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Status survey for endangered Bakersfield cactus

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Bakersfield cactus (*Opuntia basilaris* var. *treleasei*) is endemic to the southeastern corner of the San Joaquin Valley, California. Populations of Bakersfield cactus continue to be lost due to conversion of habitat to agricultural and urban uses. We conducted a status survey of sites with Bakersfield cactus based on occurrence records from the California Natural Diversity Database (CNDDB). Of the 39 sites in the CNDDB (30 presumed extant and 9 presumed extirpated), we visited 33 and examined aerial photography or conducted aerial surveys of the remaining sites. Based on our surveys, 25 populations were confirmed extant, 11 are believed to be extirpated, and the status of 3 could not be determined. Furthermore, two previously unreported populations were documented, and six undocumented translocated populations were identified. Of 33 sites with Bakersfield cactus, 27 occur entirely or partly on private lands. For the 27 naturally occurring extant populations, estimated size ranges from 2 to over 11,000 plants, but 16 (59%) populations have 100 plants or fewer. Habitat conditions within extant populations ranged from relatively undisturbed to highly disturbed, and remaining populations are fragmented and generally occur on small parcels. Only four entire populations and parts of eight others are permanently conserved. Based on the reduced number of extant populations and the reduced number of plants within many populations, Bakersfield cactus appears to be declining on multiple landscape scales. Conservation needs include the permanent conservation of additional populations, increased protections from impacts, vegetation management within populations, increasing the number of populations and the number of plants within populations, a population viability analysis, surveys for additional populations, and outreach programs.

Key words: Bakersfield cactus, endangered species, habitat loss, *Opuntia basilaris* var. *treleasei*, San Joaquin Valley, status survey

Bakersfield cactus (*Opuntia basilaris* var. *treleasei*) is endemic to the southeastern corner of the San Joaquin Valley of central California. This taxon historically occurred from just north of Bakersfield south to the Wheeler Ridge area at the southern end of the valley; cactus populations may have been more or less continuous within this area. Many sites with Bakersfield cactus have been converted to agricultural or urban uses (U.S. Fish and Wildlife Service 1998, 2011). Extant Bakersfield cactus populations are fragmented and generally occur on small parcels. Although some of these parcels are protected lands (e.g., California Department of Fish and Wildlife [CDFW], Tejon Ranch Conservancy), an increasing number are surrounded by incompatible land uses (e.g., urban development) and are subject to frequent disturbance from destructive trespass activities (e.g., off-highway vehicle use, dumping, and fires). Also, some of the extant cactus populations are on private lands where developments are planned for the future. Thus, populations of Bakersfield cactus continue to be lost, and habitat conditions are being degraded for some remaining populations.

The status of most of the remaining Bakersfield cactus populations has not been assessed for over two decades. According to the California Natural Diversity Database (CNDDB; CNDDB 2010), the most recent large-scale status survey was conducted by Moe (1989), and updates were provided on a few specific populations between 1989 and 2002 (CNDDB 2010). Periodic status surveys for listed species are necessary to determine whether populations are still extant and to assess current site conditions throughout the range. This information is crucial for devising appropriate conservation and management actions to prevent extinction or facilitate recovery of such species.

Our goal was to conduct surveys to determine the current status of Bakersfield cactus throughout its range. Specific objectives were to (1) document the presence or absence of Bakersfield cactus at locations listed in occurrence records in the CNDDB; (2) estimate the number of individuals present in extant populations; (3) assess current habitat conditions at each site to determine whether habitat improvement measures might be necessary to enhance the potential viability of each population; (4) identify actual and potential threats to the populations at each site; and (5) develop recommendations for the conservation and recovery of Bakersfield cactus.

Materials and Methods

Study area and occurrence locations.—All known locations for Bakersfield cactus occur within Kern County, California (Figure 1). It occurs primarily in chenopod scrub and grassland habitats in the southeastern portion of the San Joaquin Valley (U.S. Fish and Wildlife Service 1998). Bakersfield cactus also has been found in some areas with blue oak (*Quercus douglasii*) woodlands.

Prior to conducting field work, we compiled a list of sites where Bakersfield cactus was known to occur, based on historic or recent observations. The initial list was generated based on Element Occurrences (EO) in the CNDDB (CNDDB 2010), which listed 45 Bakersfield cactus occurrences. However, six of these were on the east side of the Tehachapi Mountains and preliminary genetic analyses indicated that these may not be *Opuntia basilaris* var. *treleasei* (P. Smith, California State University-Bakersfield, personal communication). Of the remaining 39 occurrences, 29 were presumed extant, and nine were known to be, or thought to have been, extirpated (Figure 1). Additional locations were added to the list based on our personal knowledge as well as information from individuals (e.g., local biologists and land owners) who knew of cactus occurrences not yet reported to the CNDDB.

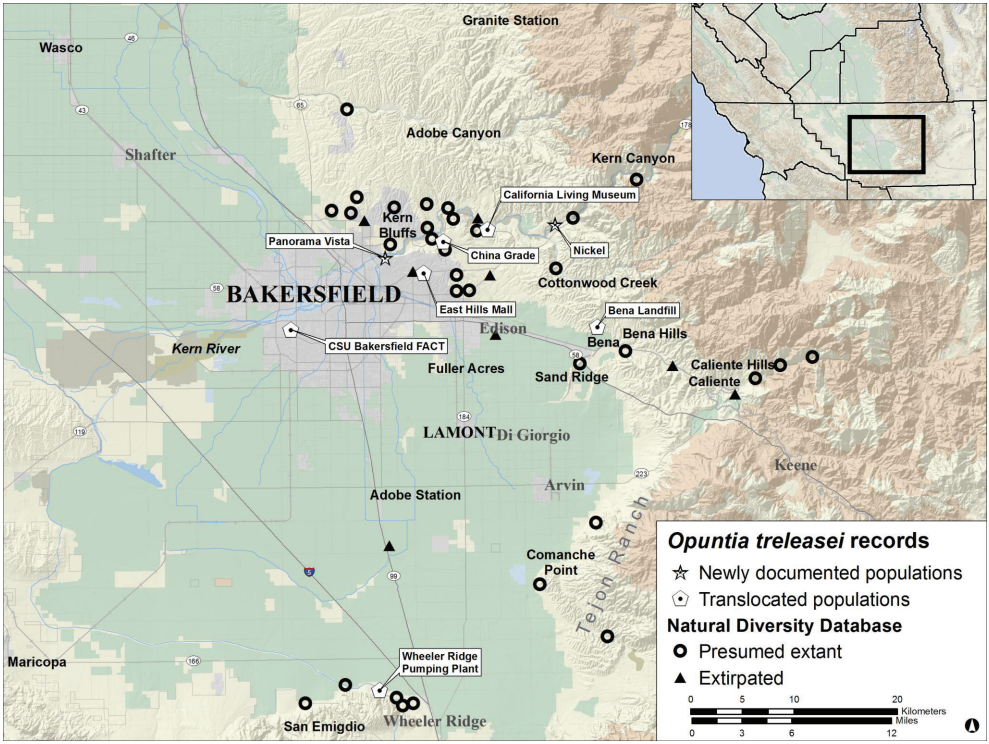

Figure 1.—California Natural Diversity Data Base occurrence records for Bakersfield cactus and locations of new and translocated populations in the San Joaquin Valley, California.

Next, we attempted to identify landowners for each of the locations. This was achieved by superimposing a GIS layer of Kern County parcels on a GIS layer of cactus occurrence records and aerial photographs to determine whether habitat was still present on parcels with known occurrence records. For parcels with habitat, we used the Assessor Parcel Number (APN) and the program Parcel Quest (http://www.parcelquest.com) to obtain landowner information from county property records. For many of the locations, the cactus population occurred on multiple parcels, and we attempted to contact all landowners to secure permission to access their property to survey for cactus.

Survey protocol.—During site visits, we attempted to survey as much of each EO or new site as possible. In particular, we attempted to visit each parcel with a different owner. Parcels under different ownership frequently were subject to different land uses or management that produced differential effects on cactus presence and condition. At least two field biologists conducted each survey. Surveys were conducted on foot and information relevant to each population was recorded (Appendix I).

Some sites could not be accessed, primarily because they were on private lands and attempts to secure permission from landowners to visit those sites were not successful. To the extent possible, those sites were examined from public roads, adjacent public lands, or adjacent private lands for which access had been granted. When these approaches were not possible or were insufficient for thoroughly inspecting a site, we surveyed from the air to determine whether suitable habitat for Bakersfield cactus was present and, if so, to see

if we could observe any cactus on the sites. We flew over these sites in a chartered, fixed-wing, single-engine aircraft. Two biologists and a pilot conducted surveys from an altitude of approximately 300–600 m. Each site was circled for whatever time was necessary to conduct a thorough inspection.

Results

Site visits and population status.—Sites with Bakersfield cactus were visited during March 2010–May 2011. Detailed information on each site can be found in Cypher et al. (2011b:Appendix B). Time spent at each site varied from about one to six hours; some of the larger populations were visited multiple times in order to achieve more complete survey coverage.

Of the 39 EOs listed in the CNDDB, we visited all, or portions, of 33, and confirmed that Bakersfield cactus was present at 25 (Table 1). We did not find cactus at eight sites. Although the putative determination is that these eight populations are extirpated, habitat was still present at these sites and additional visits are warranted to confirm our findings. We were unable to access six EOs that were on private lands. Based on an examination of aerial imagery and also on aerial surveys conducted on 18 May 2010 and 4 May 2011, no habitat remained at three of these sites and Bakersfield cactus likely is no longer extant (Table 1). Habitat appeared to be present on the remaining three sites, but we could not determine whether Bakersfield cactus was still present.

Table 1. —Status of Bakersfield cactus populations based on surveys conducted from March 2010 to May 2011.

	Population status		
Population	Confirmed extant	Confirmed or likely extirpated	Unknown
CNDDB Element Occurrences:			
Visited (*n*=33)	25	8	
Not visited (*n*=6)		3	3
Previously undocumented	2		
Translocated	6		
Totals	33	11	3

Of the 39 EOs listed in the CNDDB, 25 populations were confirmed extant, 11 are probably extirpated, and the status of 3 could not be determined (Table 1). Additionally, we were alerted by landowners to the presence of two previously undocumented populations, both of which were visited and assessed. Finally, we identified six Bakersfield cactus populations that were created by translocating cactus clumps or pads from other sites (Figure 1). Thus, Bakersfield cactus populations currently are present at a minimum of 33 sites (Table 1).

Ownership for lands with Bakersfield cactus populations includes both public and private entities (Table 2). Public lands are owned by the U.S. Forest Service, CDFW, California Department of Water Resources, or Kern County. Some private lands are owned

Table 2.—Land ownership for 33 sites with Bakersfield cactus as of May 2011. Most occurrences extend across lands with different ownership and therefore may be included in more than one category.

Ownership	Entity	Number of populations
Public	Federal	1
	State	7
	County	2
	Total Public	10
Private	Conservation organizations	2
	Corporations or individuals	23
	Multiple entities	1
	Total Private	26

by conservation organizations including the Center for Natural Lands Management, The Wildlands Conservancy, and the Kern River Corridor Endowment and Holding Company. Most of the populations occur on private lands, some of which are owned by corporations (e.g., Tejon Ranch Company, various oil companies, Pacific Gas & Electric Corporation [PG&E], development corporations) and some are owned by families or individuals. Few of the populations occur on lands with a single owner, but most populations occur on two or more parcels with different owners.

Population attributes.—Estimated population size for the 27 natural (non-translocated) populations of Bakersfield cactus assessed ranged from 2 to over 11,000 plants. Of these, 16 (59%) had 100 plants or fewer (Figure 2) while only 2 were estimated to consist of >1,000 plants. Among the assessed populations for which previous population

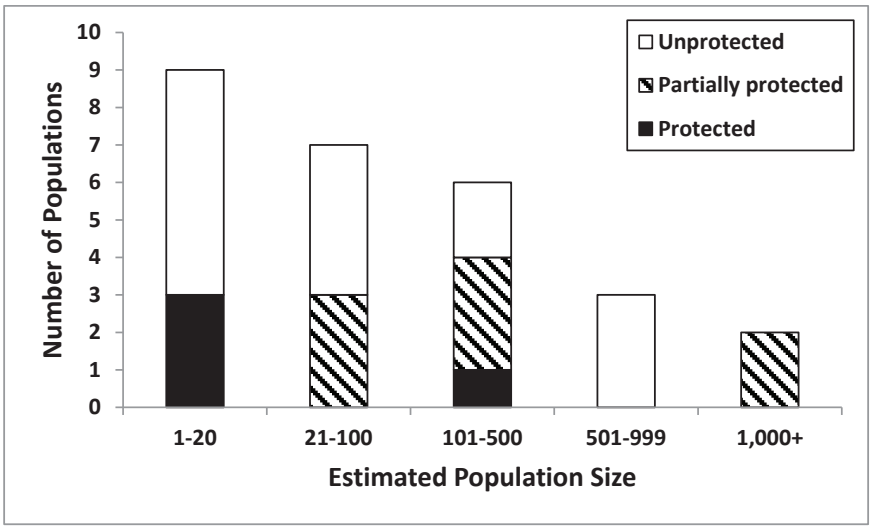

Figure 2.—Number of populations by size category and status of protection for extant populations of Bakersfield cactus based on surveys conducted in the San Joaquin Valley, California, March 2010 – May 2011.

size estimates were available from CNDDB records, 10 were approximately the same size as previously reported, 2 were considerably larger, and 9 were considerably smaller. For the two populations that were larger (EO-23 and EO-24), both were on private lands where past access might have been limited, thereby resulting in incomplete counts. Also, differences in past and current population estimates could be a result of different methods of enumeration. Among the nine populations for which our estimates were smaller, some of the more notable declines included a drop from 500 down to 100 plants on EO-7; 50–75 down to 18 on EO-8; 2,000 down to 250–500 on EO-15; "several hundred" down to 50 on EO-20; 2,500–3,000 down to 500 on EO-25; and 14,000 down to 5,000 on EO-36. The apparent decline noted on EO-25, however, could be attributable to our lack of access to a large portion of this site. For some populations, declines were attributable to destruction of portions of the populations, while abundance appeared to be unchanged in the undisturbed portions. For other populations, declines appeared to have occurred within areas that did not seem to have been disturbed (e.g., EO-15 and EO-36).

Habitat conditions varied considerably among the 27 extant natural populations. In some populations, habitat disturbance was considerable, but conditions were relatively undisturbed at others. Broadly characterized, habitat was relatively undisturbed in 12 populations, low to moderately disturbed in 12 populations, and highly disturbed in 3 populations. Among partially disturbed populations the disturbance was, in some cases, distributed throughout the population. In other cases, some portions of a population evidenced disturbance, yet other portions appeared relatively undisturbed.

Internal disturbances within populations included roads (both paved and unpaved), off-highway vehicle use, human foot traffic, illegal dumping, target shooting, burning, sand mining, erosion, oil field activities, flooding, and competition from invasive non-native plants. Invasive non-native plants were present in most populations, but in some areas appeared sufficiently abundant to potentially constitute a competitive threat to Bakersfield cactus. Also, cattle grazing occurs in many populations. This activity technically constitutes a disturbance, but grazing at low to moderate intensities generally does not appear to adversely impact Bakersfield cactus and may even improve conditions by reducing the density of non-native grasses.

External threats included all of the disturbances described above, as well as habitat conversion for urban, industrial, and agricultural developments. Indeed, residential and commercial development is occurring at a rapid pace in areas northeast of Bakersfield. Industrial developments include ongoing oil field activities and expansion of sand or gravel mines. Agricultural development also is an ongoing threat: during our status survey a portion of EO-3 was converted to citrus groves.

Level of administrative protection varies considerably among the 27 natural populations, and ranges from lands being protected from development in perpetuity to a complete absence of protections. As described earlier, some populations extend across lands with different owners, and level of protection varies with ownership. Lands owned and managed by the U.S. Forest Service or CDFW are public lands on which protection of endangered species is mandated; as a result, cactus populations on these lands are very secure. Additionally, some populations occur on lands that have been placed under permanent conservation easements; among these are lands managed by the Tejon Ranch Conservancy (EO-21, 25, and 38) and private lands under easements with The Nature Conservancy (EO-23 and 24) and these populations also are very secure.

Other lands currently have protective measures in place, but those are not guaranteed in perpetuity. For example, lands owned and managed by the Center for Natural Lands Management (EO-3; Sand Ridge Preserve), The Wildlands Conservancy (EO-44; Wind Wolves Preserve), the Kern River Corridor Endowment and Holding Company (EO-18 and a previously undocumented population; Panorama Vista Preserve), and the California Department of Water Resources (EO-36 and 49) currently benefit from stringent protective measures implemented by these organizations, among which are fencing, restricted access, or avoidance measures. Cactus populations on lands owned by certain corporations receive some protection from policies or procedures (mostly avoidance), but there are no permanent protections in place. Finally, populations on some private lands, particularly grazing lands, currently receive some protection primarily because public access is proscribed or highly restricted. Among the 27 natural populations, four are entirely protected in perpetuity and portions of eight others are similarly protected. The remaining 15 populations have no permanent protection.

Among the 6 translocated Bakersfield cactus populations (Figure 1), population size ranges from 1 to 22 plants. The California Living Museum population consists of about a dozen plants and occurs among native plant gardens at a small zoo. These plants were translocated from multiple sites in the 1980s. This population is well protected, although not in perpetuity. The East Hills Mall population consists of about 10 plants in a highly disturbed landscape embankment next to a busy road and parking lot. These plants were collected and placed in this location when the mall was constructed in the 1980s. The population is in decline and probability of persistence in the current location is considered low. The California State University-Bakersfield population consists of about 10 plants, and is located on the grounds of the Facility for Animal Care and Treatment. These plants were translocated from various natural populations in the 1980s prior to the Bakersfield cactus being listed, and no formal protections are in place.

The China Grade Landfill population consists of about 10 plants in a relatively undisturbed buffer surrounding that inactive landfill. Some plants were translocated in 2008 to this site from another portion of the landfill, as were others after they were salvaged from a site in northeast Bakersfield that was about to be developed. Current zoning precludes development of that site, but no other formal protections are in place.

The Wheeler Ridge Pumping Plant population consists of one plant growing in what appears to be a small succulent garden established on the edge of a parking area, and was translocated from another location. The Bena Landfill population consists of 13 surviving plants from 10 clumps and 25 pads that were translocated from the nearby Sand Ridge Preserve (EO-3) in 2009 (Cypher et al. 2011a, Cypher et al. 2014). The plants are in a relatively undisturbed buffer area of this still active landfill. Under a Habitat Conservation Plan prepared by the Kern County Waste Management Department, the buffer area was set aside as compensation for landfill activities, and will be conserved in perpetuity.

Discussion

Survey limitations.—Information collected during this survey provided substantial insights into the current status of the Bakersfield cactus, but there are some limitations to the data that must be considered. The population sizes provided are estimates; factors inhibiting precise estimates included populations dispersed over large areas, plants obscured by topography or vegetation, and lack of access to some portions of populations (e.g.,

portion of EO on private land for which access was not secured). In three instances (EO-8, EO-26, and EO-43), lack of access precluded our ability to visit any part of a population, but we were able to verify that habitat persisted on these sites. Lack of information on these three populations probably constitutes the most significant deficiency in the survey results.

Further complicating our efforts, vegetation conditions were not optimal for conducting surveys. Vegetation density was high during the survey, a result of above-average precipitation during the 2009-2010 and 2010-2011 rain years (California Department of Water Resources 2013), and obscured cacti at times. Wet conditions during winter 2010-2011 also delayed access to some sites, and also promoted regrowth of dense vegetation.

Increased density of vegetation may have affected survey results in two ways. It is possible that cacti were present but not detected on some sites, resulting in a conclusion that the population had been extirpated. It is also possible that cacti obscured by dense vegetation may have resulted in underestimates of population size. It is our opinion, however, that searches were sufficiently thorough and the likelihood of either of those potential outcomes is low.

We emphasize that the population sizes provided are estimates; factors inhibiting precise estimates included populations dispersed over large areas, plants obscured by topography or vegetation, and lack of access to some portions of populations (e.g., portion of EO on private land for which access was not secured).

Species status.—At least 27 natural populations of Bakersfield cactus currently are known to persist and 6 translocated populations have been documented, resulting in a minimum of 33 extant populations. Bakersfield cactus likely occurs in additional locations that have not yet been documented. Vast areas of potential habitat have not been surveyed, primarily because it occurs on private lands. In particular, considerable potential habitat still occurs in the Kern Front region, Caliente Creek drainage, and Comanche Point region of Tejon Ranch. Indeed, significant numbers of Bakersfield cactus plants have been found in recent opportunistic surveys in the Comanche Point region of Tejon Ranch, and the probability is high that additional plants occur in areas not yet surveyed.

In this paper, the term population has been used interchangeably with element occurrence; occurrence, however, is probably the more accurate term. A "population" generally is defined as a group of individuals that occur in a given geographic area and that have a higher probability of reproducing with individuals within the group than without (Pianka 1978). The working definition generally employed by CNDDB for plants is that occurrences separated by at least one-quarter mile are considered separate occurrences, while those closer than this distance generally are lumped as a single occurrence. Bakersfield cactus likely was, at one time, widely distributed within San Joaquin Valley portions of the Kern River and Caliente Creek drainages (U.S. Fish and Wildlife Service 1998) and the current, highly fragmented distribution is the result of anthropogenic processes, and likely limits opportunities for gene flow or dispersal among the remaining EOs. Nevertheless, genetic partitioning within the range of Bakersfield cactus appears to be minimal (Smith 2013), and evidence of genetic isolation or other deleterious effects has not been detected. Sexual reproduction appears to be infrequent and most reproduction is vegetative through the shedding and rooting of pads (U.S. Fish and Wildlife Service 1998).

Protection status, threats, and on-going impacts.—Of the remaining occurrences of Bakersfield cactus, permanent protections are in place for four entire populations and portions of eight others. These protections include ownership and management by federal

or state natural resource agencies, and permanent conservation easements on lands managed by non-profit conservation organizations or on private lands. These occurrences may still face anthropogenic or biological threats, but are administratively secure. Furthermore, they include parts of some of the larger remaining cactus populations. Other populations, or portions thereof, currently are receiving active or passive protection, but such protections are not permanent.

Many of the Bakersfield cactus populations, including protected ones, are subject to a variety of internal and external threats. These disturbances can lead to physical damage to plants, soil contamination, fires, altered hydrologic patterns, or erosion of supporting substrate. Non-native invasive plants can compete with cactus for moisture, nutrients, and sunlight. Particularly problematic species in Bakersfield cactus populations included red brome (*Bromus madritensis* spp. *rubens*), wild oats (*Avena* spp.), Russian thistle (*Salsola* spp.), and Sahara mustard (*Brassica tournefortii*). Survival and growth of Bakersfield cactus increased substantially when non-native grasses were controlled around cactus clumps (Cypher and Fiehler 2006). Internal threats may be responsible for the marked declines in the number of Bakersfield cactus plants observed in 9 (36%) of the 25 populations assessed in previous status surveys.

Many of the remaining sites with Bakersfield cactus are subject to grazing by cattle, the effects of which likely vary with grazing intensity. Cows do not appear to feed on the cactus, but occasionally injure plants by kicking or trampling. Alternatively, cattle grazing may provide potential benefits to cactus populations. Cattle can reduce the biomass of plants that potentially compete with the cactus and also provide fuel for fires. Additionally, the detachment and movement of cactus pads might contribute to dispersal and establishment of new plants. Detached pads must come into contact with soil to become established, and this situation is facilitated when grazing reduces density of competitors.

The most substantial threat to remaining Bakersfield cactus populations is habitat conversion. Of the 11 occurrences now thought to be extirpated, at least six are attributable to agricultural or urban development. Additionally, portions of several other occurrences have been lost due to development; a striking example of continuing habitat loss was the conversion of a portion of EO-3 to a citrus grove during this survey. Other populations also are under threat from imminent development, particularly several in the northeastern portion of Bakersfield where urban development is occurring at a rapid pace.

The risk to Bakersfield cactus populations associated with the multitude of internal and external threats is enhanced by the small size of many of the known natural populations. Of the 27 populations, 16 (59%) comprise 100 plants or less. Populations with such low numbers of plants are already vulnerable to demographic or environmental stochasticity. Furthermore, the potential for natural dispersal (and subsequent establishment of new populations) appears to be low (U.S. Fish and Wildlife Service 1998). Unlike other *Opuntia* species that produce fruits that are highly attractive to potential animal dispersers, Bakersfield cactus fruits tend to be dry (Parfitt and Baker 1993) and likely are unappealing to potential dispersers. Further, Bakersfield cactus appear to readily produce seeds, but many of these seeds apparently are destroyed by insects or rodents prior to germination (E. Cypher, personal observation) and seedlings rarely are observed. The primary dispersal strategy employed by this plant appears to be the shedding of pads. However, these pads rarely move far from the parent plant unless moved by gravity, flowing water, or animals. Even where such occurs, the highly fragmented condition of remaining habitat substantially reduces the probability of a pad being transported to a suitable, unoccupied habitat patch.

A future threat to the persistence of Bakersfield cactus may be the cactus moth (*Cactoblastis cactorum*), an exotic insect native to South America. This species lays its eggs on the spines of *Opuntia* cactus and the larvae feed on the pads and kill them in the process. It was detected in the Florida Keys in 1989 and has impacted a rare cactus (*Opuntia corallicola*) that occurs there (Stiling et al. 2004). Since its initial detection in Florida, the moth has spread north and west. In 2009, it was detected in Louisiana (U.S. Department of Agriculture 2011); experts expect that it is only a matter of time before the moth reaches the southwestern United States, including California (Stiling 2002). Where it occurs, the moth has had devastating effects on *Opuntia* populations.

Conservation Needs and Strategies.—During the past decade or so, the number of Bakersfield cactus populations has declined. Additionally, declines in cactus abundance are evident in a number of the remaining populations. Furthermore, remaining populations are at risk from a number of immediate threats, and potential future threats could profoundly impact this taxon. Given the current situation and future prospects for Bakersfield cactus, aggressive conservation measures are warranted and may be necessary just to prevent its extinction.

Conservation needs for Bakersfield cactus include (1) the permanent conservation of additional populations; (2) increased protections from impacts; (3) habitat management within populations; (4) expansion within existing populations and the creation of new populations; (5) a population viability analysis to determine the optimal number of populations to maintain long-term viability of the taxon; (6) additional surveys for new populations; and (7) outreach and education programs.

Permanent conservation of additional populations could be achieved through purchase of properties by a natural resource agency or other entity willing to forfeit development rights for those lands, or through permanent conservation easements. Many remaining populations, particularly smaller ones and those located within the rapidly expanding urban landscape of Bakersfield, could benefit from increased site-specific protections, among which are fencing, road closures, signage, and the establishment of buffer areas around the populations. Additionally, vegetation management potentially could improve the health of some populations by reducing competition from non-native species or through a reduction in fuel loading. Moreover, reducing abundance of exotic plants, particularly in the immediate vicinity of cactus plants, could improve population vigor (Burger and Louda 1994, Cypher and Fiehler 2006).

Translocation to expand existing populations or create additional populations offers immense potential to improve the status of this species, and is an established methodology (Allen 1994, Given 1994, Falk et al. 1996, Stiling et al. 2000, Cypher et al. 2014). Six new Bakersfield cactus occurrences established through translocation were identified during this survey. Additionally, another population on CDFW lands was expanded significantly using translocated cactus pads recovered during a salvage effort (Cypher et al. 2014). To date, five new populations of Bakersfield cactus have been established using this technique, and in 2014 six additional populations will be created and three others expanded using this methodology (B. Cypher, unpublished data).

Completion of a population viability analysis would help determine a target number for new, translocated populations and help identify the optimum, or at least the minimum, size necessary to maintain viability of individual populations. Further surveys should be conducted to locate new Bakersfield cactus populations and, if they exist and are properly conserved, those populations would decrease the potential for extirpation of this

taxon. Finally, outreach and education programs may benefit Bakersfield cactus by raising awareness of the plight of this taxon, as well as the potential for funding or other support for conservation and recovery efforts.

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Appendix I

Information collected for each Bakersfield cactus location during a status survey conducted in the San Joaquin Valley, California, 2010–2011.

Variable	Description
EO #	Element Occurrence number from CNDDB or unique label for new populations
Location	General location of EO or population
Land owner	Owner(s) of parcels within each Element Occurrence or new population
Conservation Status of Site	Whether all or portions of the site have any status that would conserve them in perpetuity, such as being owned by a federal or state conservation organization, or being covered by a conservation easement
Genetic sample collected	As part of a collaborative study of genetic variation and partitioning among Bakersfield cactus populations, 1-10 genetic samples (pads) were collected from each population and submitted to CSU-Bakersfield
Size of extant population	The number of plants (cactus clumps) was counted or estimated for each population. Clumps are defined as "groups of pads that are rooted at the same point" (U.S. Fish and Wildlife Service 1998)
Estimated overall area	General estimate of the area covered by the population.
% cover inside area	Estimate of proportion of population area actually covered by cactus
Habitat conditions	General description of dominant plant community and plant species, terrain, soil type, and any other pertinent habitat information
Internal disturbances	Any evidence of disturbance within the population including OHV use, roads, human foot traffic, dumping, shooting, grazing, burning, and invasive non-native plants
Extent of area disturbed within the population area	Percentage of area disturbed within the population
Estimated threat level from internal disturbances	Qualitative ranking of the threat to the population from internal disturbances

Appendix I (Continued)

Variable	Description
Adjacent land uses	Uses and activities on lands immediately adjacent to the population
Estimated threat level from activities on adjacent lands	Qualitative ranking of the threat to the population from activities on lands immediately adjacent to the population
Probability of population presence in 100 years	Qualitative assessment of the probability that the population will persist and be present in 100 years, assuming that all current conditions within and around the population remain the same
Recommendations for conservation	Recommended measures for protecting, enhancing, or expanding the population
Point total	Points were assigned for protection status, population size, parcel size, internal threat level, and external threat level