Ben Lomond Wallflower
(*Erysimum teretifolium*)

5-Year Review:
Summary and Evaluation

photo by Rick York and CNPS

U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
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5-YEAR REVIEW
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1. GENERAL INFORMATION

1.1. Reviewers

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1.2. Methodology used to complete the review:

This review was carried out by staff of the Ventura Fish and Wildlife Office, U.S. Fish and Wildlife Service (USFWS). The source for much of the background material used to generate this review was the Sandhills Conservation and Management Plan based on the doctoral work of McGraw (2004a and 2004b). Other information was collected from a variety of sources including: the Internet, published and unpublished literature, and personal communications with experts in the field. Due to land ownership patterns and the fragmented nature of the sand parkland habitat containing *Erysimum teretifolium* populations, much information was also obtained through personal communication with various private and public entities. We received no information from the public in response to our Federal Register (FR) notice initiating a request for information on this species (see section 1.3.1, below).

1.3. Background:

1.3.1. FR Notice citation announcing initiation of this review:

The FR notice initiating this review was published on February 14, 2007 (72 FR 7064). This notice opened a 60-day request for information period, which closed on April 16, 2007.

1.3.2. Listing history

Original Listing
FR notice: 59 FR 5499
Date listed: February 4, 1994
Entity listed: species (*Erysimum teretifolium*)
Classification: endangered

1.3.3. Associated rulemakings

No other federal rulemakings apply.
Listed by the State of California as endangered in 1981.

1.3.4. Review History

The status of *Erysimum teretifolium* was reviewed during preparation of the recovery plan for this species published in 1998. Otherwise, no 5-year review has been conducted.

1.3.5. Species' Recovery Priority Number at start of 5-year review: The Recovery Plan indicated that the recovery priority number is 9; however, this was in error because the species was mistakenly identified as a subspecies for the purpose of calculating this number. The Recovery Priority number at that time should have been 8. This denotes a full species having a moderate degree of threat and a high recovery potential.

1.3.6. Recovery Plan or Outline

Name of plan: *Recovery Plan for Insect and Plant Taxa from the Santa Cruz Mountains in California*

Date issued: September 28, 1998

Dates of previous revisions, if applicable: None

2. REVIEW ANALYSIS

2.1. Application of the 1996 Distinct Population Segment (DPS) policy

The Endangered Species Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listings as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

2.2. Recovery Criteria

2.2.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

__X_ Yes
____ No

2.2.2. Adequacy of recovery criteria.

2.2.2.1. Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

__X_ Yes
_____ No

2.2.2.2. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

__X__ Yes; however, a new potential threat, herbivory, needs to be evaluated.
____ **No**

2.2.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information (for threats-related recovery criteria, please note which of the 5 listing factors* are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here):

The recovery objective for *Erysimum teretifolium* is delisting through habitat protection and appropriate management actions. At the time of listing, Factors A, D, and E were considered the primary threats to the species. Factors B and C were not applicable to this species at that time. Development of delisting criteria was deferred until additional information on the species was available. The four downlisting criteria are as follows:

1. The 17 currently known populations have been secured through fee title acquisition, conservation easements, or Habitat Conservation Plans (HCPs).
This recovery criterion addresses Listing Factors A, D, and E. For the purposes of this review, we are considering 20 populations (see discussion under Distribution, section 2.3.1). Of these populations, approximately 20 percent are on secured sites while approximately 80 percent are on unsecured sites. The populations that may be considered secure include those on state and county-managed reserve and park lands (Quail Hollow Ranch County Park and Bonny Doon Ecological Reserve) and two on privately-owned lands at former sand quarries. Quail Hollow Quarry has been conserved through a HCP. In addition, as part of the establishment of a local conservation bank, a conservation easement was established in May 2007 on a parcel that supports a specific portion of the Quail Hollow population. Additionally, habitat at the Kaiser Sand and Gravel Felton Plant, now known as the Hanson Aggregates, Felton Sand Plant, has been protected through a Memorandum of Understanding and property setback requirements. Aside from these sites, the majority of known populations remain unsecured. We therefore consider that this criterion has not been met. We believe that this criterion is adequate and appropriate to the recovery of this species.

* A) Present or threatened destruction, modification or curtailment of its habitat or range;
B) Overutilization for commercial, recreational, scientific, or educational purposes;
C) Disease or predation;
D) Inadequacy of existing regulatory mechanisms;
E) Other natural or manmade factors affecting its continued existence.

2. Management plans for populations on public lands (Quail Hollow Ranch County Park and Bonny Doon Ecological Reserve) are developed and being implemented.
This recovery criterion addresses Listing Factor A. The vegetation management plans for Quail Hollow Ranch County Park and Bonny Doon Ecological Reserve have not yet been completed (DeWald, Reserve Manager, Bonny Doon Ecological Reserve, pers. comm. 2006; Samuel, Director, Santa Cruz County Parks Department, pers. comm. 2007). Therefore, we consider that this criterion has not been met. We believe that this criterion is adequate and appropriate to the recovery of this species.

3. Conservation measures for this species are included in Habitat Conservation Plans that have been developed and implemented for listed insect species including: a) Graniterock Quarry, b) Kaiser Sand and Gravel Felton Plant (now Hanson Aggregates), and c) the County of Santa Cruz. This recovery criterion addresses Listing Factors A, D, and E.

This species was included in two HCPs implemented by Quail Hollow Quarry for the Mount Hermon June beetle (*Polyphylla barbata*) and the Zayante band-winged grasshopper (*Trimerotropis infantilis*), both federally endangered species. Hanson Aggregates completed a HCP in 1999 for both of these insect species; although it did not include *Erysimum teretifolium* as a covered species, the measures undertaken for the insects benefit *E. teretifolium* as well. The Santa Cruz County draft HCP (a regional plan for the sandhills species) is still under development and has not been implemented. Because *E. teretifolium* is not included in all HCPs developed for the locally listed insect species and not all HCPs indicated in the recovery plan have been implemented, we consider that this criterion has not been met. We believe that inclusion of this species in all HCPs which overlap geographically with known *E. teretifolium* populations is appropriate. However, we suggest that the USFWS consider revising the criterion to indicate a broader need to include the species in all applicable HCP's. See section 4.5.

4. Population numbers are stable or increasing.
Of the 20 populations examined in this review, we consider 3 populations to be extirpated and 13 populations to likely be extant. Of the likely extant populations, we consider 2 to be stable with extensive management, and 3 to be decreasing. The population trend of the remaining 8 likely extant populations is unknown due to a lack of information. Therefore, we consider that this criterion has not been met. We believe that this criterion is adequate and appropriate to the recovery of this species.

In addition to the recovery criteria, the following "Needed Recovery Actions" were identified in the Recovery Plan for *Erysimum teretifolium*:

1. Development of a HCP with the County of Santa Cruz that minimizes disturbance from sand mining and residential development.

This action has not been implemented, as discussed in recovery criterion #3 above.

2. Development and implementation of management plans for State-owned units (a portion of Quail Hollow Ranch County Park and Bonny Doon Ecological Reserve).
This action has not been implemented, as discussed in recovery criterion #2 above.

3. Conduct research focusing on causes of reproductive failure and how to increase reproductive success.
One research project has been undertaken to attempt to increase reproductive success. Clearing of woody vegetation and litter removal have been initiated in a 0.25-acre area, and a monitoring regimen is in place within the "Santa Cruz Wallflower Treatment Area" in Bonny Doon Ecological Reserve.

4. Manage for reduction of succession of woody species into occupied habitat.
To date, this sort of management technique has only been implemented in the experimental area mentioned in "Needed Recovery Action" #3, above.

2.3. Updated Information and Current Species Status

2.3.1. Biology and Habitat

Morphology and Life History Characteristics: *Erysimum teretifolium* is a short-lived perennial or sometimes annual plant in the mustard family (Brassicaceae). The plant initially grows as a simple basal rosette of purplish, narrowly linear leaves; eventually the basal rosette withers as a floral spike forms, typically in the second or third year, terminating in a raceme of yellow flowers. This species is self-incompatible, and cross-pollination is necessary for fertilization to occur. Little is known about the pollination biology of *E. teretifolium*. Chalcedon checkerspot butterflies (*Euphydryas chalcedona*), ants, European honeybees, and bumble bees have all been seen on the flowers of this species, but the potential for these insects to achieve pollination is unknown (McGraw 2004b). An anomalous trait has been observed in flower form in one of the two relatively stable populations of the species (S. Schettler, pers. comm. 2006, Consultant, Greening and Associates). This apparent mutation affects the flower shape, but no information regarding effects on pollination or reproductive success in these individuals has been carried out.

Small oval to round seeds are produced in siliques (seed pods) which dehisce and drop the seeds directly below the parent plant in a "seed rain". Observations by McGraw (2004b) indicate that the numbers of siliques produced per plant is quite variable (10-107) and that seed production is positively correlated to silique length (9-15 centimeters produced 5-65 seeds). Seeds germinate after the first heavy rains in the fall, and were found to germinate at least up to 5 years after reaching maturity (McGraw 2004a and McGraw 2004b).

Distribution: *Erysimum teretifolium* is known only from the sandhills of Santa Cruz County, California, and is distributed over an area approximately 9 miles from east to west and 5 miles from north to south. Within this area, most of the populations occur in an area between the communities of Ben Lomond, Mount Hermon, and Glenwood, while outliers are located in the Bonny Doon area (approximately 5 miles to the west) and one is located in Beulah Park (approximately 3 miles to the south). It is likely that populations were once more widely scattered throughout the sandhills area prior to fragmentation of habitat and suppression of natural fire cycles.

For the purposes of this review, we are considering 20, rather than 17 (as noted in the recovery plan) populations (see Appendix 1). Populations currently recognized in the California Natural Diversity Database (CNDDB) are referred to as Element Occurrences (EOs) and include EO #s 5, 6, 7, 9, 11, 12, 13, 14, 18, 23, 24, 25, 26, 27, and 28. In addition; we are treating one CNDDB occurrence (EO #1) as 3 separate occurrences, following the former CNDDB occurrence numbers 1, 2, and 22, due to the physical barriers that separate them. We are also retaining the former EO #16 that was absorbed into EO #11. For the purposes of this review, all populations will be identified with Identification Numbers according to the aforementioned numerical designations (Appendix 1) and retain usage of the term population as it is more biologically applicable and appropriate. Finally, we note one additional population that has been observed by three specialists from a distance but has not been closely examined due to difficult access (R. Morgan, pers. comm. 2007, Botanist/Consultant; S. Schettler, pers. comm. 2006; J. McGraw, Population and Community Ecologist/Consultant, pers. comm. 2007b). Of these populations, roughly 25 percent are under some form of conservation management while approximately 75 percent are not.

At present, we consider 3 of the 20 populations being addressed here to be extirpated (see Table 1). These include ID #7 in Bonny Doon Ecological Reserve; ID #16 along Mount Hermon Road, where habitat no longer exists; and ID #27, where the last supporting habitat was destroyed (R. Morgan, pers. comm. 2007). These extirpations do not constitute a major reduction in overall range for the species. However, three other populations have not had *Erysimum teretifolium* observed for 25 years or longer and recent searches have not even revealed habitat in these areas (J. McGraw pers. comm. 2007b, C. West pers. obs. 2007). Many of these populations are located on the periphery of the species' range, and, if they are found to be extirpated, this would constitute a significant reduction in range and overall distribution.

Abundance: While the historical number of populations of *Erysimum teretifolium* is unknown, the CNDDB tracks remaining populations. Of the 20 populations considered for this review, we consider 5 of these to be decreasing in numbers (most recent surveys show reduction of 40 percent or more of individuals from highest recorded numbers) and 3 extirpated. It should be noted that several of these populations have only two data sets from surveys available upon which to base these findings. Trends are impossible to determine at many sites since either there are only data from a single survey or no survey data was available (Table 1). Of the 13 populations considered extant (individuals have

been observed within the last 25 years), two populations are currently held stable only with intensive management and enhanced with plantings (see Table 1).

CNDDB data show that this species has never had very high numbers of individuals. Only 2 of the known populations have supported total annual numbers of individuals in the thousands, and only 6 populations have supported 100 or more individuals annually. These numbers are the highs reported and likely correlate with favorable climatic conditions. In most years at these sites, population numbers were much lower. The annual total of individuals over all populations has ranged between 1,000 and 3,000 individuals per year in the most productive recent years.

Table 1. Status, trend, and observation information for the 20 populations considered in this review. ID # corresponds to designation in Appendix 1. Derived from CNDDB 2006; V. Haley, pers. comm. 2007; J. McGraw, pers. comm. 2007b; R. Morgan, pers. comm. 2007; and S. Schettler, pers. comm. 2006.

ID #	Extant	Extirpated	Decreasing	Potentially Extirpated	Steady	Single Observation	No Survey Data	Trend Unknown
1	X		X					
2	X							X
5				X				
6	X				W/ plantings			
7		X						
9				X				
11	X				W/ plantings			
12	X					X		X
13				X				
14	X							X
16		X						
18						X	X	X
22	X		X					
23	X					X		X
24	X					X		X
25	X					X		X
26	X					X		X
27		X						
28	X		X					
Beulah Park	X						X	X

The population with the highest quality *Erysimum teretifolium* habitat remaining is the South Ridge at Quail Hollow Quarry (ID #1) (J. McGraw 2004b; S. Schettler, pers. comm. 2006). Although available data were gathered somewhat sporadically over time, they illustrate the recent downward trend in numbers of individuals, even within this large patch of high quality habitat (Fig. 1). Schettler (pers. comm. 2006) estimates an

average downward trend in numbers of 8 to 10 percent annually since 1999 within many plots at this location.

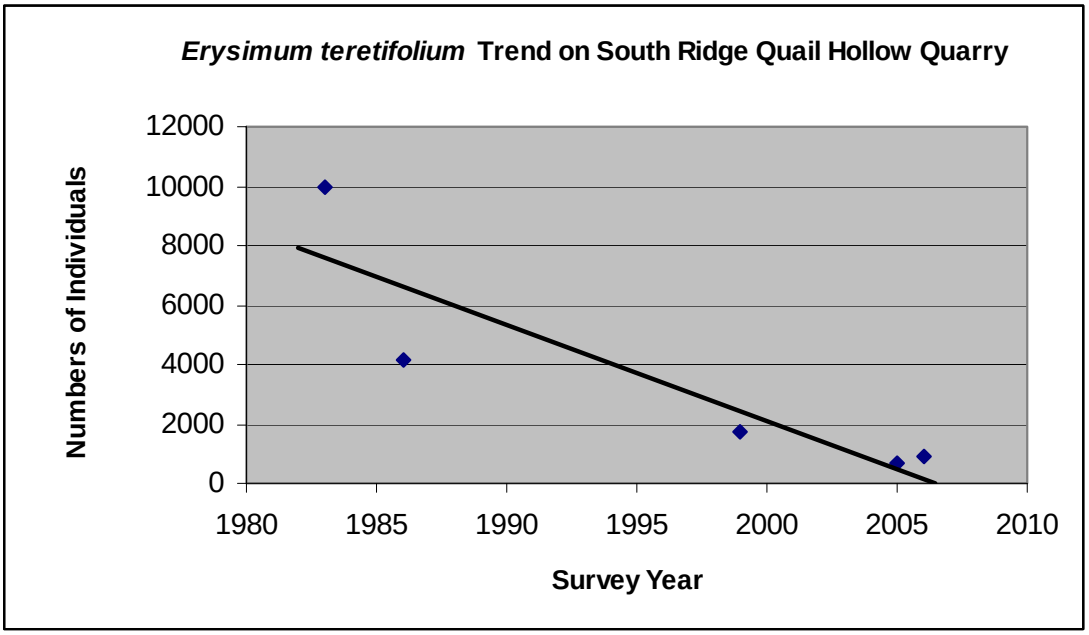

Figure 1. Population trend of *Erysimum teretifolium* individuals on the South Ridge of Quail Hollow Quarry from 1983 to 2006 (derived from CNDDB 2006 and Schettler pers. comm. 2006).

Habitat Characteristics: As summarized in the recovery plan (USFWS 1998), the Zayante sandhills is a unique habitat type that is comprised of outcrops of sandy soils derived from marine deposits. These soils support endemic habitat pockets of sandhills chaparral and ponderosa pine parkland communities. A suite of associated plants and insects, including four other federally listed species, occur in association with this habitat type and nowhere else. Sand mining and urban development have reduced this already rare, geographically limited habitat. These two factors were initially the major threat to *Erysimum teretifolium* populations. Although the effects from past development and sand mining remain and habitat reduction continues from these factors, fire suppression and resulting habitat conversion are now the leading cause of habitat degradation and reduction in range. Suppression of natural fire regimes has led to habitat conversion via the encroachment of woody invasive and native species and invasive annual grasses (Brunette 1997, USFWS 1998). This encroachment has led to conversion of much of the existing open, sandy soil habitat required by *E. teretifolium* and other shade intolerant sandhills plants, resulting in the establishment of shade-providing species and a build-up of leaf litter. Both of these effects negatively impact germination and completion of the life cycle in *E. teretifolium,* though the specific causal mechanisms for this effect are unknown (McGraw 2004a).

Predation: Recent research has found that many animal species utilize *Erysimum teretifolium* as a food source and that this herbivory may affect the plant at the population level (Brunette 1997, McGraw 2004b). Herbivory by small mammals has been shown to

result in delayed reproduction or even mortality and usually occurs where plants are adjacent to shrubs and trees (McGraw 2004b). This is of concern where habitat conversion is an issue and encroaching shrubby vegetation may be creating cover for small mammals close to existing populations of *E. teretifolium*. The ability of this species to extend its life span by 2 or more years in order to delay reproduction when developing flowers are browsed has been observed (Brunette 1997, McGraw 2004b). Subsequent flowering results in a higher number of inflorescences but shorter fruits, which in turn contain fewer seeds and contribute to an overall reduction in fecundity (J. McGraw, pers. com. 2007a). Brunette (1997) noted that many of the adult plants at his Bonny Doon study site appeared to be older than 2 years.

Brunette (1997) also observed a lack of a soil seed bank at this location and suggested that herbivory by deer over successive years may have caused these individual plants to extend life spans in an effort to postpone reproduction with no actual reproduction occurring. In the "Needed Recovery Actions" section of the Recovery Plan, it is mentioned that research should be conducted "… focusing on causes of reproductive failure and how to increase reproductive success…" (USFWS 1998). While no further mention of "reproductive failure" is made within the Recovery Plan, it seems likely that this recommendation is in reference to the total lack of seed bank observed by Brunette (1997) while adult and reproductive plants were present in the area. He noted that "failure to reproduce due to prolonged postponement could be disastrous for this population…." and that this site had a high probability of extinction (Brunette 1997). No individuals have been seen at this site since 1995 (V. Haley, Consultant, Native Vegetation Network, pers. comm. 2007). Browsed populations show an initial response to herbivory that may give the appearance of health for a number of years while, in actuality, the seed bank is being depleted and no actual reproduction is occurring. For this reason, it is critical for surveys to be completed while flowers are present to get an accurate measure of reproductive individuals.

2.3.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1. Factor A, Present or threatened destruction, modification or curtailment of its habitat or range:

Threats that were considered to seriously impact this species were discussed at the time of listing (USFWS 1994). Four of these threats pertain to this factor and are addressed here.

Sand Mining:

At the time *Erysimum teretifolium* was listed, sand mining was occurring on a large scale on many of the largest remaining deposits of Zayante sandhills parkland soils. Consequently, sand mining was considered a primary threat to this and all other species endemic to this limited habitat. Current sand mining is still destroying occupied *E. teretifolium* habitat. However, this mining is being managed through a

HCP in place at the Quail Hollow Quarry. Unless new mining operations are proposed, future sand mining will be a reduced threat to the remaining habitat of the species because many of the mining operations are either being closed or are nearing closure (McGraw 2004b; B. Davilla, pers. comm. 2006).

A substantial amount of the sandhills habitat had already been destroyed by mining operations prior to the listing of *Erysimum teretifolium* and other sandhills species. At one time, it was believed that restoration of these privately-owned mine sites would aid in recovery efforts for many sandhills species. However, some restoration specialists working with the species now believe that previously quarried areas, even if restored, will likely never support successful sandhills communities (McGraw 2004b; S. Schettler, pers. comm. 2006). This belief stems from the poor recovery record for sandhills habitat, likely due to the upheaval of a fragile system where biotic and abiotic factors coevolved in delicate balance over long time periods and are either to difficult or costly to replicate.

Urban Development:
Urban development was considered to be another primary threat to this species at the time of listing. This development is not occurring at as rapid a rate as it was in the past, but the lasting effects of past development remain (e.g., habitat fragmentation, habitat alteration from landscaping). There are several sites that are immediately adjacent to existing homes on private property that could provide good preservation opportunities. However, even if these areas were preserved, and little to no further development occurred, fragmentation at these sites would remain an issue. Populations on these isolated fragments may eventually suffer from a reduction in gene flow, inbreeding depression, and higher susceptibility to stochastic extinctions (see section 2.3.2.5).

Agricultural Conversion:
Agricultural conversion was considered to be a minor threat to this species at the time of listing. This threat still remains relatively minimal. There is some grape production in the Bonny Doon area for winemaking purposes. Recent aerial photos do indicate the existence of exposed sandy soils in the area that may provide suitable habitat; however, private ownership of most of the surrounding properties has precluded any recent surveys of the area for *Erysimum teretifolium*. Additionally, signs posted in fallow vineyard areas indicate the application of insecticides and/or herbicides to the soil (C. West, pers. obs. 2007). Effects of these applications directly on *E. teretifolium* or on its pollinators are unknown.

Recreational Use:
Recreational use of sandhills habitat was considered to be a primary threat at the time of listing. At this time, recreational use continues to threaten some populations of *Erysimum teretifolium.* While a HCP and recreational plan are still being developed for Quail Hollow County Park (former EO #22), fences and signs have already been erected to protect critical sandhills habitat. However, fences are often cut and neighboring equestrians use the area, resulting in large quantities of erosion (J.

McGraw, pers. comm. 2006; C. West, pers. obs. 2007). Another population (EO #14) on private land also shows much erosion due to recreation. This site is visible from nearby public land and supports some large specimens of *E. teretifolium* (C. West, pers. obs. 2007). Although there are "no trespassing" signs in place and wire fencing, there is extensive erosion, apparently from sandboarding (C. West, pers. obs. 2007). The effects of recreational activities are also apparent at the South Ridge site in Quail Hollow Quarry (former EO #1). Recreational activity at this site seems to be limited to hikers and dog-walkers accessing areas on foot, despite fencing and signage (C. West, pers. obs. 2007).

Conservation Measures Undertaken:

Research Efforts:
Research was completed by McGraw (2004a) on various habitat management strategies. This research focused on the response of *Erysimum teretifolium* to: prescribed fire versus manual vegetation clearing, the proximity of trees, and the interaction of soil disturbance and non-native plants. Research was completed by Brunette (1997) examining the soil seed bank and population structure of *E. teretifolium.* Research is currently under way at the Bonny Doon Ecological Reserve using manual vegetation clearing to determine its potential to improve *E. teretifolium* habitat and increase reproductive success.

Recreation Management: At Quail Hollow Ranch County Park (a portion of EO #1) and Quail Hollow Quarry South Ridge (a portion of EO #1), control of illegal recreational use has been undertaken via the erection of fencing to protect habitat. Although some reduction in traffic has occurred, human, dog, and horse tracks, cut wire fences, and substantial erosion indicate that fencing has not been adequate to protect these areas (C. West, U.S. Fish and Wildlife Service, pers. obs. 2007).

Habitat Restoration: Several restoration projects have included the removal of woody non-native plants. The Mount Hermon Association and the San Lorenzo Valley Water District removed brooms (*Cytisus* sp. and *Genista* sp.) and *Acacia* species with private stewardship grants through the USFWS, and the Zayante Fire Department and the Santa Cruz Resource Conservation District removed *Acacia* from Quail Hollow Ranch County Park (J. McGraw, *in litt*. 2006). Unfortunately, the effects of these clearing projects were short-lived and the brooms and *Acacia* have re-colonized these areas (J. McGraw, pers. comm. 2007b; R. Oliver, pers. comm. 2007). This underscores the difficulties involved with control of pioneering non-native species, which can drive succession in sandhills habitats.

2.3.2.2. Factor B, Overutilization for commercial, recreational, scientific, or educational purposes:

Overutilization was not identified as a factor at the time of listing, and is not known to currently be a factor.

2.3.2.3. Factor C, Disease or predation:

Predation of this species was not mentioned as a threat at the time of listing. Since then, observations of herbivory and potential effects at the population level have been noted by researchers (Brunette 1997, McGraw 2004b). Pocket gophers (*Thomomys bottae*) have been shown to consume up to 8 percent of rosettes prior to seed set in monitored populations (McGraw 2004b). Observations indicate that up to 37 percent of adult plants may be browsed by mule deer (*Odecoileus hemionus*), which greatly increases the likelihood of those plants dying without successfully reproducing (J. McGraw, pers. comm. 2007a).

2.3.2.4. Factor D, Inadequacy of existing regulatory mechanisms:

County Protections:
The sandhills parkland habitat is designated as a sensitive habitat through the Santa Cruz County Sensitive Habitats Protection Ordinance; reviews of projects within these areas should receive additional consideration for conservation of sensitive resources. However, limited conservation for the species is achieved through this mechanism. The City of Scotts Valley and the County are continuing to develop a HCP for the sandhills region; however, considerable work remains for this plan to be finalized. Therefore, many populations and their habitat on private land have not received protection or conservation.

State Protections:
Erysimum teretifolium has been afforded certain protections by the State of California since 1981 when it was State-listed as endangered. Under the California Endangered Species Act (CESA), import into state, export out of state, take, possession, purchasing, or selling *E. teretifolium* is illegal except as otherwise provided by the California Native Plant Protection Act (NPPA). The long list of exemptions associated with NPPA, especially with regard to privately owned property, severely limits the protections afforded under it. The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) does afford some protection for the species under State law via mitigation requirements; however, use of mitigation as a conservation tool is at the discretion of the lead agency and is not required.

Due to the requirement for State agencies to comply with CESA, populations on County Park and State Reserve lands (e.g., Bonny Doon State Ecological Reserve and Quail Hollow Ecological Reserve) would be considered as sensitive resources if projects were proposed at those sites. The State and County have not yet completed management plans that would include prescriptions for the species at these sites, so the CEQA process has not been initiated.

The California Surface Mining and Reclamation Act also affords some protections to sensitive species and habitats, but conservation under this act calls for protection as prescribed in the Endangered Species Act and CESA. Some direction is given

regarding reclamation and restoration; however, as noted in the discussion of sand mining under Factor A above, restored quarried areas are not likely to support successful, self sustaining, sandhills communities (McGraw 2004b; S. Schettler, pers. comm. 2006).

Federal Protections:

No populations are found on Federal lands. Where the species occurs on private lands, protections afforded by section 7 of the Endangered Species Act are triggered only if there is a Federal nexus (i.e., an action funded, permitted, or carried out by a Federal agency). On private lands without a federal nexus, HCPs are implemented by the landowner in conjunction with an incidental take permit to mitigate the effects of take. Only a few HCPs and management plans have been implemented so far and most have only provided a portion of the necessary protections. The USFWS has participated in the efforts to develop the HCPs mentioned above through section 10 of the Act (see sections 2.2.3 and 2.3.2.1).

While the above-listed regulations provide limited protections for *Erysimum teretifolium* on private and public property, many of the current threats to the species are either currently unregulated, or of a kind not addressed by land use regulations (such as invasive species encroachment, predation, and fragmentation effects). Thus regulatory restrictions, even when applicable, are currently inadequate to conserve this species.

2.3.2.5. Factor E, Other natural or manmade factors affecting its continued existence:

Fire Suppression and Non-native Plants:

Disruption of natural fire cycles was originally identified as a major threat at the time of listing, and remains as one of the most serious ongoing threats to the persistence of this species (McGraw 2004b; P. Levine, Environmental Coordinator, County of Santa Cruz Planning Department, pers. comm. 2006; J. McGraw, pers. comm. 2006; S. Schettler, pers. comm. 2006). Sandhills communities are fire-adapted, and fire plays a major role in resetting soil succession (McGraw 2004b). Fire has also been shown to play a role in the reduction of invasive non-native species in the sandhills parkland and chaparral habitat types (McGraw 2004b). Not only does suppression of fire directly leave leaf litter in place to accumulate, but McGraw (2004a) found that non-native species prevented sloughing of this litter that otherwise occurs easily during rain and wind events from the bare sandy soil. Subsequently, the litter build-up resulting from this anchoring effect by stems of non-native plants altered the temperature and light availability at the soil surface. Temperature and light cues experienced by *Erysimum teretifolium* seeds, on or within the bare sandy soil of its habitat, are required for germination (McGraw 2004a). Further, excessive litter allows additional non-native species to establish themselves due to changes in microclimate and exclusion of native species. This self-favoring process eventually alters soil conditions and encourages encroachment of woody species, which ultimately leads to habitat type conversion. Even with litter removal via manual

methods such as raking, McGraw (2004a) found that the remaining non-native plants reduced soil moisture content, causing an increased risk of desiccation in *E. teretifolium* seedlings. Manual litter removal also may disrupt natural nutrient and soil succession cycles. While natural sloughing of excess litter, as previously mentioned, keeps the sandy soil free of shading and cooling effects, there is also a possibility that the burning in place of some residual litter by frequent fires is needed to maintain certain levels of soil development. Burning of this vegetative matter may allow nutrients to remain available to subsequent generations germinating from existing seed banks.

Fire Suppression and Habitat Conversion:

At the time of listing, vegetation succession leading to increased canopy density due to fire suppression was considered a threat to *Erysimum teretifolium,* which is relatively intolerant of shade. Perhaps more importantly, the habitat conversion leading to this increased canopy density will eventually result in a habitat type which cannot support many of the open sand specialists unique to sandhills parkland (McGraw 2004b, P. Levine, pers. comm. 2006). Many areas where *E. teretifolium* formerly occurred have undergone extensive habitat conversion; in several of these areas, it is doubtful whether the open sandy soil required by this species still exists. Surveys are needed to determine if these sites still support populations. Several efforts to remove woody vegetation and/or non-native species have been carried out in locations that support *E. teretifolium.* While these efforts were successful in the short-term, all sites have reverted to pre-removal vegetation levels (J. McGraw, pers. comm. 2007b).

Stochastic Extirpation:

Due to the naturally patchy distribution of sandhills habitat, geographic and biological isolation of individual populations is to be expected; however, with increased successional pressures due to fire suppression, encroachment by nonnative plants, and human development, sandhills "islands" have shrunk in size and become even more fragmented (McGraw 2004b). Maintaining genetic diversity through gene flow among and within populations is achieved through two processes: seed dispersal and cross-pollination. Habitat fragmentation may affect both these processes. Because seed dispersal distance is limited in *Erysimum teretifolium* (seeds usually fall directly below the parent plant), fragmented populations are likely to remain isolated. Cross-pollination between populations is dependent on the availability of suitable habitat to sustain insect pollinators, and to allow pollinators to travel easily between populations.

As mentioned in section 2.3.1., trend information for many populations is lacking. Of the populations surveyed in recent years, most have had very low numbers of individuals, and many had no individuals present. As habitat conversion increases due to various factors and remaining habitat is further fragmented and reduced in size, populations will continue to shrink and the risk of stochastic extinctions will increase.

During recent surveys, several populations on the periphery of the range of the species were recorded as having no individuals. Typically, peripheral populations experience the lowest amount of gene flow and represent the most genetically distinct portions of a species range, often contributing significantly to genetic variation (Faugeron et al 2004, Eckstein et al 2006). This may be especially true for *Erysimum teretifolium*, given the fragmented mosaic that makes up the remaining sandhills parkland habitats of the Santa Cruz Mountains. Many individual sandhills habitat pockets, and hence *E. teretifolium* populations, are separated by large tracts of forested lands and deep, well-developed riparian systems. This fact indicates the potential of geographic isolation of these pockets for thousands or even hundreds of thousands of years (J. McGraw, pers. comm. 2008). If these peripheral populations have been extirpated, this could indicate a significant reduction in the genetic diversity of this species.

2.4. Synthesis

The primary threat at the time of listing was direct removal of habitat due to sand mining (USFWS 1994). Prior to listing, much existing prime habitat within the core of this species' range was lost or fragmented and likely cannot be restored. This activity is no longer an active threat because many of the quarry operations are either closed or nearing closure (McGraw 2004b; B. Davilla, Consultant, Ecosystems West, pers. comm. 2006). Residual effects, however, pose a serious challenge to future conservation efforts.

Alteration in habitat due to increased canopy cover and litter accumulation resulting from fire suppression is the most serious threat now facing the recovery of this species. Fire suppression and the proliferation of non-native plants continue throughout *Erysimum teretifolium*'s range and conversion of habitat to conditions unsuitable for the species is widespread. Introduction of fast-growing and hardy non-native species has only exacerbated the problem. Further declines in numbers of individuals and populations and continued habitat fragmentation, has increased the risk of stochastic extinction events in small, isolated populations of *E. teretifolium*, thus reducing chances for recovery of this species.

Herbivory of leaves and inflorescences, mainly by deer, is a threat that was not discussed at the time of listing. Potential effects of this herbivory include reduced survival and fecundity of plants resulting in a reduction of observed juvenile plants and seed banks (Brunette 1997; McGraw 2004b; J. McGraw, pers. comm. 2007a). This threat has yet to be addressed.

The result of the threats to this species mentioned above is a decline in numbers across most of the range and the extirpation of at least three known populations. A lack of consistent monitoring efforts makes determination of overall trends somewhat speculative. However, only two populations appear to be maintaining a stable size, and this has been achieved only with active management. Of the remaining known populations, half are either declining or possibly extirpated, and a lack of information regarding the remainder makes assessment of their status impossible. Moreover, only about 20 percent of existing populations are at sites protected from development through fee title acquisition, conservation easements, or HCPs.

Clearing of non-native brooms and acacia at some locations has been undertaken; however, recurrence of the removed vegetation at these sites has returned them to pre-removal levels. This clarifies the need not only for non-native and invasive species removal efforts, but for continued maintenance of sites to enhance potentially suitable habitat for *Erysimum teretifolium*. Studies at the one remaining population within Bonny Doon Ecological Reserve involving manual vegetation and ground litter removal are ongoing. These activities may provide restoration managers better methods with which to recover the remaining populations of this species.

Due to ongoing threats across the range of the species and observed declines in most populations for which data are available, we conclude that *Erysimum teretifolium* continues to meet the definition of endangered, and are not recommending a change of status.

3. RESULTS

3.1. Recommended Classification

____ Downlist to Threatened

____ Uplist to Endangered

____ Delist (Indicate reasons for delisting per 50 CFR 424.11):

__X_ No change is needed

3.2. New Recovery Priority Number _5_

This denotes a full species with a high degree of threat and low recovery potential.
This reflects a change from the previous recovery priority number 9, which indicated a subspecies (in error) with a moderate degree of threat and high recovery potential. This change in Recovery Priority Number reflects the decreases in population numbers observed in all monitored populations of this species and the extirpation of at least three of 20 known populations. Additionally, the primary current threat to this species, habitat conversion, remains unaddressed.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

1. Surveys and monitoring should be undertaken for all known populations and potential habitat to ensure that potential populations are identified and reliable demographic information is collected. Outreach to owners of private holdings with potentially conservable habitat and populations should be attempted and permission should be secured to survey these private holdings where necessary. Specifically, all populations listed in the CNDDB and McGraw (2004b) should be surveyed to focus future recovery efforts, especially the areas between and surrounding Vista Robles Drive and Marion Avenue in Ben Lomond and the area around the intersection of Pine Flat Road and Bonny Doon Road in Bonny Doon. In addition, coordination

of recovery partners and consolidation of population data into the CNDDB records should be undertaken. Additionally, survey methods should be standardized to insure data accuracy. Methods employed by Brunette (1997) may be suitable for this purpose.

2. Expand research efforts focusing on potential causes of reproductive failures and methods to increase reproductive success as mentioned in the "Needed Recovery Actions" section of the recovery plan. As part of these efforts, the effects of predation on the species should be examined and pollination mechanisms should be identified. With clarification of such processes, management of landscape level influences on the species may be undertaken, such as predatory deterrence and management of potential pollinator barriers. Such research may contribute greatly in the form of increased survival, boosting reproductive success, and maintaining inter-fragment pollination to maximize gene flow, thereby avoiding inbreeding depression.

3. More detailed knowledge of populations and completion of management plans should allow active management to prevent encroachment of both native and non-native species in fire-suppressed areas, which threaten type conversion of the habitat and potential extirpation of individual populations. Prescribed burns mimicking natural fire cycles would be the most effective way to thin vegetation and restore open habitat; however, in many areas the proximity of human habitation precludes this as an option. Mechanical means of vegetation and leaf litter removal (i.e., raking) have proven effective in reducing the chances of habitat type conversion (McGraw 2004a and McGraw 2004b). Effectiveness of this method to improve *Erysimum teretifolium* habitat and increase reproductive success is being examined at Bonny Doon Ecological Reserve. If these studies prove effective, this method should be initiated in occupied habitat where fire would create unacceptable risk to local communities. Outreach to local landowners in such areas may facilitate the implementation of such management strategies over larger, contiguous pieces of occupied habitat and thereby maximize the conservation potential of all remaining populations. Such vegetation clearing efforts should be approached from a fuels reduction angle, which further benefits all parties involved.

4. Increased USFWS oversight as time allows may accelerate completion of the draft HCP with the County of Santa Cruz and other management plans under development. These plans need to be completed to help guide implementation of effective recovery efforts.

5. We suggest the USFWS consider revising the third criterion for downlisting in the recovery plan. This criterion lists specific HCPs by name. Many HCP projects are abandoned for various reasons. Additionally, entities listed on HCPs may change name and ownership over time. Such changes may in turn lead to alterations of the HCP title or content. For these reasons, including specific HCPs in draft form as downlisting or delisting criteria should be avoided. A blanket statement reflecting the need to include the species in any HCP that covers its occupied range would be more appropriate.

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APPENDIX 1: Summary of documented populations of *Erysimum teretifolium*

Identifier used in this review (ID#)	CNDDB Identifier (EO#)	Size class of sandhills habitat[a]	Owner/Manager	Maximum Number of Individuals Seen at Site (Year)	Minimum Number of Individuals Seen at Site (Year)	Number of Individuals Seen During Last Survey (Year)
1	1	Large	Private (Graniterock)	10,000+ (1983)	600 (xx)	900 (2006)
2	1	Large	Private	700+ (?)	400 (1986)	400 (1986)
5	5	Large	Private	8 (1977)	0 (2003)	0 (2003)
6	6	Medium	Private (Cemex)	<1000 (planted) (2006)	65+ (xx)	<1000 (planted) (2006)
7	7	Medium	California Department of Fish and Game	<1000 (1982)	0 (Several surveys since 1995)	0 (Several surveys since 1995)
9	9	Unknown	Private	"Numerous" (1938)	0 (1986)	0 (1986)
11	11	Medium	Private	512 (1995)	363 (1986)	(?) Slight increase with plantings
12	12	Small	Unknown	? (Collected 1936)	155 (1986)	155 (1986)
13	13	Unknown	Unknown	? (Collected 1939)	0 (1986)	0 (1986)
14	14	Small	Private	100+ (1983)	10 (1982)	70 (1986)
16	11	Large	Private	? (Collected 1957)	0 (1986)	0 (1986)
18	18	Unknown	Unknown	? (Collected 1899)	? (Collected 1899)	? (Collected 1899)
22	1	Medium	County of Santa Cruz/State of California	440+ (?)	30 (2006)	30 (2006)
23	23	Small	Private	200 (1986)	200 (1986)	200 (1986)
24	24	Small	Private	128 (1986)	128 (1986)	128 (1986)
25	25	Small	Private	40 (1986)	40 (1986)	40 (1986)
26	26	Small	Private	140 (1986)	140 (1986)	140 (1986)
27	27	Small	Private	1 (1986)	Site built upon. Habitat gone.	N/A
28	28	Small	California Department of Fish and Game	2000+ (1994)	77 (2006)	77 (2006)
Beulah Park	None	Unknown	Unknown	Unknown	Unknown	N/A

[a] Small = <10 acres; Medium = 10 to 100 acres; Large = >100 acres.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Ben Lomond wallflower (*Erysimum teretifolium*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened

____ Uplist to Endangered

____ Delist

_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

Review Conducted By: Chris West

FIELD OFFICE APPROVAL:

Field Supervisor, Fish and Wildlife Service

Approve Diane K Noda Date 7/2/08

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve Acting Date 7/10/08