaccurate location data to recent surveys with high precision GPS data.

  - Chose locations to visit based on the reason for the survey. For a re-survey of a known location, use data from all available dates to note changes over time at that location. For survey an area that does not have documented populations, plan to visit nearby sites using the most recent data to verify phenological stage and form a search image.
  - If the purpose of the visit is to more precisely map an old, inaccurate location, note inconsistencies in the location description that lead to a larger search area. For very old collections that use road names and mileage to describe the location, review old highway atlases and aerial imagery to account for changes in road names/numbers and possible road realignments.

- Prepare maps

  Maps should include all of the features necessary for finding the plant location. Include primary and alternate access routes in case the road is impassable on your selected route. Note potential hazards such as stream crossings and private land which may have locked gates.

  - Reported locations

  Prepare paper or electronic maps that include both the mapped location plus any locational uncertainty (See Biotics website for locational uncertainty mapping methodology http://www.natureserve.org/prodServices/biotics/biotics-learn-more.jsp#method)

  - Habitat features

    If the survey includes searching for a poorly documented location or general surveys for rare plants in a previously undocumented area, highlight areas of potential habitat on the maps. A quick model for guiding surveys can be produced by mapping the intersection of the known elevation band with distinctive habitat features such as soil and vegetation types that the plant is known to occupy.

- Contact the landowner for permission before surveying on private land or public land that is subject to travel restrictions, such as wildlife refuges and state parks.

Field Surveys

Conduct surveys in a manner that is safe and consistent with accepted plant collection and documentation techniques.

- **Vehicle travel**

- When travelling in vehicles, state employees must adhere to the policies in the State of Nevada Motor Pool Division Vehicle use Handbook, the State Administrative Manual, and state driving laws.
- State employees must also have a current Defensive Driving certificate on file.
- Carry adequate safety equipment for emergencies including a fire extinguisher, shovel, emergency supplies backpack, first aid kit, list of county emergency dispatch phone numbers, and the satellite phone if traveling outside of cell phone coverage areas.

- **Foot travel:**
  - Be familiar with hazards associated with outdoor work. See http://www.cdc.gov/niosh/topics/outdoor/ to review potential Physical and Biological hazards that may be encountered outdoors.
  - Wear appropriate protective clothing such as a wide-brimmed hat, long sleeves and pants, and boots or closed toe shoes to avoid sunburn, thorns, poisonous plants and animals, and insect bites.
  - Carry adequate water, first aid kit, and communication devices when traveling more thana few minutes' walk from the vehicle.

- **Search methods**
  - Census or re-survey of a well-documented location.
    - ✓ Plan out a search method that is appropriate for the goals of the survey.
      - If a census is desired, divide populations into smaller sections to reduce error in counting.
      - If a complete census is not feasible, use the methods outlined in "Instructions for Estimating Patch Density."
      - Refer to project guidelines if using a particular transect method or duplicating previous surveys.
      - Decide beforehand whether it is more appropriate to collect point locations of individual plants or polygon locations.
      - Document evidence of threats and changes in biological processes as these factors are important in determining species ranks.
    - ✓ Search method should be able to accurately locate plants in their environment. For small plants or dense vegetation, areas should be searched very closely and thoroughly. For larger plants or very sparse vegetation, walking more widely spaced transects may be appropriate.
    - ✓ For widely scattered plants, it may be helpful to flag or mark plants or patches to avoid double counting.
  - Locating a poorly documented population.
  - Familiarize yourself with the target plant(s).
    - ✓ Visit a known location of the target species to observe the current phenology of the plants. Pay careful attention to non-flowering individuals as these may be encountered without flowering individuals nearby. Note particular habitat or vegetation affinities that may help in locating new populations. If the plant is very unfamiliar, make sure you can identify the key features that

distinguish it from other species. When visiting any known population, take a few notes and photographs and submit a Species Survey Report.

- ✓ Keep in mind other rare plants that may be found in the same location as the target species and be familiar enough with them to identify them if encountered.
- ✓ Travel to the approximate documented location. Take into account ambiguous landmarks or directions that may lead to other sites.
- ✓ If the habitat is appropriate, search the immediate area in a spiral pattern, adjusting for terrain and vegetation if necessary. Multiple surveyors can divide the search area to work more quickly.
- ✓ If the habitat is not appropriate, search the surrounding area for suitable habitats. Use maps from 1.C.ii to locate suitable landforms and vegetation types. Repeat search pattern in suitable habitats.
- ✓ If search is not successful, repeat steps 2-4 in any alternate locations that the directions could refer to.
- ✓ If there are multiple areas of suitable habitat within the area of locational uncertainty, search several, even if plants are located. Don't assume that the first population encountered is the one referred to in the original collection.

- **Searching an undocumented area for rare plants**

  - ✓ Familiarize yourself with the target plant(s).

    - Visit a known location of the target species to observe the current phenology of the plants. Pay careful attention to non-flowering individuals as these may be encountered without flowering individuals nearby. Note particular habitat or vegetation affinities that may help in locating new populations. If the plant is very unfamiliar, make sure you can identify the key features that distinguish it from other species.
    - Travel around the area of interest and identify areas with suitable habitats for rare plants. You can informally rank by decreasing suitability in order to prioritize search areas.
    - Search suitable habitat areas, adjusting the size and walking speed of transects to account for plant size and vegetation density.

  - ✓ Verifying plant identity

    - If you are unfamiliar with the target species, carry along a key (or copies of the relevant sections) and photographs to aid in identification. Use step 2.c.ii.(1) to observe the plant at a known location and familiarize yourself with the current phenological stage. Plants can appear very different from drawings and photos as juveniles or during drought years.
    - If there are multiple species present and you are unable to determine which plant is the target species, thoroughly document and collect each species to submit to an expert for identification.
    - xii) For new locations, collect voucher specimens to submit to a herbarium. See 2.e.iv.(1).

- **Documentation**

  Adequate documentation is essential to the survey process. Without documentation the work cannot be used by others.

  - Notes

  Take notes in a field notebook, survey form, or electronic format. Notes should include observations about both the target species and the environment. See the Nevada Native Species Survey Report for a list of types of we collect data.

  - ✓ Phenology, associated species, and habitat description are very useful for searching for the species in the future.
  - ✓ Threats, changes in biotic and abiotic processes, pollinator types and numbers, and population count or estimate are all helpful in ranking the viability of the occurrence and species.

- **GPS**
  - Learn how to use the equipment and store the appropriate data before going out to survey for plants. Set a datum that is appropriate for the project. The standard NNHP datum is now UTM NAD83 Zone 11N.
  - Carry all of the accessories needed to use the device, including data cables, chargers, and spare batteries. For remote work where power is not available, consider a solar charging unit.
  - Decide beforehand whether it is more appropriate to collect point locations of individual plants or polygon locations.
  - Store the data in a way that is not easily confused, either by using unique names for points or by keeping good notes about data collected.
  - If using the GPS to geotag photographs, turn on the track log and synchronize the time on the camera and/or photograph the time display on the GPS.
- **Camera**
  - Learn how to use the equipment and store the appropriate data before going out to survey for plants.
  - Carry all of the accessories needed to use the device, including data cables, chargers, and spare batteries. For remote work where power is not available, consider a solar charging unit.
  - If using the GPS to geotag photographs, synchronize the time on the camera and/or photograph the time display on the GPS.
  - Take photos of details useful for identifying the plants. Know the key characteristics and try to show them in the photos.
  - Take photos of the habitat, in particular any unique or unusual habitat features or evidence of threats.
  - If using the photos to document plant locations (by geotagging) try to take consistent photos by holding the camera at the same height and angle each time. Try to stand as close to the plant as possible and avoid shading the plants with your body or the camera.

- **Voucher Specimens:**
  - For new locations, collect voucher specimens to submit to a herbarium. See http://www.ibiblio.org/unc-biology/herbarium/courses/chpt18.html for more information about collecting specimens for submission to a herbarium. Key points include :

    ✓ Collect material appropriate for identifying the species.
    ✓ Store and press the material in a way that avoid excessive damage to the plant tissues and makes the parts that are important for identification easy to find.
    ✓ Label specimens with location information and date.
    ✓ Note and/or photograph flower color or three dimensional shapes that will be lost by pressing.
    ✓ Do not collect more than 5% of the plants at a site (1 out of 20). For very small populations, collect only enough material to identify the species (i.e., collect a small piece of the stem with a few leaves or flowers instead of collecting the entire plant) OR take detailed photographs of the diagnostic parts of the plant.

  - If there are multiple species present and you are unable to determine which plant is the target species, thoroughly document and collect each species to submit to a specialist for identification.
- **Post-Survey Documentation**
  - Transcribe notes:

    ✓ Transcribe any paper notes into the Species Survey Report form.
    ✓ Review electronically collected notes for errors soon after the survey.

  - Review GPS data:

    ✓ Download data and make a backup copy.
    ✓ Apply differential correction to points if higher accuracy is desired.
    ✓ Export to a shapefile for use in Biotics.

  - Review Photographs:

    ✓ Download photos and make a backup copy.
    ✓ Use PhotoTracker, RoboGeo, or Microsoft Pro Photo Tools to geotag photos, adjusting the time and date of the photo if necessary to match the GPS track.
    ✓ Tag photos with keywords including: Scientific and common names and EST_ID of species in the photo, project name (if any), location name.
    ✓ Use caption field to describe anything special about the subject of the photo.
    ✓ Copy the photos to an appropriate location on the T:// drive for inclusion in the photo library. Send Janel an email if any of the new photos should be added to the website.
    ✓ Post good qualit photos to public online repositories such as CalPhotos. For species that are very rare or subject to poaching (such as cacti) avoid giving detailed location data or posting photos with recognizable landmarks.

  - Enter data into Biotics:

    ✓ See documentation at Natureserve.com and NNHP Mapping Methodology Manual.

References and Additional Resources

California Native Plant Society Survey Guidelines.
http://www.cnps.org/cnps/rareplants/pdf/cnps_survey_guidelines.pdf

Natureserve Mapping and Ranking Methodology http://www.natureserve.org/prodServices/bio gtics/biotics-learn-more.jsp#method

NNHP Nevada Native Species Survey Report forms and other forms http://heritage.nv.gov/submit

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Centers for Disease Control. NIOSH Workplace Safety and Health Topics. Hazards to Outdoor Workers. http://www.cdc.gov/niosh/topics/outdoor/

Appendix B: Survey Site Maps

Appendix C: Survey Site and EO Representative Photos

Photo C-1. Wamp Spring survey area - Blue Diamond cholla diagnostic photo (with spineless fruit).

Photo C-2. Wamp Spring survey area - Blue Diamond cholla in habitat.

Photo C-3. Wamp Spring survey area - burned habitat.

Photo C-4. Wamp Spring survey area - burned habitat with young Blue Diamond cholla.

Photo C-5. Gann/Walker Spring survey area - Blue Diamond cholla diagnostic photo.

Photo C-6. Gann/Walker Spring survey area - Blue Diamond cholla in habitat.

Photo C-7. Gann/Walking Spring survey area - Blue Diamond cholla with spiny fruit.

Photo C-8. Jumbo survey area - Blue Diamond cholla diagnostic photo.

Photo C-9. Jumbo survey area - Blue Diamond cholla in habitat.

Photo C-10. Indian Ridge survey area - halfring milvetch diagnostic photo.

Photo C-11. Indian Ridge survey area - halfring milkvetch plant.

Photo C-12. Indian Ridge survey area - halfring milkvetch plant.