

Sand Food (*Pholisma sonorae*)

Legal Status

State: S2¹

California Rare Plant Rank:
1B.2²

Federal: Bureau of Land
Management Sensitive

Critical Habitat: N/A

Recovery Planning: N/A



Photo courtesy of Jordan Zylstra.

Taxonomy

Sand food (*Pholisma sonorae*) is a parasitic perennial herb now placed in the borage family (Boraginaceae), although the genus was previously included in the lennoa family (Lennoaceae) (Jepson Flora Project 2011a; CNPS 2011a). *Pholisma sonorae* was published as a new combination by G. Yatskievych in 1982 based on the synonym *Ammobroma sonorae* published by A. Gray in 1854 (Jepson Flora Project 2011b). Sand food stem length is approximately 5 to 15 decimeters (1.6 to 4.9 feet) in height (CPC 2010; Jepson Flora Project 2011a). A full physical description of the species can be found in the Jepson eFlora (Jepson Flora Project 2011a).

Distribution

General

Sand food occurs in the Sonoran Desert in southeastern Imperial County, and in western Arizona and northwestern Mexico (Figure SP-P29; CNPS 2011a; Jepson Flora Project 2011a). All of the California occurrences are in the Plan Area (CDFG 2011a).

¹ **S2:** Imperiled.

² **1B:** Rare, threatened, or endangered in California and elsewhere; **X.2:** Fairly threatened in California.

Distribution and Occurrences within the Plan Area

Historical

Of the 12 occurrences documented in the California Natural Diversity Database (CNDDDB), 10 are considered historical, with the oldest dating back to 1902. However, these occurrences are still presumed to be extant, and more recent collections have been made in some of these areas from the Consortium of California Herbarium (CCH) and are discussed below (CCH 2011). The historical CNDDDB occurrences range from Kane Spring southeast to Midway Well and Ogliby in Imperial County (CDFG 2011a; Figure SP-P29).

Recent

The two recent occurrences of sand food in the Plan Area by the CNDDDB are in the Algodones Dunes and south of Highway 78 in the northern portion of East Mesa (CDFG 2011a). The Algodones Dunes populations are on lands managed by the Bureau of Land Management (BLM) (CDFG 2011a; BLM 2010). The East Mesa occurrence is located on Department of Defense lands managed by the Navy (CDFG 2011a).

There are also CCH records that would update historical CNDDDB records. There appears to be a collection from 2010 mapped at Element Occurrence #1 that is on Department of Defense Navy lands in the northern portion of East Mesa (CCH 2011; CDFG 2011a). Another CCH collection from 2001 overlaps Element Occurrence #27 west of Glamis on lands managed by the BLM (CCH 2011; CDFG 2011a).

Natural History

Habitat Requirements

Sand food occurs in low desert on dunes (CNPS 2011a; Jepson Flora Project 2011a) in drifting deep sand, usually on the windward face (CDFG 2011a). In the Algodones Dunes, it was generally found in somewhat flat areas (Phillips et al. 2001). Sand food lacks chlorophyll and is parasitic on roots of desert perennials, usually shrubs. Desert eriogonum (*Eriogonum deserticola*), fan-leaf tiquilia (*Tiquilia plicata*),

and Palmer's tiquilia (*T. palmeri*) appear to be the most common host plants, but others that have been recorded include Wiggin's croton (*Croton wigginsii*), Spanish needle (*Palafoxia arida*), ragweed (*Ambrosia* spp.), camphorweed (*Pluchea* spp.), and possibly honey mesquite (*Prosopis glandulosa*) (CDFG 2011a; CCH 2011; Jepson Flora Project 2011a). Sand food grows below 200 meters (656 feet) (CNPS 2011a; Jepson Flora Project 2011a). Table 1 lists primary habitat associations and parameters for sand food.

Table 1. Habitat Associations for Sand Food

Land Cover Type	Habitat Designation	Habitat Parameters	Supporting Information
Desert dunes, Sonoran Desert scrub	Primary	Sandy soils, below 656 feet elevation	CNPS 2011a; CDFG 2011a; Jepson Flora Project 2011a

Reproduction

Sand food blooms from April to June (CNPS 2011a). The inflorescences form the "cap" of this mushroom-shaped species with several purple flowers forming a ring toward the outer edge of the cap. The hairy calyces surrounding each flower produce a gray-white fuzzy appearance and protect the plants from sun and heat (CPC 2010). Each flower head produces hundreds of fruit capsules, each with 12–20 one-seeded nutlets about 1.0 millimeter (0.04 inch) in diameter (AGFD 2004).

Seed germination is probably stimulated by chemicals secreted from host roots (Kujit 1969, cited in Armstrong 1980). Sand food seeds are very small and might be moved around in the wind-blown sand or washed into cracks (Armstrong 1980). In addition, certain ants, such as harvester ants, could possibly carry the small seeds into their storage burrows deep in the sand (Armstrong 1980).

Likely pollinators of sand food in order of decreasing importance are sand wasp (*Bembix rugosa*), midge (*Leptoconops californiensis*), and bee flies (*Aphoebantus* spp.) (Wiesenborn 2003). In addition, small ants and mealybugs have been observed on mature flower heads (Armstrong 1980).

Ecological Relationships

Sand food is a perennial root parasite lacking chlorophyll that dies back to undifferentiated tissue at the infection site on the host plant every year (AGFD 2004). It may fail to appear during drought years (AGFD 2004). However, based on monitoring in the Algodones Dunes, sand food abundance is not strongly correlated with precipitation, probably because it depends upon the health of its host plants, which are all relatively long-lived perennial species (Willoughby 2004).

Sand food produces special “pilot” roots that explore and seek the host plant roots; then haustorial roots develop to invade the host plant (Kujit 1969, cited in Armstrong 1980). Host plant species include white bursage, desert eriogonum, arrow-weed, Emory’s psorothamnus, fan-leaf tiquilia, and Palmer’s tiquilia. Both sand food and the host plants appear robust and healthy even during severe drought (CPC 2010).

Sand food’s succulent stems store a lot of water (Phillips et al. 2001). Because sand food has no root hairs, water is probably taken directly from the sand and absorbed through the stomata on the scale-like leaves. Sand food stems are composed mainly of water-storage tissue and can store large amount of water (Armstrong 1980). Sand food can be very large and can be heavier than its host, able to outweigh its host by more than 36 times. It appears to be capable of storing enough water and nutrients to not “overtax” its host (Armstrong 1980). Water can actually move into the host plant during times of drought stress (Yatskievych 1985, cited in CPC 2010). Therefore, the relationship between sand food and its host plant is not parasitic in the strictest sense; host plants do not appear to be negatively affected by infestation and may even benefit from the interaction (AGFD 2004).

Moreover, sand food is fleshy and palatable and was a food source for Native Americans (Armstrong 1980).

Population Status and Trends

Global: G2, Imperiled (CDFG 2012b)

State: S2, Imperiled (CDFG 2012b)

Based on 6 years of monitoring data (1977, 1998, 1999, 2000, 2001, and 2002), Willoughby (2004) observed that the abundance of sand food in the area open to off-highway vehicle (OHV) use (subject to interim closure in November 2002) of the Algodones Dunes managed by the BLM was higher in 2002 compared to any of the earlier years. This may have resulted at least in part from sampling methods because, unlike in previous years, 4 of the 24 transects were walked rather than driven (Willoughby 2004). However, the abundance class values observed in 2002 were higher than could be accounted for by the difference in sampling methods alone. Because the species is cryptic and poses no hazard to vehicle tires, it is unlikely that the species is avoided by dune buggies (Willoughby 2004). Therefore, the higher 2002 values may also be the result of the additional protection afforded by interim vehicle closures that went into effect in November 2000. On the other hand, the values in 2001 for the area open to OHV use were not correspondingly higher as would have been expected if vehicle closures were responsible for an increase in sand food abundance. However, compliance with the OHV closure may have improved in 2002 over 2001 (Willoughby 2004).

Beginning with a pilot study in 2003, the BLM shifted its monitoring to estimate actual densities and population numbers, as opposed to the abundance class approach used from 1998 to 2002 (Willoughby 2004). In 2004, 78,417 sand food inflorescences (both live and dead) were estimated to occur throughout the entire Algodones Dunes; of these, an estimated 46,470 were living inflorescences (Willoughby 2005). Densities of sand food were much higher in 2004 in the area of the Algodones Dunes north of State Highway 78 than in the dunes south of the highway, possibly because the dunes are lower in the north with higher cover of host plants such as desert eriogonum (Willoughby 2004).

Threats and Environmental Stressors

Sand food is threatened by vehicles, military activities, agriculture, habitat loss, and non-native plants (CNPS 2011a). The Imperial (Algodones) Dunes are located primarily on BLM lands within the Plan Area, and although OHV use has been restricted in a small section of habitat, the majority of the land is open to the public. Potential host plants and sand food are subject to destruction where they are located close to OHV recreational sites (CPC 2010).

Conservation and Management Activities

One of the known sand food occurrences recorded in CNDDDB is located in the Imperial Sand Dunes Recreation Area managed by BLM (CDFG 2011b). The BLM has prepared an Imperial Sand Dunes Draft Recreation Area Management Plan that, when approved, will be implemented for the protection and management of Algodones Dunes species, including sand food (BLM 2010).

Since 1998, the BLM, California Department of Fish and Game (CDFG), and California Native Plant Society (CNPS) have participated in annual surveys that monitor several endemic plant species in the Algodones Dunes (also known as the Imperial Sand Dunes), including sand food. Surveys were conducted in both wilderness and in OHV Open Areas. The BLM analyzes these data and uses them to make land management decisions (CNPS 2011b). BLM transects across the dunes counted 486 flower heads in 1998, 385 in 1999, 1,576 in 2000, 3,740 in 2001, and 3,317 in 2002. More comprehensive surveys in 2004 counted approximately 78,417 flower heads (CDFG 2011b).

In November 2000, BLM was required by court order to temporarily close five areas in the Imperial Sand Dunes Recreation Area to OHV use, totaling 49,300 acres (73 FR 41007–41022; USFWS 2008). These vehicle closures will remain in place until the Imperial Dunes Recreation Plan has been finalized and approved by the court.

Data Characterization

The general distribution of sand food is well known based on its restriction in California to the Sonoran Desert in southeastern Imperial County (Jepson Flora Project 2011a). Population trends are not well established because monitoring efforts have been affected by differing sampling methods, timing of surveys, and differences in survey areas between survey years (Willoughby 2004, 2005). Specific factors affecting sand food occurrences are not well understood. Sand food occurrences in the Algodones Dunes were difficult to predict—many sites support sand food hosts but lack sand food (Phillips et al. 2001).

Management and Monitoring Considerations

Sand food would likely benefit from management of OHV use in occupied areas in the Imperial Sand Dunes Recreation Area. The BLM has prepared the Imperial Sand Dunes Draft Recreation Area Management Plan that, when approved, will be implemented for the protection and management of Algodones Dunes species, including sand food (BLM 2010).

Dunes must remain unstabilized for sand food to persist (CPC 2010). However, although dune stabilization at the Barry Goldwater bombing range may be an issue, the sheer size of the Algodones Dunes (40 miles long and 3–6 miles wide) will ensure that stabilization will not be an issue except in geological time frames. In addition, because seeds do not reliably germinate, and there is no known way of perpetuating sand food seeds in cultivation, in situ conservation efforts rather than ex situ conservation are the key to perpetuation of the species (CPC 2010).

Sand food is a cryptic plant; only the inflorescence is visible aboveground. Therefore, monitoring can only be done during or after flowering since it is impossible to detect non-flowering plants. Differences in sand food abundance between years of sampling in the BLM Wilderness Management Area may have resulted from differences in the timing of monitoring (Willoughby 2005).

Predicted Species Distribution in Plan Area

There are 988,904 acres of modeled suitable habitat for sand food in the Plan Area. Modeled suitable habitat occurs in the southern portion of the Plan Area up to 1,400 feet in elevation. Modeled suitable habitat includes Mojavean-Sonoran desert scrub or cliff, scree, and other rock vegetation communities with sand dune or sedimentary substrates. Appendix C includes specific model parameters and a figure showing the modeled suitable habitat in the Plan Area.

Literature Cited

- 73 FR 41007–41022. Proposed Rule: “Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to Delist *Astragalus magdalenae* var. *peirsonii* (Peirson’s milk-vetch).” July 17, 2008.
- AGFD (Arizona Game and Fish Department). 2004. “*Pholisma sonorae*.” Draft Plant Abstract, compiled and edited by Heritage Data Management System. Phoenix, Arizona: AGFD. Last revised February 5, 2004. Accessed November 15, 2011. www.azgfd.com/w_c/edits/documents/Pholsono.d_003.pdf.
- Armstrong W.P. 1980. “Sand Food: A Strange Plant Of The Algodones Dunes.” *Fremontia* 7:3–9.
- BLM (Bureau of Land Management). 2009. “Vehicle Closures.” *U.S. Department of the Interior, Bureau of Land Management, California, El Centro Field Office*. Accessed May 27, 2011. http://www.blm.gov/ca/st/en/fo/elcentro/recreation/ohvs/isdra/dunesinfo/vehicle_closures.html.
- BLM. 2010. *Imperial Sand Dunes Draft Recreation Area Management Plan and Draft Environmental Impact Statement*. Vol. II. U.S. Department of Interior Control no. DES-09-16; Publication Index no. BLM/CA/ES-2009-023+1793. El Centro, California: BLM, El Centro Field Office. March 2010. Accessed May 2011. <http://www.blm.gov/ca/st/en/fo/elcentro/recreation/ohvs/isdra/dunesinfo/docs/isdramp.html>.

CCH (Consortium of California Herbaria). 2011. Accession results for *Eriogonum kennedyi* var. *pinicola*. Accessed December 28, 2011. <http://ucjeps.berkeley.edu/consortium>.

CDFG (California Department of Fish and Game). 2012a. "*Pholisma sonorae*." Element Occurrence Query. California Natural Diversity Database (CNDDDB). RareFind, Version 4.0 (Commercial Subscription). Sacramento, California: CDFG, Biogeographic Data Branch. Accessed February 2012.

CDFG. 2012b. *Special Vascular Plants, Bryophytes, and Lichens List*. California Natural Diversity Database (CNDDDB). January 2012. Accessed March 2012. http://www.dfg.ca.gov/biogeodata/cnddb/plants_and_animals.asp.

CNPS (California Native Plant Society). 2011a. "*Pholisma sonorae*." *Inventory of Rare and Endangered Plants*. Online ed. Version 8-01a. Sacramento, California: CNPS. Accessed November 2011. <http://www.cnps.org/inventory>.

CNPS. 2011b. "Conservation Program." Accessed November 18, 2011. http://cnps.org/cnps/conservation/desert_actions.php.

CPC (Center for Plant Conservation). 2010. "*Pholisma sonorae*." *CPC National Collection of Imperiled Plants Plant Profiles*. Last revised February 4, 2010. Accessed November 15, 2011. http://www.centerforplantconservation.org/collection/cpc_viewprofile.asp?CPCNum=3407.

Jepson Flora Project. 2011a. "*Pholisma sonorae*." G. Yatskievych. *Jepson eFlora* [v.1.0]. Berkeley, California: University of California. Accessed December 5, 2011. <http://ucjeps.berkeley.edu/IJM.html>.

Jepson Flora Project. 2011b. "*Pholisma sonorae* (Torr. ex A. Gray) Yatsk." Jepson Interchange for California Floristics. Accessed December 5, 2011. http://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?37884&expand=1.

NatureServe. 2011. "*Pholisma sonorae*." *NatureServe Explorer: An Online Encyclopedia of Life*. Version 7.1. Arlington, Virginia:

NatureServe. Last updated July 2011. Accessed November 2011. <http://www.natureserve.org/explorer>.

Phillips, A.M., III, D.J. Kennedy, and M. Cross. 2001. *Biology, Distribution, and Abundance of Peirson's Milkvetch and Other Special Status Plants of the Algodones Dunes, California*. Final Report. Prepared for the American Sand Association. Submitted by Thomas Olsen Associates Inc.

USFWS (U.S. Fish and Wildlife Service). 2008. *The 5-Year Review: Short Form Summary for Astragalus magdalenae var. peirsonii (Peirson's milk-vetch)*. Carlsbad, California: USFWS. September 2008.

Weisenborn, W.D. 2003. "Insects on *Pholisma sonorae* (Lennoaceae) Flowers and Their Conspecific Pollen Loads." *Madroño* 50:110–114.

Willoughby, J. 2004. *Monitoring of Special Status Plants in the Algodones Dunes, Imperial County, California, 1977, 1998, 1999, 2000, 2001, and 2002*. Sacramento, California: Bureau of Land Management, California State Office. October 2004.

Willoughby, J. 2005. *2004 Monitoring of Special Status Plants in the Algodones Dunes, Imperial County, California*. Sacramento, California: Bureau of Land Management, California State Office. March 24, 2005.

