Santa Cruz Island Malacothrix

(*Malacothrix indecora*)

5-Year Review: Evaluation and Summary

Photo: Ken Niessen, USFWS

U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
Ventura, California

September 2022

GENERAL INFORMATION:

Species: *Malacothrix indecora*
FR citation: 62 FR 40954
Date listed: July 31, 1997
Classification: Endangered

BACKGROUND:

Most recent status review:
U.S. Fish and Wildlife Service. 2010. *Malacothrix indecora* (Santa Cruz Island malacothrix) and *Malacothrix squalida* (island malacothrix) 5-Year Review: Summary and Evaluation. Ventura Field Office. Ventura, California.

FR Notice citation announcing this status review:
Initiation of 5-Year Status Reviews of 40 species in California, Nevada, and Oregon. Notice of initiation of reviews; request for information (87 FR 5832), February 2, 2022.

ASSESSMENT:

Introduction:
Santa Cruz Island malacothrix *(Malacothrix indecora*, Asteraceae) is an annual forb that grows to 10 centimeters (4 inches) tall and has medium yellow flowers. The species generally occurs on coastal bluffs and slopes, often on midden sites, at elevations of less than 20 meters (65 feet). The species occurs on Santa Cruz Island, Santa Rosa Island, and San Miguel Island, Santa Barbara County, California. The islands are part of Channel Islands National Park (CINP). Most of Santa Cruz Island (76%) is private property of The Nature Conservancy, CINP owns the rest of Santa Cruz Island and all of Santa Rosa Island, and San Miguel Island is owned by the Navy but is administered by CINP. Both CINP and TNC lands are managed for natural resource conservation.

Santa Cruz, Santa Rosa, and San Miguel Islands each have a history of non-native mammalian herbivores (Table 1, McEachern *et al*. 2016 pp. 759-760, A. Adams, pers. comm. 2021) which greatly affected island plants and vegetation. At the time of Santa Cruz Island malacothrix listing in 1997, cattle, sheep, pigs, and horses were on Santa Cruz Island, cattle, elk, mule deer, and horses were on Santa Rosa Island, and San Miguel had only black rats. On Santa Cruz Island, all the non-native ungulates were removed before the 2010 5-yr review, and on Santa Rosa Island cattle were removed before, and elk, mule deer, and horses were removed after the 2010 5-year review. Black rats remain present on San Miguel Island, but on the west end, which is the other end of the island about 13 kilometers (8 miles) from where Santa Cruz Island malacothrix occurs.

Table 1. Non-native mammalian herbivores on Santa Cruz (SCZ), Santa Rosa (SRI), and San Miguel (SMI) Islands (McEachern *et al*. 2016 pp. 759-760, A. Adams, pers. comm. 2021). Bold common names indicate species present on the islands after Santa Cruz Island malacothrix 1997 listing, and bold dates indicate last date on island after listing.

common name	scientific name	dates present SCZ	dates present SRI	dates present SMI
goat	*Capra aegagrus hircus*	late 1880s, 1919 - 1920	1883 - early 1900s	late 1880s - 1890?
fallow deer	*Dama dama*	never introduced	1890 - 1949	never introduced
donkey	*Equus africanus asinus*	never introduced	1880s	early 1950s - 1976
cattle	*Bos taurus*	1830 - **1999**	1844 - **1998**	1851 - 1917?
sheep	*Ovis aries*	1853 - **2001**	1869 - 1937	pre1850 - early 1970s
pig	*Sus scrofa domestica*	1852 - **2006**	never present	1851 - 1897?
elk	*Cervus canadensis*	never introduced	1879 - **2011**	never introduced
mule deer	*Odocoileus hemionus*	never introduced	1880 - **2015**	never introduced*
horse	*Equus ferus caballus*	1830 - **2009**	1844 - **2020**	1851 - 1958
black rat	*Rattus rattus*	never introduced	never introduced	early 1900s-**present**

* One radio-collared mule deer swam from Santa Rosa Island to San Miguel Island in late 2012 or early 2013 (Williams *in litt*. 2022).

At the time of the 1997 listing of Santa Cruz Island malacothrix (Service 1997), the threats to the species were soil loss and habitat alteration by non-native mammalian herbivores (pigs and sheep on Santa Cruz Island and cattle, mule deer and elk on Santa Rosa Island), herbivory by the same non-native mammals, habitat alteration and trampling by seabirds, extirpation and extinction because of genetic effects of small population sizes and random catastrophic events, and competition from non-native plants. The 2000 recovery plan (Service 2000) also identified trampling by hikers. The 2010 5-year review (Service 2010) specified competition with introduced iceplants (*Carpbrotus* spp. and *Mesembryanthemum* spp.), and identified the threat of increased susceptibility to wave and storm damage resulting from climate change.

This current 5-year review evaluates these previously identified threats to Santa Cruz Island malacothrix, and discusses the current significance of these threats. The current 5-year review does not identify any additional threats to the species.

Information acquired since the last status review:
This 5-year review was conducted by the U.S. Fish and Wildlife Service (Service) Ventura Fish and Wildlife Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on February 2, 2022. We also contacted species experts to request any data or information we should consider in our review. Additionally, we conducted a literature search and a review of information in our files.

Population data:
Distribution: The distribution of Santa Cruz Island malacothrix has not changed since the last 5-year review (Service 2010). There are at three extant and one historical occurrences on Santa Cruz Island, one extant occurrence on Santa Rosa Island, and two presumed extant occurrences on San Miguel Island (Table 2). The San Miguel Island occurrences have not been visited in more than 20 years; whether they remain extant is unknown. Santa Cruz Island malacothrix, contrary to information in the last 5-year review, is not known to occur on Anacapa Island (Appendix A).

Table 2. Santa Cruz Island malacothrix occurrences and documented abundances. **CNDDB** = California Natural Diversity Database (CDFW 2022), **EO** = Element Occurrence, **SCZ** = Santa Cruz Island, **SRI** = Santa Rosa Island, **SMI** = San Miguel Island CCH2 = Consortium of California Herbaria 2 database.

CNDDB EO #	island	occurrence	year	source	# of plants
1	SCZ	Black Point	1980	CNDDB 2022	101 – 1,000
1	SCZ	Black Point	1985	CNDDB 2022	present
1	SCZ	Black Point	2000	CNDDB2022	0
1	SCZ	Black Point	2003	McEachern *et al.* 2010	0
1	SCZ	Black Point	2004	McEachern *et al.* 2010	0
1	SCZ	Black Point	2019	Schneider and Carson 2019	present
1	SCZ	Black Point	2020	Schneider and Carson 2020	present
2	SCZ	Twin Harbors	1939	CCH2 2022	present
6		Potato Harbor	1968	CCH2 2022	present
6	SCZ	Potato Harbor	2006	McEachern *et al.* 2010	18
6	SCZ	Potato Harbor	2019	Schneider and Carson 2020	present
6	SCZ	Potato Harbor	2020	Schneider and Carson 2020	present
7	SCZ	Platt's Harbor	2006	McEachern *et al.* 2010	125+
7	SCZ	Platt's Harbor	2019	CaPR 2022	300
7	SCZ	Platt's Harbor	2020	Schneider and Carson 2020	present
5	SRI	Lobo Cyn to Cow Cyn	1996	CNDDB 2022	519
5	SRI	Lobo Cyn to Cow Cyn	1998	CNDDB 2022	13,194
5	SRI	Lobo Cyn to Cow Cyn	1999	CNDDB 2022	3,750
5	SRI	Lobo Cyn to Cow Cyn	2000	CNDDB 2022	1000 - 4,000
5	SRI	Lobo Cyn to Cow Cyn	2003	Levine *et al.* 2008	~9,000
5	SRI	Lobo Cyn to Cow Cyn	2004	Levine *et al.* 2008	~5,000
5	SRI	Lobo Cyn to Cow Cyn	2005	Levine *et al.* 2008	~2,500
5	SRI	Lobo Cyn to Cow Cyn	2006	Levine *et al.* 2008	~2,000
5	SRI	Lobo Cyn to Cow Cyn	2007	Levine *et al.* 2008	~1,000
5	SRI	Lobo Cyn to Cow Cyn	2017	McEachern *et al.* 2021	5 - 10
5	SRI	Lobo Cyn to Cow Cyn	2018	McEachern *et al.* 2021	5 - 10
5	SRI	Lobo Cyn to Cow Cyn	2019	McEachern *et al.* 2021	447 - 517
5	SRI	Lobo Cyn to Cow Cyn	2020	McEachern *et al.* 2021	1,100
5	SRI	Lobo Cyn to Cow Cyn	2021	McEachern and Gados 2021	505
5	SRI	Lobo Cyn to Cow Cyn	2022	McEachern in litt. 2022	3,627
3	SMI	Cuyler Harbor	1932	CCH2 2022	present
3	SMI	Cuyler Harbor	1995	CCH2 2022	several hundred
3	SMI	Cuyler Harbor	1998	CNDDB 2022	4,574
3	SMI	Cuyler Harbor	1999	CNDDB 2022	1,626
3	SMI	Cuyler Harbor	2002	CNDDB 2022	5,351

CNDDB EO #	island	occurrence	year	source	# of plants
4	SMI	between Hoffmann Pt and Glass Float Beach	1932	CCH2 2022	present
4	SMI	between Hoffmann Pt and Glass Float Beach	1995	CCH2 2022	250+
4	SMI	between Hoffmann Pt and Glass Float Beach	1998	CNDDB 2022	9,448
4	SMI	between Hoffmann Pt and Glass Float Beach	1999	CNDDB 2022	12,767 – 18,767
4	SMI	between Hoffmann Pt and Glass Float Beach	2002	CNDDB 2022	9,771

Abundance: Often the abundance of Santa Cruz Island malacothrix has not been recorded, and when it has been, there can be a few to several thousand individuals (Table 2) per occurrence in a particular year. However, the exhaustiveness of surveys varies, and many of the survey results in Table 2 may represent partial counts. In general, the Santa Cruz Island occurrences seem to have few plants, and the San Miguel occurrences, while historically larger (up to 14,000 plants) have not been visited in more than 20 years so their current condition is unknown. The single Santa Rosa Island occurrence is typically a few hundred to a few thousand plants.

Trends in abundance: Trends in abundance are difficult to identify with the current data. The longest time series, for Lobo Canyon to Cow Canyon, is irregularly variable over more than 20 years, with a high of more than 13,000 in 1998 and steadily decreasing numbers between 2003 (~9,000) and 2007 (~1,000). The last count, in 2022, was ~ 3,500 plants.

Conservation seed banking:
There are several recent accessions of wild collected Santa Cruz Island malacothrix seed from Platt's Harbor on Santa Cruz Island and Lobo Canyon to Cow Canyon on Santa Rosa Island in a Center for Plant Conservation approved conservation seed bank (Table 3). Potato Harbor, Twin Harbor, and Black Point on Santa Cruz Island and both occurrences on San Miguel Island are not represented.

Table 3. Santa Cruz Island malacothrix conservation seed banking at a Center for Plant Rescue approved facility. Data from CaPR 2022. **CNDDB** = California Natural Diversity Database, **EO** = Element Occurrence, **SRI** = Santa Rosa Island, **SCZ** = Santa Cruz Island, **SBBG** = Santa Barbara Botanic Garden. * = additional seed banked at the National Laboratory for Genetic Resource Preservation

CNDDB EO #	population	island	collection date	facility	bulked or maternal lines	# maternal lines	# seeds
5	Lobo Cyn to Cow Cyn	SRI	6/16/2017	SBBG	maternal lines	5	unknown
5	Lobo Cyn to Cow Cyn	SRI	6/28/2018	SBBG	maternal lines	2	unknown
5	Lobo Cyn to Cow Cyn	SRI	5/21/2020	SBBG	bulked	na	959 (*477)
5	Lobo Cyn to Cow Cyn	SRI	5/25/2020	SBBG	maternal lines	25	1753 (*748)
5	Lobo Cyn to Cow Cyn	SRI	5/21/2020	SBBG	bulked	na	1393 (*694)
5	Lobo Cyn to Cow Cyn	SRI	5/25/2021	SBBG	maternal lines	45	1710 (*709)
7	Platt's Harbor	SCZ	5/2/2019	SBBG	maternal lines	3	166
7	Platt's Harbor	SCZ	5/18/2019	SBBG	bulked	na	194
7	Platt's Harbor	SCZ	5/28/2021	SBBG	maternal lines	2	59

Restoration seed bulking:
Santa Cruz Island malacothrix has been grown in the nursery for restoration seed bulking (Schneider and Carson 2020 pp. 18-21, Schneider *et al.* 2021 pp. 15-16, 19-21, 23; Table 4). Individuals are self-compatible (successful pollination can occur within plants) and self-fertilizing (successful pollination can occur without an external pollen vector), but pollination can be enhanced by hand-pollination (Schneider and Carson 2020 p. 19).

Table 4. Santa Cruz Island malacothrix restoration seed bulking at the Santa Barbara Botanic Garden. 2020 data from Schneider and Carson 2020; 2021 data from Schneider *et al.* 2021. **SCZ** = Santa Cruz Island; **SRI** = Santa Rosa Island.

year	island	# seeds sown	# seeds germinated	% germination	# of plants becoming reproductive	total # of seeds produced
2020	SCZ	297	37	12	not reported	29,299
2021	SRI	50	4	8	not reported	43,419
2021	SCZ	233	28	12	10	64,302

Two conclusions can be reached from seed bulking data. First, percent of germination is similarly low when comparing years or islands. Second, even with relatively few seeds germinating and seemingly few seedlings surviving to reproduction, large numbers of seeds can be produced in the nursery. However, if nursery-produced seeds perform similarly to wild-collected seeds, it may be that only about 10% of the resulting seeds are viable. Results of seed viability tests, if they were performed, were not reported.

Tissue collection for genetic study:
Although there are currently no plans to conduct any genetic study of Santa Cruz Island malacothrix, tissue was collected for future work from 5 plants from each of the three extant Santa Cruz Island occurrences (Schneider and Carson 2020, pp. 37-38).

Life history research:
The 2010 5-year review briefly mentions what was then ongoing work by Levine *et al.* (2008, 2010, 2011) to describe island precipitation patterns (p. 17). The three papers describe the results of field work on Santa Rosa Island, and are discussed below.

Levine *et al.* (2008, pp. 799-803) found low natural abundance of Santa Cruz Island malacothrix in drought years, and variable abundance in non-drought years, with a large amount of that variability in abundance explained by the temperature of the first major rain of the season. Relatively high rainfall amounts, as in an El Nino year, result in low seed set and population growth rate. Additionally, they found a weak negative correlation between population growth rate and surrounding vegetation cover.

In an experimental field precipitation study, Levine *et al.* (2010, pp. 136-138) found that Santa Cruz Island malacothrix population growth rate was relatively insensitive to precipitation amount, and that population growth rate could be limited by competition with surrounding vegetation. The most abundant competitor, the native *Lasthenia gracilis* (Asteraceae, at the time identified as *Lasthenia californica*), is sensitive to rainfall amounts, so its competitive effects can be negligible at lower rainfall amounts.

In a second experimental study, Levine *et al.* (2011 pp. 2241-2242) again found that Santa Cruz Island malacothrix germination responded positively to the temperature associated with the first major storm of the season and that warmer nightly low temperatures after the storm were associated with reduced germination. Consistent with greater germination in cooler storm events, Santa Cruz Island malacothrix showed declining germination from 5º to 10º C (41º to 50º F), which covers the range of natural temperature variation in storm events. Fecundity did increase with later precipitation due to greater likelihood of plant survival over the growing season. Both variation in germination and fecundity contribute to the population growth rate.

Summarizing these three papers, Santa Cruz Island malacothrix germinates best in years with an initial cold major rain and grows best if that is followed by a normal total rainfall amount spread over a relatively long season. The species is susceptible to competition, but can better tolerate drier conditions that its most abundant competitor. With some later season rainfall, plants can live longer, and have increased fecundity, and both germination and fecundity affect population growth rate.

EVALUATION OF THREATS:

At the time of the 1997 listing of Santa Cruz Island malacothrix (Service 1997), the threats to the species were soil loss and habitat alteration by non-native mammalian herbivores (pigs and sheep on Santa Cruz Island and cattle, mule deer and elk on Santa Rosa Island), herbivory by the same non-native mammals, habitat alteration and trampling by seabirds, extirpation and extinction because of genetic effects of small population sizes and random catastrophic events, and competition from non-native plants. The 2000 recovery plan (Service 2000) also identified trampling by hikers. The 2010 5-year review (Service 2010) specified competition with

introduced iceplants (*Carpobrotus* spp., *Mesembryanthemum* spp.), and identified the threat of increased susceptibility to wave and storm damage as a result of climate change. The current 5-year review does not identify any additional threats to the species. The current importance of the identified threats is evaluated below.

Soil loss and habitat alteration by non-native ungulate herbivores:
With the complete removal of non-native ungulate herbivores on Santa Cruz Island by 2006 (Table 1, 1-2 horses remained until 2009) there has been significant passive soil and vegetation recovery (Beltrane *et al.* 2014 entire). This is also the case for Santa Rosa Island after most of the animals were removed by 2011 (Table 1, except for a few deer until 2014 and a few horses until 2020), and even more so for San Miguel Island, where ungulates were removed by the mid-1970s. Subjectively, there is little current indication of continuing soil loss and habitat degradation from the past effects of non-native mammalian herbivores in areas where Santa Cruz Island malacothrix occurs (K Niessen pers. obs.). While direct impacts of non-native mammalian herbivores are gone, it is likely that the effects of non-native plants facilitated by the ungulates will continue into the future (see *Competition with non-native plants* below).

Herbivory by non-native ungulate herbivores:
With the complete removal of non-native ungulate herbivores, the threat of herbivory has been eliminated.

Competition with non-native plants:
At the time of listing (Service 1997), competition with non-native plants was identified as a general threat to listed Channel Island plants. In the last 5-year review (Service 2010), Santa Cruz Island malacothrix was specifically considered to be threatened by competition from non-native iceplants (Aizoaceae: *Caprobrotus* spp. and *Mesembryanthemum* spp.). No research has been conducted to examine possible effects of non-native iceplants on Santa Cruz Island malacothrix. It may be that iceplants do have negative effect, but if so, the magnitude of the threat is unknown.

Santa Cruz Island malacothrix may compete with surrounding vegetation (Levine *et al.* 2010 p. 136), particularly the native annual *Lasthenia gracilis*, but the intensity of competition is likely to vary with vegetation density as determined by rainfall. If non-native grasses are potential or actual competitors, their effects may increase in the future. Non-native annual grasses may increase with anticipated climate change (Sandel and Dangremond 2012 entire), and thus negative effects competition on Santa Cruz Island malacothrix may increase. Threat of competition of from non-native annual grasses remains.

Climate change and sea level rise:
Expected climate change for the geographic region of the northern Channel Islands predicts both rising annual temperatures (Langridge 2018 pp. 13-15) and less frequent, more episodic rainfall (Langridge 2018 pp. 16-17). Changes in climate could threaten Santa Cruz Island malacothrix in two ways, as demonstrated by work on Santa Rosa Island. First, as vegetation and habitat shift with climate change, Santa Cruz Island malacothrix might not be able to disperse to suitable germination or recruitment habitat (Levine *et al.* 2008 p. 796). Second, the proper environmental cues (low temperature at first major rainfall) could occur less frequently or not at all, decreasing

germination of Santa Cruz Island malacothrix and causing declines in abundance and possible extirpations (Levine *et al.* 2008 pp. 800-805; Levine *et al.* 2011 pp. 2241-2246). Climate change mediated vegetation shifts and changes in germination cues are threats to the species.

In the California Channel Islands, climate change induced sea level rise is predicted to be about 0.25 m (0.8 ft) by 2050 (Sweet *et al*. 2022 p. 19) and 1.0 m (3.3 ft) by 2100 (Sweet *et al.* 2022 p. 23). Santa Cruz Island malacothrix is generally found below 20 meters (60 feet) elevation on the immediate coast on relatively soft substrate. All occurrences are threatened by storm surf erosion even without climate change induced rising sea level, which increases the threat. Sea level rise is an increasing threat for the species.

Genetic effects of small population sizes and random catastrophic events:
The Santa Cruz Island occurrences of Santa Cruz Island malacothrix have few plants, and the San Miguel occurrences, while historically larger (up to 14,000 plants) have not been visited in more than 20 years so their current condition is unknown. The single Santa Rosa Island occurrence is typically a few hundred to a few thousand plants. While under nursery conditions, a relatively robust plant can produce several thousand seeds (Table 4), only about 10% of these seeds germinate, and about half of the seedlings survive to reproduction. Santa Cruz Island malacothrix likely has seeds that remain viable in the soil for fewer than 10 years (K. McEachern, USGS, pers. comm. 2022). Overall, for occurrences where above-ground numbers are few, it follows that the number of viable seeds in the soil seed bank are also few. Few plants in few locations, a small soil seedbank, and poor seed viability all make Santa Cruz Island malacothrix more vulnerable to population extirpation and species extinction (Gilpin and Soule 1986 p. 32). The threat of extinction for Santa Cruz Island malacothrix by random naturally occurring events due to limited distribution and small population sizes remains.

Habitat alteration and trampling by seabirds:
At listing, seabirds were described as trampling and negatively altering the habitat of Santa Cruz Island malacothrix on San Miguel Island and adjacent Prince Island. Prince Island is a mistaken location for Santa Cruz Island malacothrix (Appendix A). The occurrences on San Miguel Island have not been visited in more than 20 years, so the threats from seabirds there are currently unknown, but are presumed to still exist.

Trampling by hikers:
Because the Santa Cruz Island occurrences of Santa Cruz Island malacothrix are extremely difficult to access and off-trail hiking on San Miguel Island is prohibited, the occurrences of Santa Cruz Island malacothrix on these islands are not likely to be threatened by trampling by hikers. However, the Santa Rosa Island occurrence is continually threatened by hiker trampling because its edge is within 30 centimeters (1 foot) of a very popular day hiking trail between Lobo Canyon and Cow Canyon, and day hikers do not always stay on the trail. Cow Canyon beach is the closest approved backcountry beach camping area northwest of the pier at Becher's Bay. Campers are known to illegally camp on the marine terraces above approved backcountry beach camping areas, and at Cow Canyon these marine terraces are locations where Santa Cruz Island malacothrix grows. There have been as many as 14,000 plants in this occurrence, but the numbers are highly variable, with some years having fewer than 10 plants. The Santa Rosa Island occurrence is particularly important because it is the only one on the island, and likely

genetically distinct from occurrences on Santa Cruz and San Miguel Islands. It is also important because currently the Santa Cruz Island occurrences have small population numbers, while the numbers of plants in the San Miguel Island occurrences, although large more than 20 years ago, are currently unknown. This means the Santa Rosa Island occurrence has the largest recently documented number of plants of all occurrences, and if it inadvertently becomes extirpated by hiker/camper activity, it could be the extirpation of the majority of the plants of the species. This could be prevented if the area of the Santa Rosa Island occurrence were made off limits to the public from the time of first rains and germination (October) to the time of last seed dispersal (August).

Summary of threats:
The threats to Santa Cruz Island malacothrix from soil loss and habitat alteration from non-native ungulate herbivores have been substantially decreased. However, the competitive effects of non-native plants that were facilitated by non-native mammalian herbivores remains, and may well increase under climate change.

The species remains threatened by decreased reproductive vigor and stochastic extirpation and extinction because it has so few populations, so few individuals, perhaps a small soil seed bank, and seeds of low viability. Climate change may threaten Santa Cruz Island malacothrix by causing spatial shifts in habitat that the species cannot follow, and disrupt germination cues and conditions such that successful recruitment decreases. Additionally, climate change induced rising sea level may enhance erosion of low elevation locations where the species occurs. The San Miguel Island occurrences may remain threatened by seabird roosting and nesting activities, and the Santa Rosa Island occurrence between Lobo and Cow Canyons is threatened by trampling from day hikers and campers.

EVALUATION OF DOWNLISTING AND DELISTING CRITERIA:

The current status of criteria in the 2000 Recovery Plan (Service 2000, pp. 67) is as follows:

Downlisting criteria for Santa Cruz Island malacothrix

1. *Maintain existing stable populations on San Miguel, Santa Cruz, and Santa Rosa Islands for a period of 15 years that includes the normal precipitation cycle.*
    - Most populations have not been monitored regularly since the time of the recovery plan. This criterion has not been met.
2. *Seed stored in CPC cooperating facilities.*
    - There is some seed for two occurrences stored in a CPC (Center for Plant Conservation) cooperating facility; it is not comprehensive across the species distribution or across years. This criterion has not been met.
3. *Seed germination and propagation techniques understood.*
    - Seeds have been successfully germinated and bulked in the nursery. This criterion has been met.
4. *Successful outplanting techniques developed.*

- Experimental outplanting has successfully been conducted (Levine *et al.* 2008, 2010, 2011). This criterion has been met.

5. *Life history research conducted.*
    - The life history of Santa Cruz Island malacothrix has been well researched (Levine *et al.* 2008, 2010, 2011). This criterion has been met.
6. *Weed management plan developed and implemented.*
    - Channel Islands National Park has no weed management plan. This criterion has not been met.
7. *If declining, determine cause and reverse trend.*
    - Data are not available to effectively evaluate trends in abundance. This criterion has not been met.

Delisting criteria for Santa Cruz Island malacothrix

1. *No decline after downlisting for 10 years.*
    - This criterion is not currently applicable.
2. *All potential habitat surveyed.*
    - There is other potential habitat on Santa Cruz Island and San Miguel Island that has not been surveyed for the species. This criterion has not been met.

CONCLUSION:

The evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and the analysis of the status of the species in our previous 5-year review remain accurate reflections of the species current status. After reviewing the best available scientific information, we conclude that Santa Cruz Island malacothrix remains an endangered species.

RECOMMENDATIONS FOR FUTURE ACTIONS:

1. Survey San Miguel Island occurrences to verify their continued persistence.
2. Establish regular monitoring for known natural populations of Santa Cruz Island malacothrix on Santa Cruz, Santa Rosa, and San Miguel Islands.
3. Enhance existing natural populations on Santa Cruz Island.
4. Establish new recovery populations on Santa Cruz Island.
5. Improve the completeness of coverage over years for Santa Cruz Island malacothrix in conservation seed banks, for both Santa Cruz and San Miguel Islands.
6. Survey additional potential habitat on Santa Cruz and San Miguel Islands.
7. Restrict public access to the Lobo Canyon-Cow Canyon population during the Santa Cruz Island malacothrix growing season.

APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approved STEPHEN HENRY Digitally signed by STEPHEN HENRY
Date: 2022.09.26 14:05:57 -07'00'

LITERATURE CITED:

Beltran, R.S., N. Kreidler, D.H. Van Vuren, S.A. Morrison, E.S. Zavaleta, K. Newton, B. Tershy, and D.A. Croll. 2014. Passive restoration of vegetation after herbivore eradication on Santa Cruz Island, California. Restoration Ecology 22: 790-797.

[CaPR] California Plant Rescue. 2022. Online seed collection database. Retrieved August 22, 2022 from https://www.caplantrescue.org/collections-database.html#memberssearch

[CCH2] Consortium of California Herbaria. 2022. Symbiota Portal search for *Malacothrix squalida*. Retrieved August 22, 2022, from https://www.cch2.org/portal/collections/listtabledisplay.php

[CDFW] California Department of Fish and Wildlife. 2022. California Natural Diversity Database (CNDDB) Occurrence Report. Retrieved August 22, 2022, from https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx#

Hochberg, M.C., S.A. Junak, R.N. Philbrick, and S. Timbrook. 1979. Botany. Pp. 5.1 – 5.92 in D.M. Power (ed.). Natural Resources Study of the Channel Islands National Monument, California. Prepared for the National Park Service (Contract No. CX-2000-8-0040) by Santa Barbara Museum of Natural History, Santa Barbara, California. 712 pp.

Langridge, R. 2018. Central Coast Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.

Levine, J. M., K. McEachern, and C. Cowan. 2008. Effects of a fluctuating rainfall environment on rare island annual plants. Journal of Ecology 96:795-806.

Levine, J. M., K. McEachern, and C. Cowan. 2010. Do competitors modulate rare plant response to precipitation change? Ecology, 91:130–140.

Levine, J. M., K. McEachern, and C. Cowan. 2011. Seasonal timing of first rainstorms affects rare plant population dynamics. Ecology 92:2236-2247.

McEachern, K., T. Atwater, P.W. Collins, K. Faulkner, and D.V. Richards. 2016. Managed Island Ecosystems. Pp. 755-778 in H. Mooney and E. Zavaleta (eds.) Ecosystems of California. University of California Press, Berkeley, California. 984 pp.

McEachern, A.K., Chess, K.A., and Niessen, K.G. 2010, Field surveys of rare plants on Santa Cruz Island, California, 2003–2006: Historical records and current distributions. U.S. Geological Survey Scientific Investigations Report 2009–5264, 34 p.

McEachern, K. and M. Gados. 2021. USGS Threatened and endangered plant recovery research activities in the northern Channel Islands, California, 2021. U.S. Geological Survey WERC Channel Islands Field Station Annual Activities Report to the U.S. Fish and Wildlife Service, Ventura Field Office, Ventura, CA. USGS-WERC, Ventura, CA. 26 pp.

McEachern, A.K., Niessen, K.G., Rudolph, R.P., and Lee, L.F.S. 2021. Rare plant occurrences geodatabase for the northern Channel Islands. U.S. Geological Survey data release, https://doi.org/10.5066/P9ZRSZ1N.

Sandel, B., and E.M. Dangremond. 2012. Climate change and the invasion of California by grasses. Global Change Biology 18: 277-289.

Schneider, H.E. and S.A. Carson. 2020. A comprehensive collaborative project to recover 14 listed plant species on the Channel Islands – 2020 annual report. Unpublished report, Santa Barbara Botanic Garden, Santa Barbara, CA. 48 pp.

Schneider, H.E., K.M. Mason and S.A. Carson. 2021. A comprehensive collaborative project to recover 14 listed plant species on the Channel Islands – 2021 annual report. Unpublished report, Santa Barbara Botanic Garden, Santa Barbara, CA. 54 pp.

[Service] U.S. Fish and Wildlife Service. 1997. Endangered and Threatened Wildlife and Plants; Final Rule for 13 Plant Taxa from the Northern Channel Islands, California FR 62 40954-40974.

[Service] U.S. Fish and Wildlife Service. 2000. Thirteen plant taxa from the northern Channel Islands recovery plan. Portland, Oregon. 94 pp.

[Service] U.S. Fish and Wildlife Service. 2010. *Malacothrix indecora* (Santa Cruz Island malacothrix) and *Malacothrix squalida* (island malacothrix) 5-Year Review: Summary and Evaluation. Ventura Field Office. Ventura, California. 38 pp.

Gilpin, M.E. and M.E. Soule. 1986. Minimum viable populations: Processes of species extinction. Pp. 19-34 in M.E. Soule (ed.) Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, Massachusetts. 584 pp.

Sweet, W.V., B.D. Hamlington, R.E. Kopp, C.P. Weaver, P.L. Barnard, D. Bekaert, W. Brooks, M. Craghan, G. Dusek, T. Frederikse, G. Garner, A.S. Genz, J.P. Krasting, E. Larour, D. Marcy, J.J. Marra, J. Obeysekera, M. Osler, M. Pendleton, D. Roman, L. Schmied, W. Veatch, K.D. White, and C. Zuzak. 2022. Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp.

In litteris:

Cowan, C. 2022. Email regarding *Malacothrix* on East Anacapa Island in 2010. *In litteris* sent to Ken Niessen, Botanist, U.S. Fish and Wildlife Service, Ventura Fish and Wildlife Office, Ventura, California. Dated August 16 2022.

Davis, W.S. 1987. Letter regarding *Malacothrix indecora* description and occurrences. *In litteris* sent to Rick York. From files at California Natural Diversity Data Base, Sacramento. Dated June 21 1987.

Junak, S. 2022. Email regarding *Malacothrix* on East Anacapa Island in 2010. *In litteris* sent to Ken Niessen, Botanist, U.S. Fish and Wildlife Service, Ventura Fish and Wildlife Office, Ventura, California. Dated August 16 2022.

McEachern, K. 2022. Email regarding 2022 Lobo-Cow Malacothrix indecora survey. *In litteris* sent to Ken Niessen, Botanist, U.S. Fish and Wildlife Service, Ventura Fish and Wildlife Office, Ventura, California. Dated July 22 2022.

Williams, I. 2022. Email regarding mule deer on San Miguel Island. *In litteris* sent to Ken Niessen, Botanist, U.S. Fish and Wildlife Service, Ventura Fish and Wildlife Office, Ventura, California. Dated Aug 23 2022.

APPENDIX A:

When reviewing literature for this 5-year review, several errors were discovered in previous Service documents. These errors are listed below. These errors do not affect the status of the species as determined by this 5-year review, and do not change the overall conclusions of the previous documents.

1. The 2010 5-year review (Service 2010, pp. 2, 6, Table 1 p.8, and elsewhere) reported that Santa Cruz Island malacothrix had been collected in 2010 on East Anacapa Island. There are no records of these collections in the Consortium of California Herbaria database (CCH2 2022), in CNDDB (CDFW 2022), or in the CINP rare plant geodatabase maintained by USGS (McEachern *et al.* 2021). Island plant experts agree that they have never seen Santa Cruz Island malacothrix specimens from Anacapa Island (Cowan *in litt.* 2022, M. Guilliams SBBG pers. comm. 2022, Junak *in litt.* 2022, K. McEachern USGS pers. comm. 2022), and that material examined from 2010 from East Anacapa Island was a different taxon, *Malacothrix foliosa* subsp. *crispifolia* (Junak *in litt*. 2022).
2. The 1997 listing document (Service 1997 p. 40961) and the 2000 recovery plan (Service 2000 p. 47) incorrectly state that the species was collected on Prince Island, offshore from San Miguel Island; this is repeated in the last 5-year review (Service 2010 p. 5, but not in Table 1 p.7). From the relevant references (Hochberg *et al*. 1979 and Davis *in litt.* 1987), it is clear that Prince Island was used as a reference point for locations on San Miguel Island, and that the collections were made on San Miguel Island.
3. The last 5-year review (Service 2010 p. 7, Table 1) incorrectly combines three different locations into CNDDB EO 2. Green 1886 has no information that allows it to be ascribed to a particular geographic location on Santa Cruz Island and is not included in any EO. Williams 1939 correctly belongs in EO 2 at Twin Harbors. Chess *et al.* 2006 is not at EO 2 but is at EO 7 at Platt's Harbor.
4. The 2000 Recovery Plan (Service 2000, pp. 67) incorrectly switches the common names for *Malacothrix indecora* and *Malacothrix squalida* in the recovery criteria table. The scientific names are correct.