Ventura Marsh Milk-vetch

(Astragalus pycnostachyus var. *lanosissimus)*

2025 Management and Monitoring Report

UC Santa Barbara North Campus Open Space & Coal Oil Point Reserve
January 20, 2026

Cheadle Center for Biodiversity and Ecological Restoration
Claire Wilhelm-Safian, Wayne Chapman, Lisa Stratton

Executive Summary

Ventura marsh milk-vetch *(Astragalus pycnostachyus var. lanosissimus)* is a California state and federally endangered species in the legume family (Fabaceae) which historically grew in alluvial coastal systems in Los Angeles and Ventura counties (USFWS, 2020). The species was declared extinct in the 1960s after several decades without record in surveys, but was rediscovered in 1997 in Oxnard at a planned development site; development was halted and the site was preserved in the following decades. Since then, the species has been reintroduced at McGrath State Beach in 2004 and Carpinteria Salt Marsh Reserve in 2002.

The establishment of Ventura marsh milk-vetch at North Campus Open Space and Coal Oil Point Reserve (COPR) in Santa Barbara County represent novel introductions outside of the historic range. These two locations comprise the upper and lower arms of the Devereux Slough, and intermittently tidal estuarine system. Ventura marsh milk-vetch prefers shallow or perched water tables in a dynamic system with somewhat regular disturbances to reduce competitive pressure. There was an earlier introduction to COPR in 1999 that was extirpated in 2019. The Cheadle Center reintroduced the species to COPR in 2022 in experimental seeding plots throughout the reserve, as well as establishing two experimental plots at the UCSB Campus Lagoon. Since these introductions, the Ventura marsh milk-vetch has flourished at North Campus Open Space in the original "main population" along the sandy edge of the slough and in several smaller occurrences throughout the open space. At Coal Oil Point Reserve, two of the nine seeding plots have established small, but consistent occurrences of milk-vetch over the last three years. The Campus Lagoon proved unsuitable habitat for the milk-vetch, with a lower water table than expected and significantly higher competitive pressure.

The populations at North Campus Open Space and Coal Oil Point Reserve both require active management and monitoring for continued survival of the species. Competition from both native and invasive species has been compounded by Nitrogen fixation by the milk-vetch and invasive *Melilotus sp.* These sites are vital to the conservation of a critically endangered species with only a handful of occurrences in the world. We hope the data and observations collected in this report will help inform future conservation efforts throughout the species range.

Introduction

Outplanting History

UC Santa Barbara's Cheadle Center for Biodiversity and Ecological Restoration (Cheadle Center) began working with the US Fish and Wildlife Service to plan for the introduction of the federally-endangered Ventura marsh milk-vetch (*Astragalus pycnostachyus var. lanosissimus*) at UCSB's North Campus Open Space (NCOS) in 2018. The first individuals were planted in a sandy site with high sub-surface soil moisture on the upper edge of the highwater mark of the newly restored upper arm of Devereux Slough in November 2019. These individuals were grown from seed collected from the original rediscovered population in Oxnard courtesy of Mary Carroll, the senior ecologist managing the site. In an effort to protect plants from inundation during times when the slough is fully ponded and to mimic conditions that may be related to success at planted locations in Ventura, five east-west trending berms approximately 1.5 meters wide, 0.5 meters tall, and 10 meters long were constructed with a small tractor. These were also designed to test the effect of subtle differences between north and south facing slopes as was observed in Ventura. The orientation of the berms later appeared to be unimportant at this site. At the same time, 6 milk-vetches were outplanted in the EEM Swale, a willow woodland with sandy soils near an ephemeral stream. In November 2019, 237 ten-month-old plants, grown at the Cheadle Center nursery, were planted on the site – 231 in the primary site "sandy zone" and six in the EEM Swale. Subsequently, more adults were planted on adjacent sandy mounds in the sandy zone in September 2020 (55) and October 2020 (46) (Figure 1). The outplanting effort is detailed in previous reports (Stratton et al., 2021). By 2024, the passage of time and the accumulation of

nitrogen in the soil of the main population and sandy zone had enabled invasion and increased competition from weedy species such as yellow sweetclover *(Melilotus indicus),* rabbit's foot grass *(Polypogon monspeliensis),* Western ragweed *(Ambrosia psilostachya)*, and horseweed *(Erigeron canadensis).* During the dormancy period in late 2024, managers used a tractor to artificially disturb the northern end of the main population, as well as sections in the middle, replacing the top 0.5-1 foot of nitrogen-rich soil and creating three additional berms. Several nursery-grown adults were outplanted on the newly constructed berms.

Experimental Seeding History

a. Seeding on NCOS

In December 2020, an estimated five cups of unprocessed seed were collected from the main population of previously planted individuals and dispersed experimentally across different zones of NCOS that were seen as potentially suitable habitat for the expansion of this initial population. The seeds were spread adjacent to the original planting in the "sandy zone" on a northeast-facing slope and sandy plain just southeast of the main planted population on similarly exposed fine sandy soils (Figure 1). The "Tule Seep" is a perennially wet seep surrounded by arroyo willow *(Salix lasiolepis)* and tule *(Shoenoplectus californicus)* and underlain by clay and clay loam soils. Whittier Pond is a small freshwater pond that holds stormwater year-round. The "bioswale" site is a string of vernal pools descending in elevation northwest from the mesa into the saltmarsh and has dense clay soils. Finally, several square meter plots were seeded on South Parcel on sandy soils, in mixed riparian woodland and coastal sage habitats. Each of these five zones received one cup of collected seed and fruit material. In November of 2023, a sixth seeding zone, "vernal pool swale," was added to NCOS, extending south upstream from the Bioswale population and encompassing a string of six established vernal pools. The outer transitional zone of each vernal pool was seeded with about one quart of fruiting material, for a total of ~6 quarts, collected in summer 2023. At each seeding site, germinating seedlings were observed and monitored on a monthly basis during the growing season in the first 3 years, and four times over the course of 2024, and three times in 2025.

b. Seeding Off NCOS

In the winter of 2022-23, an additional nine experimental plots were seeded at the adjacent Coal Oil Point Reserve (COPR) and two at the Campus Lagoon. Several previous attempts to establish populations at COPR were ultimately unsuccessful. Despite initial vigor, the out-planted individuals were lost to various factors, including long periods of inundation, low precipitation in dry years, rodent herbivory, and the colonization of the open planting sites by willows, ruderal natives, and creeping wild rye grass *(Elymus triticoides)* (USFWS, 2020). The 2022-23 seeding effort was paired with four index wells to study the relationship between milk-vetch success and the height of the water table and groundwater salinity. Soil samples were taken from each seeding site and analyzed for soil salinity, percent moisture, pH, and nutrient content. Findings were consistent with assumptions of the milk-vetch's life history preferences. The only successful seeding sites were those with a high water table throughout the year. Milk-vetch tended to prefer saltier groundwater, low soil SAR, and sandy, well-drained, nutrient-poor soils. The full results are detailed in the previous annual report (Chapman et al., 2024b).

Despite initial vigor in several of the seeding sites in 2023, there was only one plot, near the Dune Pond, where milk-vetch reached reproductive maturity. The Dune Pond is a ground and surface water-fed fresh to brackish coastal pond on COPR. The adjacent experimental plot often floods during the rainy season; it was inundated for approximately six weeks during February and March of 2024. As a result, no milk-vetch from the previous year survived the winter senescence. In 2024, new germinates at the COPR and the Lagoon seeding sites were monitored four times between spring and fall. Water level and quality data were collected from the index wells.

Several volunteer populations and individuals were discovered in 2023 and 2024 far from any of the purposefully seeded or planted sites. These include a group of 36 seedlings on the mesa grassland ("Grassland"), 8 near some public benches by the parking lot ("Roost"), and a single individual on the bank of the slough's eastern arm near Dilling's Link bridge ("Dilling's Link") (Figure 1). We theorize that these seeds may have been dispersed via animal or water, but the exact mechanism is unclear. Nevertheless, the milk-vetch's ability to disperse unaided by humans implies a certain level of resilience and sustainability of the NCOS metapopulation.

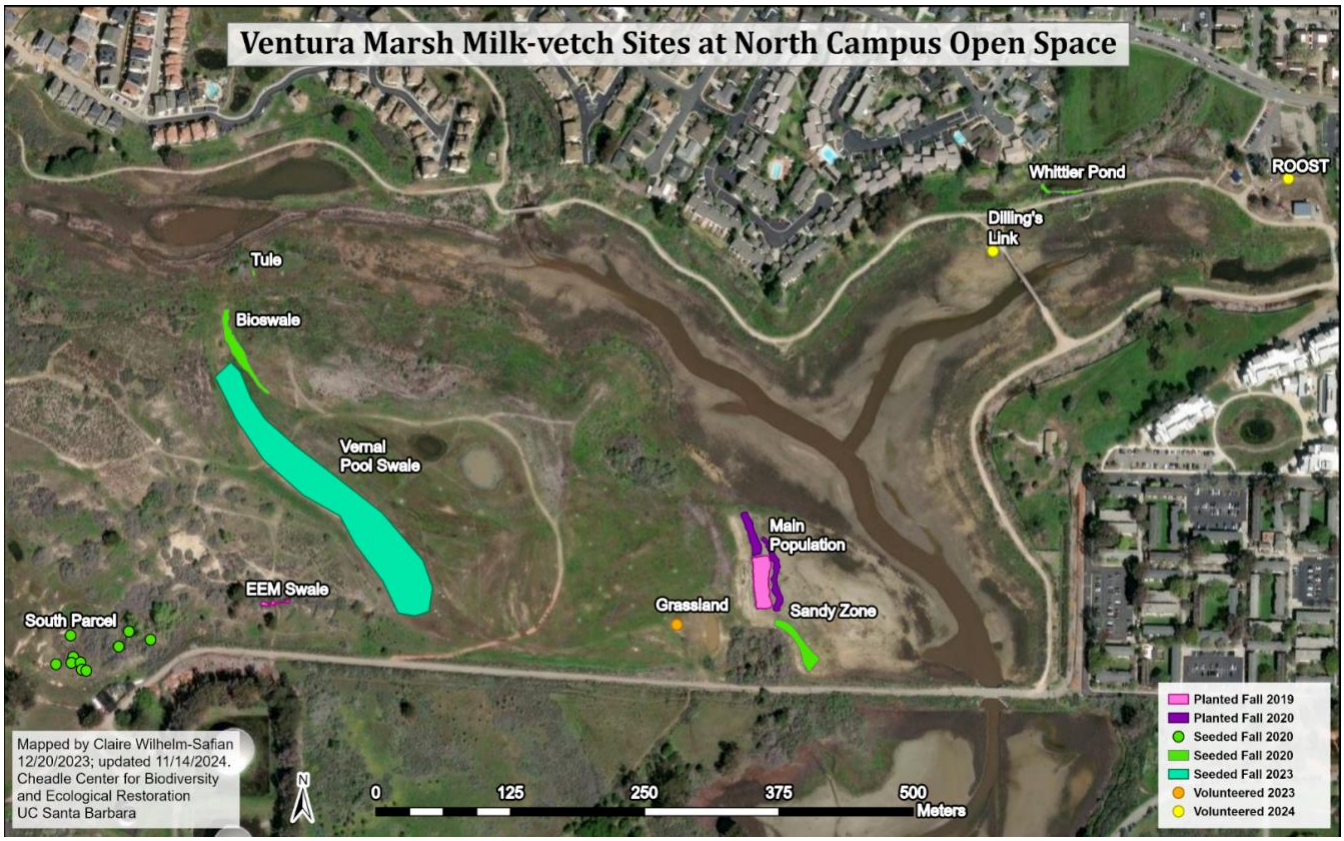

Figure 1: Map of milk-vetch plantings and seed dispersal sites at North Campus Open Space.

Monitoring Results (2019-2025)

Main Population

In previous years, each adult milk-vetch was tagged and tracked individually. However, due to the density and size of the population, it was logistically infeasible to maneuver within the area in 2023 without trampling and potentially killing plants. In that year, a sampling survey strategy was used to estimate the adult population (Chapman et al., 2024a). Although the population size and density declined in 2024, the continuity of that granular data had been disrupted, with many of the 2023 generation left untagged. In addition, due to erosion of the slope above the population, large amounts of sand have been deposited within its area, burying the ID tags from previous generations, or leaving it unclear which individual the tags referred to. Rather than tracking each adult individually, the main population was counted once in August, during the week of the seedling survey.

In 2025, the abundance had declined to the point that a complete count of both seedlings and adults was feasible without too high of a threat of trampling the milk-vetch. On February 18, just the seedlings were counted. This survey of early germinates found 1,405 seedlings. A full count of the main population was conducted in August during the peak bloom period. Each seedling was counted and its

vigor was evaluated on a scale of 1 to 4 (1 = good, 2 = fair, 3 = poor, 4 = dead). Adults were counted as well, but their vigor was not evaluated aside from dead individuals. The number of reproductive adults with either flowers or fruits was also recorded. A total of 790 adults were counted in the main population, 780 (98.7%) of which were reproductive (Figure 2). Both the number of adults and the percentage of the population that were reproductive are higher than in the August of the previous year (308 adults, overall 51.3% of which were reproductive). Additionally, 3,109 living seedlings and 1,081 dead seedlings were recorded with a relatively healthy average vigor of 2.20 (Figure 3). Overall, the population had an average vigor of 2.01.

Main Population

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2020	197	12	185	NA	95.7%
2021	524	63	461	NA	100%
2022	18 881	16 957	1 924	NA	96.6%
2023	15 078	14 264	814	2.24	75.6%
2024	3 462	3 154	308	1.77	51.3%
2025	3 899	3 109	790	2.01	98.7%

Figure 2: Table showing the main population's abundance broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2020 and 2025.

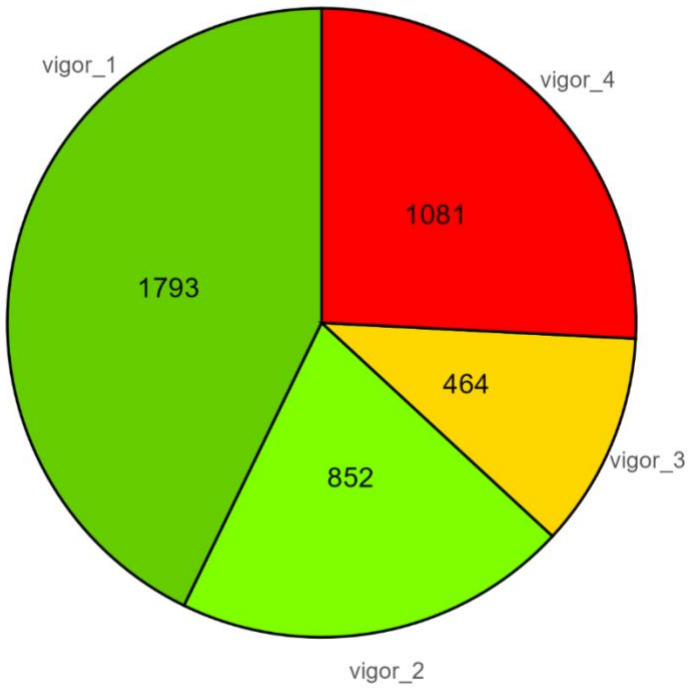

Figure 3: A pie chart showing the relative vigor of seedlings counted at the main population during the peak bloom period in August 2025.

Due to funding limitations, active management of invasive and native competitors within the main population was less frequent than in previous years. Non-native species, largely dominated by *Polypogon monspeliensis* and *Melilotus indicus* (also including *Festuca myuros, F. perennis, Bromus hordeaceus, B. tectorum, Plantago coronopus,* and *Pseudognaphalium luteoalbum)* were removed by hand, as time and resources allowed, in spring. An increase in milk-vetch germination and growth was observed following removal. By summer, much of the empty sand cleared of weeds was replaced with native forbs such as *Heterotheca grandiflora, Erigeron canadensis, Epilobium ciliatum, Ambrosia psilostachya*. On the eastern edge, where there is a slightly higher water table, several patches of wetland plants such as *Juncus bufonius, Bolboschoenus maritimus, Distichlis spicata*, *Salix sp.,* and *Cyperus eragrostis* have expanded their footprints.

What was once open, unvegetated sand when the milk-vetch was first planted in fall of 2019 has gradually been colonized by other species of forbs and grasses. The milk-vetch is a nitrogen-fixing plant, so its presence on the landscape has likely made it possible for other species to gain a foothold in this sandy plain by adding plant-available nitrogen to the soil. Unfortunately, one of those species is *Melilotus indicus,* itself an N-fixing legume. Excessive nitrogen-fixation may represent a positive feedback loop that exacerbates invasion and competition. One should also take into account the milk-vetch's short life expectancy of 3-5 years (though according to managers at McGrath State Beach, a few individuals as old as 10 years have been recorded in Oxnard). Considering that the first generation of plants were outplanted in this zone in Fall of 2019, this population decline may represent the natural ecological succession of the plant community. Fewer active management work hours, increasing plant-available nitrogen, two successive wet rain years, and an increasing seed bank have all played a role in the increase of weedy species and the decline of Ventura marsh milk-vetch from its peak in 2022. Despite the drop in population from the peak in 2022 and 2023, the site still supports 2000% more volunteer milk-vetch plants than were initially planted in 2019.

In order to manage the higher nitrogen content created by N-fixation as well as the weedy seedbank, a tractor was used to move soil from the main population and replace it with comparatively less N-rich sand from adjacent areas in the winter of 2024. The northern end of the main population was chosen to test this management strategy. In 2023, this section was minimally managed and used as a control area to test treatments such as removing dead milk-vetch branches and applying graminicide on the rest of the main population. As a result, the area was comparatively overgrown with *P. monspeliensis, F. perennis, E. canadensis, A. psilostachya,* and *P. coronopus.* Although it had supported milk-vetch in previous years, there were no individuals growing there in 2024. In late November and early December of 2024, the top 0.5-1 foot of soil was removed from the northern end of the main population using a tractor (Figure 4). A roughly equal amount of soil was deposited in its place, taken from a section of mostly open sand with scattered saltgrass adjacent to the population. Sixteen nursery-grown milk-vetches were outplanted on the fresh berms in January 2025. The majority of these individuals flowered and produced seed in the summer. While weeds did colonize the fresh, relatively nitrogen-poor soil in the newly formed berms and ditches, weed cover was notably lower and milk-vetch germination was increased compared to undisturbed areas.

Figure 4: Photo of the tractor work at the northern end of the main population in December of 2024.

Other NCOS Site Monitoring

Milk-vetch abundance decreased from the previous year at most NCOS sites, except for the vernal pool swale, where it increased from 2 to 22 in its second year since seeding (Figure 5). Despite being a relatively dry year, 2025 was the year with the second highest number of reproductive adults cumulatively across all sites, largely accounted for in the main population and sandy zone (Figure 6). Just as in previous years, no milk-vetch seedlings germinated at Whittier Pond. While a handful of seedlings germinated at South Parcel in earlier years, none were observed in 2025. These two sites were only monitored once in February. The edge of Whittier Pond was relatively open and sparsely vegetated in 2020, when the milk-vetch seed was sown, but has since filled in with thick tule *(S. californicus)*, California wild rose *(Rosa californica),* and arroyo willows *(S. lasiolepis).* Similarly, the South Parcel plots have been overgrown with Spanish clover *(Acmispon americanus)* and annual non-native grasses such as soft brome *(Bromus hordeaceus*). The EEM Swale, one of the original 2020 outplanting sites started with 5 individuals and peaked in 2023 with a population of 30, has since been extirpated in the last two years due to a lack of recruitment and increased competition with *P. monspeliensis* and an expanding overstory of arroyo willow. In 2024, an individual volunteer germinated on the north side of Devereux Slough near Dilling's Link bridge. This individual lived to reproductive maturity, but died by the end of the year. In 2025, there was no further recruitment from the seed produced in the previous year; this location will still be monitored at least once a year.

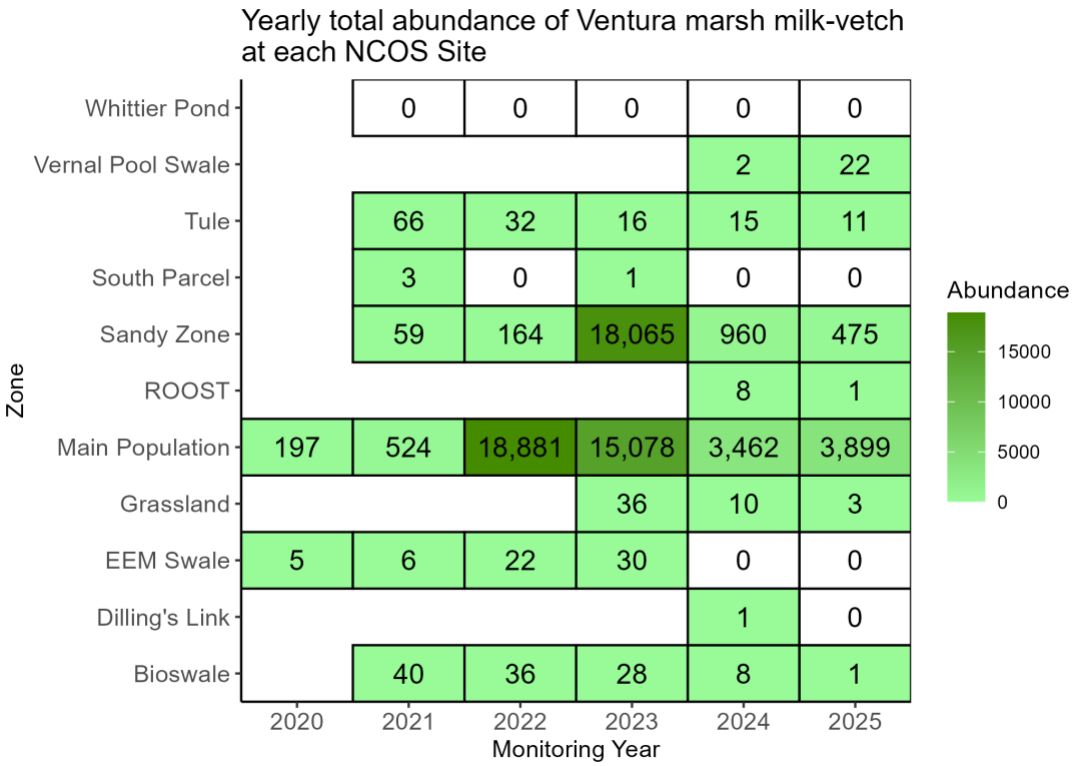

Figure 5: Table showing the yearly abundance of Ventura marsh milk-vetch at each seeding/outplanting site at North Campus Open Space. See Figure 1 for a location map.

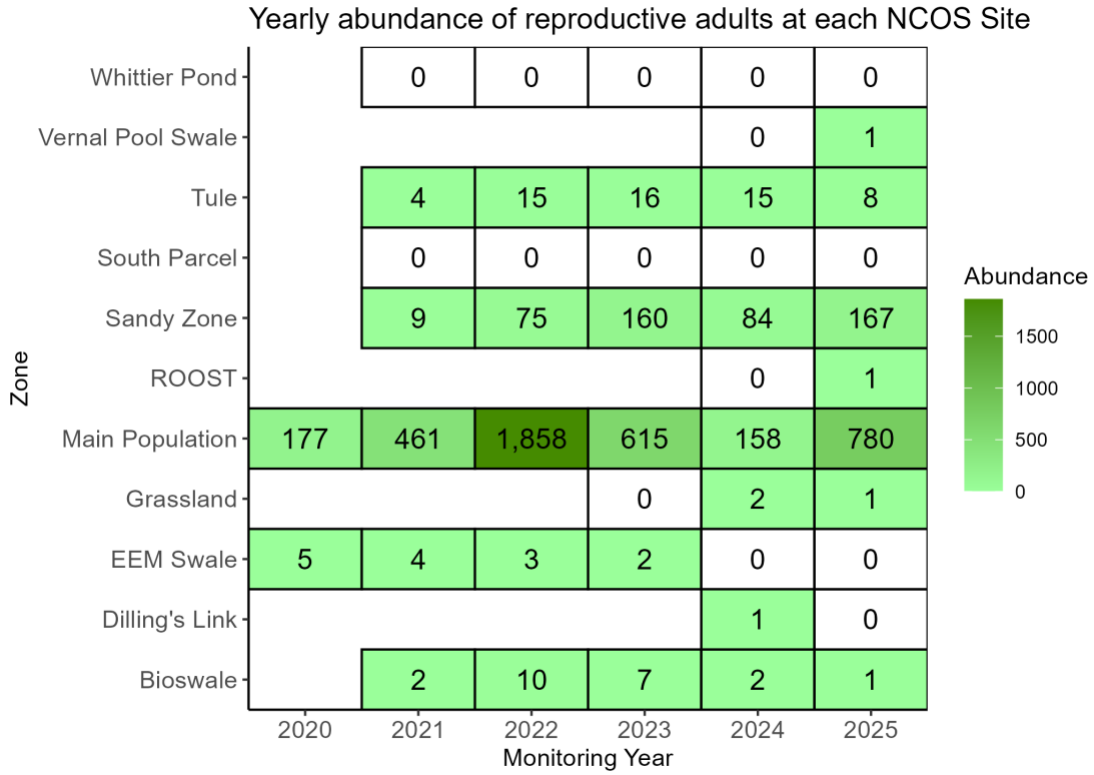

Figure 6: Table showing the yearly abundance of reproductive adults at each seeding, outplanting, and volunteer site at North Campus Open Space.

Sandy Zone

The sandy zone (referred to as “plover zone” in some previous reports) is a broad area originally consisting of mostly bare, fine grain sand, with a stable level of sub-surface soil moisture. In 2023, a stratified random sampling method was used to estimate the number of seedlings, while each adult was counted. In 2024 and 2025, both adults and seedlings were counted once around the same time as the main population survey in August.

Sandy Zone

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2021	59	50	9	NA	100%
2022	150	63	87	NA	90.8%
2023	18 065	17 884	181	1.38	88.4%
2024	960	844	116	1.85	72.4%
2025	475	304	171	1.83	97.7%

Figure 7: Table showing the population size broken down by life stage of the sandy zone as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2021 and 2025.

Recruitment in the sandy zone was lower than in 2023 and 2024, with only 304 seedlings recorded in August, compared to 844 in 2024 and the estimated 17,884 in 2023 (Figure 7). However, there were more living adults (171) counted this year compared to the last (116), suggesting that at least 65 of the previous year’s germinants survived into adulthood in their second year. The health of the population was good to decent during the August survey, with an average vigor of 1.83. A higher proportion of the adult population was blooming or seeding in August 2025 compared to the previous year (97.7% vs 72.4%), which should recharge the seed bank and result in higher germination in 2026, given good conditions.

When the population was established in 2021, most of the individuals germinated along the northeast toe of the slope. However, over the last two years, the majority of these original individuals have died off, with successive generations shifting to the southeast toe of the slope. This geographical shift may be due to slough tidal action moving seed material, paired with changing soil conditions at the site due to nitrogen fixation by the milk-vetch and invasive sweetclovers. While it was largely unvegetated in late 2020 when the milk-vetch seeds were sown, other species have expanded within the zone in the last five years, as shown in the photo in Figure 8. Yellow sweetclover (*Melilotus indicus)* germinates densely throughout the area in the spring, followed in the late spring/summer by white sweetclover *(M. albus),* though the latter tends to have a lower abundance. Native wetland species have also colonized the sandy zone, such as saltgrass *(Distichlis spicata),* fleshy jaumea *(Jaumea carnosa)*, and arroyo willow *(Salix lasiolepis)* and a few non-native forbs such as ribwort plantain (*Plantago coronopus).* This site may benefit from an artificial disturbance such as the method employed at the main population in late 2024 to bury nitrogen-rich soil and decrease competitive pressure.

Figure 8: Photo taken on 10/23/25 of the sandy zone population clustered at the southeast toe of the slope, showing adult Ventura marsh milk-vetch crowded by ribwort plantain, arroyo willow, saltgrass, and the skeletons of annual sweetclovers.

Bioswale

The bioswale site is characterized by heavy clay to clay loam soils, some perennial native grasses, weedy annual grasses (especially *Festuca perennis)*, *Baccharis pilularis,* and *Centromadia parryi ssp. australis*, and an eroding swale running through it. The population at the bioswale seeding site has dwindled from previous years. This area was largely overgrown with bur clover *(Medicago polymorpha)* and annual grasses due to the previous two wet winters. At the end of 2024, only two individuals remained in this zone, and only one survived the winter dormancy in 2025. In February, it was still in its winter senescence (Figure 9). By May it had resprouted and was relatively healthy. It flowered in the summer, but no fruit was recorded in September. This particular location never saw a higher abundance than its first year (40), and recruitment has not kept pace to reach a stable population size, with only 2 reproductive adults in the first year and 2024 and only 1 reproductive adult in 2025 (Figure 10). With the dominance of non-native annual grasses which germinate around the same time as the milk-vetch and quickly grow larger and denser, this location may no longer be suitable without extensive management.

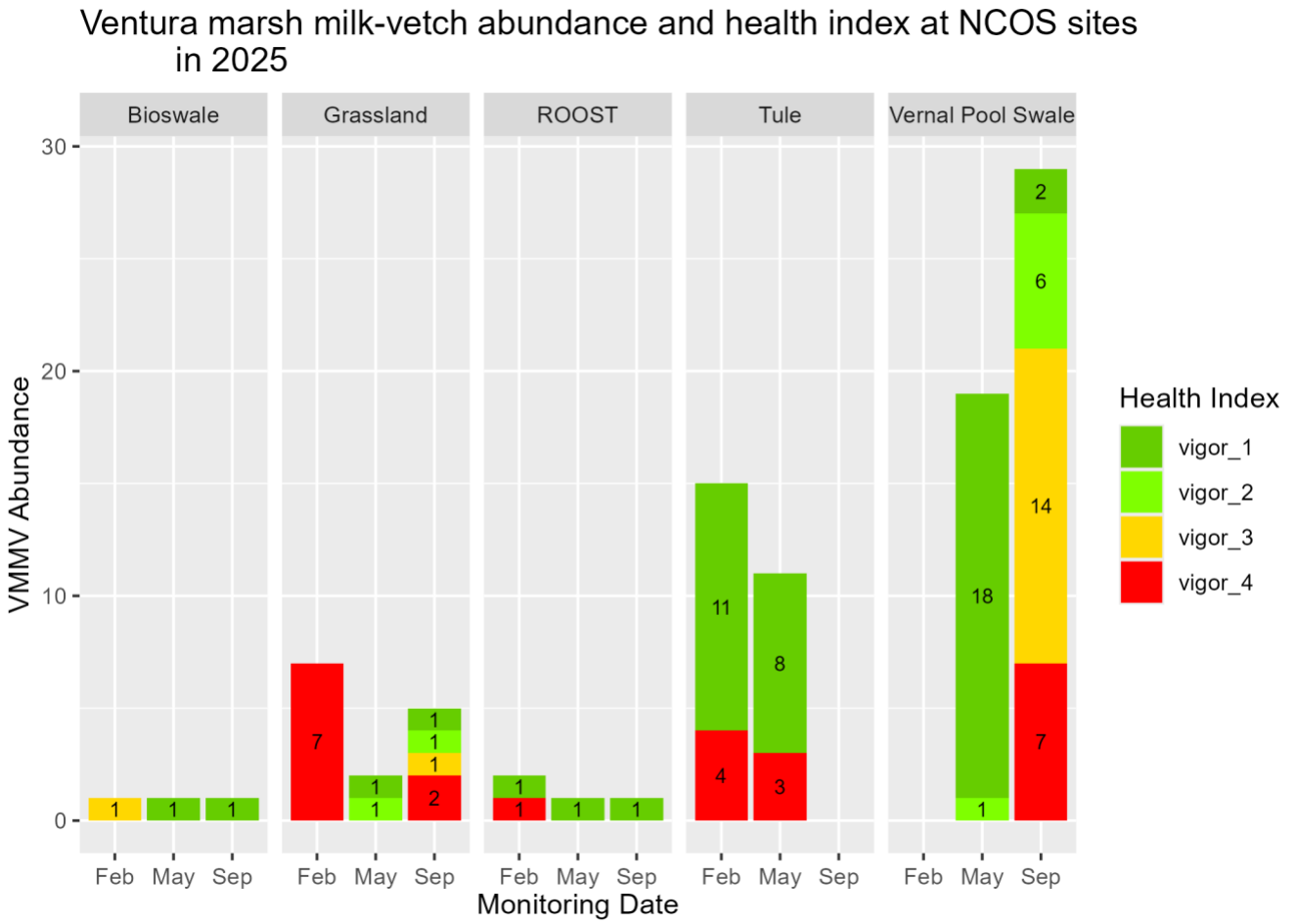

Figure 9: A bar graph showing the abundance of milk-vetch and their health index scores at the time of each monitoring visit in 2025. The bioswale, grassland, ROOST, tule, and vernal pool swale populations are compared.

Bioswale

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2021	40	38	2	NA	100%
2022	36	12	24	NA	41.7%
2023	28	18	10	NA	70%
2024	8	4	4	NA	50%
2025	1	0	1	1.00	100%

Figure 10: Table showing the bioswale's population size broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2021 and 2025.

Vernal Pool Swale

The vernal pool swale seemed to be a good candidate site for seeding due to observations of the milk-vetch doing well in other locations around the site where it was seeded or recruited spontaneously, including upland locations in heavier soils that had no notable sub-surface soil moisture, such as the upper locations of the bioswale site and various volunteer locations. In fall of 2023, after burning off the grass thatch, seed was spread along the vernal pools extending south of the bioswale population. Seeds were sown in the vernal pools themselves as well as the edges, due to the propensity of these pools to rapidly absorb water even on wet years. In 2024, only 4 seedlings were observed, and none reached reproductive maturity or survived to the end of the year. However, in 2025, at least 29 individuals germinated, with 22 surviving to September (Figures 9 and 11). Since no seed was produced from the previous generation, these milk-vetches represent late germinants from the seeds that were sown in 2023. Most remained only a few inches tall, and poor vigor was observed in September, with graying and dried out foliage. Only one individual reached reproductive maturity. It appears that conditions in the vernal pool swale are suitable in the spring and summer, but the soil may not retain enough water to support seedlings through the fall until the winter rains arrive. In early 2026, we plan to outplant nursery grown individuals from the Santa Barbara Botanic Garden to determine if adult individuals may have an easier time establishing at this location. However, it remains to be seen if conditions can support further recruitment from seed.

Vernal Pool Swale

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2024	2	2	0	NA	0%
2025	22	21	1	2.90	100%

Figure 11: Table showing the vernal pool swale's population size broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2024 and 2025.

Tule

The tule site is characterized by heavy sandy loam to clay loam soils near the upper salt marsh edge, with some perennial sub-surface soil moisture that supports *Schoenoplectus sp.*, *Salix sp.*, and non-native irises that remain from the golf course era. The population at the tule site has remained relatively stable since late 2022, with around a dozen large adults that flower and produce fruits each year (Figure 12). However, there has been no recruitment since the first year after seeding and every year a few individuals die off, with only 8 remaining by the end of 2025 (Figure 9). This site experiences very little disturbance and is shaded by arroyo willows and tule. The milk-vetch here are larger and leggier than those in the main population and sandy zone, which receive full sun throughout the day. While we have weeded the area in the past few years, the irises are particularly vigorous, resprouting from remaining chunks of rhizome. Continued management and possibly some soil disturbance may help this population thrive.

Tule

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2021	66	62	4	NA	100%
2022	32	2	30	NA	50%
2023	16	0	16	1.00	100%
2024	15	0	15	1.00	100%
2025	8	0	8	1.82	100%

Figure 12: Table showing the tule population's abundance broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2021 and 2025.

Volunteer Populations – Grassland & ROOST

In the NCOS mesa grassland, a small group of milk-vetch seedlings were found in 2023, having germinated without any purposeful human dispersal. Though they remained small, 10 of these individuals survived the winter. There was no recruitment in 2024, though by the summer, two of them reached reproductive maturity and set seed. When the grassland was grazed by sheep in the fall of 2024, these milk-vetches were caged to prevent herbivory. The cages remained throughout 2025. By the end of 2025, only 3 individuals were found in the cluster, with one flowering adult (Figure 13). The average vigor was decent to poor (2.80).

Grassland

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2023	36	36	0	NA	0%
2024	10	8	2	NA	100%
2025	3	2	1	2.80	100%

Figure 13: Table showing the grassland population's abundance broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2023 and 2025.

A group of 8 seedlings were found in June of 2024 growing on a mound just outside the North Campus Open Space field lab, nicknamed the ROOST (Figure 14). This mound was created as part of the outdoor classroom and is largely vegetated with coastal sage scrub species such as *Artemisia californica* and *Encelia californica.* The soil is compacted clay and clay-loam. The seedlings remained small, with discolored gray leaves. Only 1 individual remained by the end of the year. The lack of groundwater most likely contributed to their demise. The surviving individual resprouted after senescing during the winter and flowered in the summer of 2025; however, no fruits were recorded. The site is half a kilometer from any other successful seeding site, and 70 meters from the slough itself. Animal or accidental human dispersal is the most likely mechanism.

ROOST

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2024	8	8	0	NA	0%
2025	1	0	1	1.00	100%

Figure 14: Table showing the ROOST population's abundance broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2024 and 2025.

As mentioned earlier, the volunteer individual near Dilling's Link bridge did not survive longer than a year, though it did produce seeds. No further germination was observed in 2025 in this location. However, another individual was reported in May 2025 along Venoco Road, the paved service/pedestrian road that denotes the border between Coal Oil Point Reserve and NCOS, just north of Venoco Bridge over the slough. The milk-vetch already had red stems, indicating a second-year (or older) adult. Although the individual was not formally monitored this year, data will be collected in 2026 should it survive winter dormancy.

Coal Oil Point Reserve/Campus Lagoon Monitoring

In an effort to identify suitable milk-vetch habitat at Coal Oil Point Reserve, 9 experimental plots were sown with milk-vetch seed in November 2022 and March 2023 (Figure 15). In 2023, 623 seedlings germinated across seven of the plots (excluding plots 1 and 2 within the back dune habitat). By the end of the year, only two plots still had living milk-vetch: plots 6 West Mouth and 7 Dune Pond. Both of these plots were flooded after a rainstorm in mid-March, killing the existing vegetation and prompting a flush of germination from the milk-vetch seedbank. While the milk-vetch reacted to this stimulus at both sites, the population dwindled from 232 to just 9 individuals at plot 6, while 77 remained at the Dune Pond by the end of the year. There were 6 individuals that produced fruit at the Dune Pond, while none reached reproductive maturity at plot 6. Further details can be found in the 2023 experimental seeding report (Chapman et al., 2024b).

Germination was comparatively low in 2024, though there was a significant increase at plot 4 West Main Channel and a small increase at plot 5 West Main Channel (Fig 16). Although the highest germination was recorded at 8 East Main Channel (89 individuals), the seedlings were crowded out by grasses and forbs and did not survive to the summer. The only individuals that survived to reproductive maturity were at the 6 West Mouth and 7 Dune Pond sites. See further details in the 2024 report (Wilhelm-Safian et al., 2024).

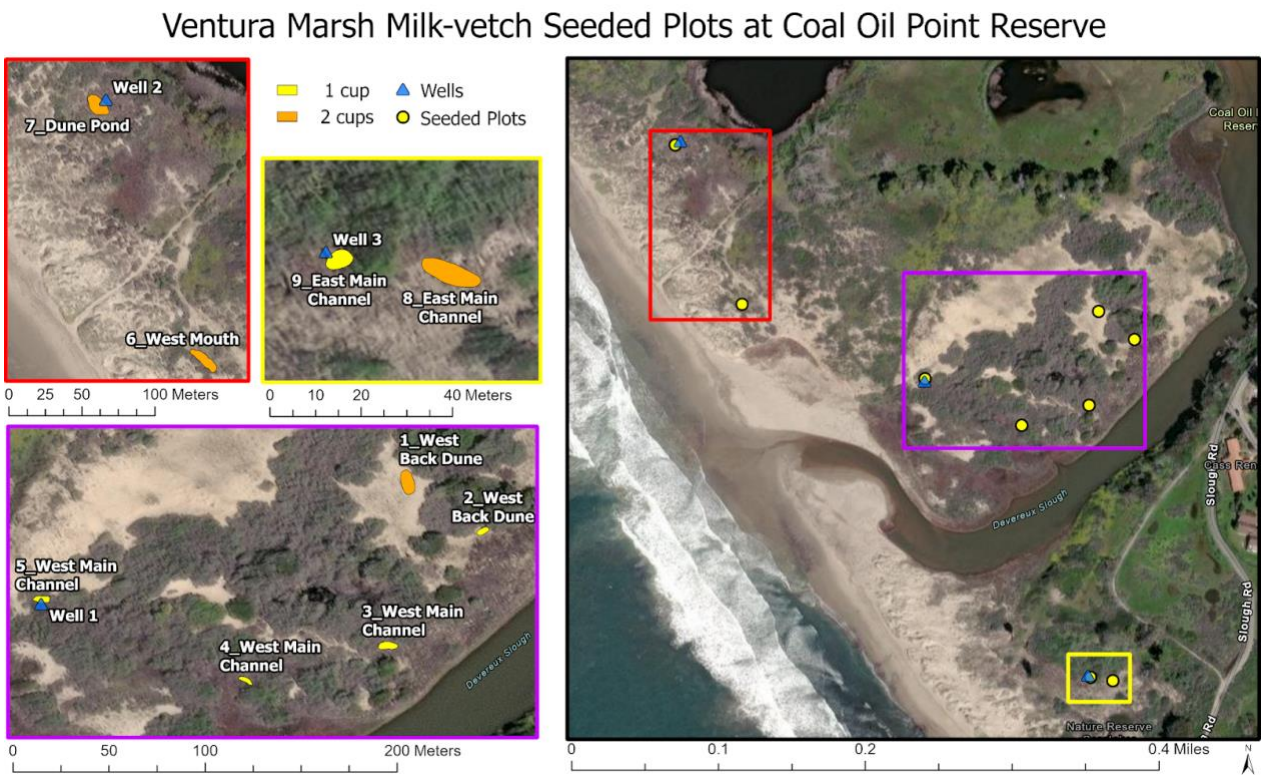

Figure 15: A map of the seeding plots established at Coal Oil Point Reserve in late 2022 and early 2023.

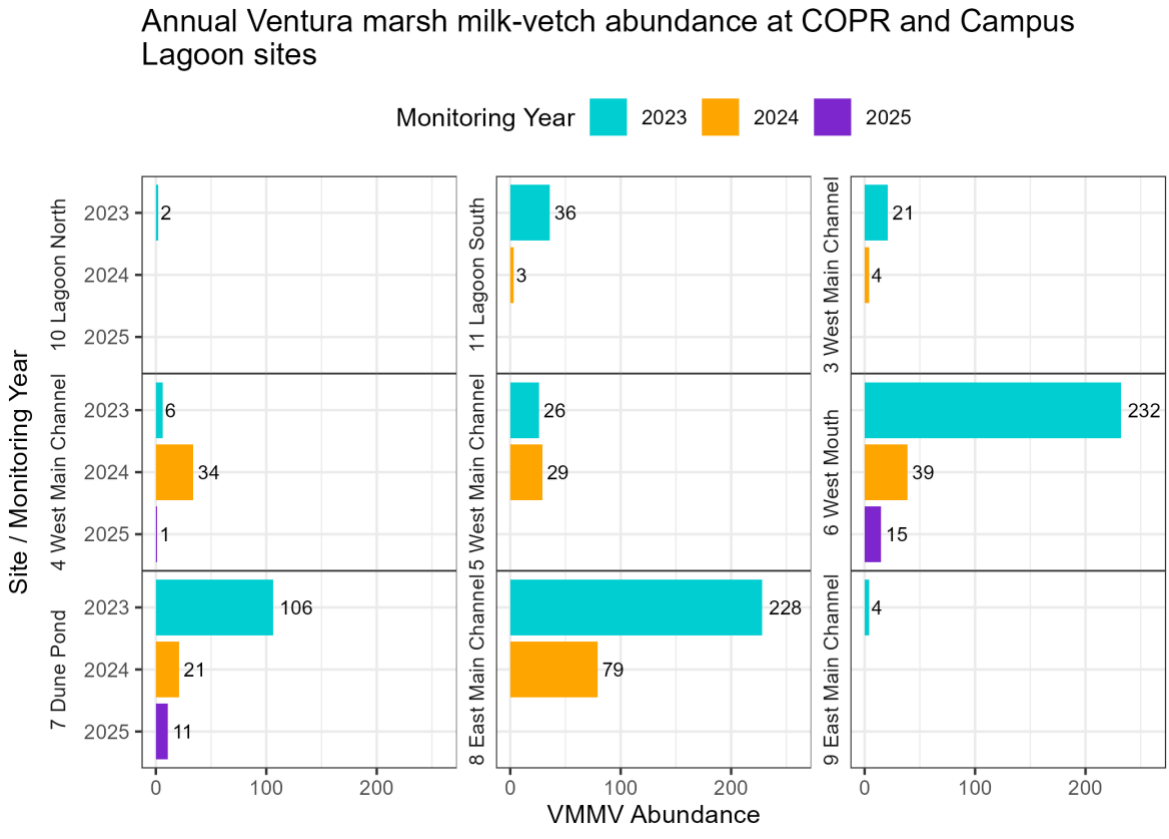

Figure 16: A bar chart showing the total abundance per year at each seeding site at Coal Oil Point Reserve and Campus Lagoon.

In 2025, the third year since establishment, it is apparent that 6 West Mouth and 7 Dune Pond are the most suitable sites at Coal Oil Point Reserve. Although both populations have decreased since the high germination in the first year, they both support healthy reproductive adults in the summer. Both sites semi-regularly flood during winter rains, which creates enough disturbance to suppress competition from weedy grasses and forbs, at least during the spring. At the Dune Pond, summer growth of rabbit's foot grass *(P. monspeliensis),* curly dock *(Rumex crispus),* evening primrose *(Oenothera* sp.), and tall flatsedge *(Cyperus eragrosits)* leads to higher competition (Figure 17). While the milk-vetch at the Dune Pond was not as abundant as the previous years and the health was generally poorer, it had a higher rate of reproductive adults (66.7%) (Figure 19). Meanwhile, there was no seedling recruitment recorded at all at 6 West Mouth, but the 15 adults were all in good health and reproductive, marking the first time any individuals survived to reproductive maturity (Figure 18).

Figure 17: A photo of plot 7 Dune Pond showing the dense competing vegetation in September 2025.

6 West Mouth

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2023	232	224	8	1.53	0%
2024	39	39	0	1.64	0%
2025	12	0	12	1.17	100%

Figure 18: Table showing the abundance of milk-vetch at 6 West Mouth broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2023 and 2025.

7 Dune Pond

MONITORING YEAR	TOTAL ABUNDANCE	# OF SEEDLINGS	# OF ADULTS	AVERAGE VIGOR	% REPRODUCTIVE ADULTS
2023	106	74	32	1.08	21.9%
2024	21	21	0	1.64	0%
2025	11	5	6	2.33	66.7%

Figure 19: Table showing the Dune Pond population's abundance broken down by life stage as well as the average vigor and percentage of the adult population that were reproductive during the peak bloom period between 2023 and 2025.

In addition to those at Coal Oil Point, two plots (10 Lagoon North and 11 Lagoon South) were sown with milk-vetch seed in 2023 (Figure 20). In 2024, no milk-vetch germinated at plot 10, and only 2 new seedlings germinated at plot 11. One individual from the previous year grew several feet tall and flowered and fruited in the summer. This adult died back in November 2024 and did not resprout in 2025.

Ventura marsh milk-vetch appears to do best with a high water table throughout the year, within 5 ft of the soil surface, although in heavier soils it seems able to persist without this to varying extents. Four 5-ft long index wells were installed at plots 5 West Main Channel, 7 Dune Pond, and 9 East Main Channel at Coal Oil Point Reserve and plot 11 Lagoon South at the Campus Lagoon. In 2024, the index wells at COPR were monitored with each visit. Each contained a pressure transducer (Solinst Levelogger® 5) hanging at the bottom of the well. The data was downloaded and compensated with data from a barometric pressure transducer to track the groundwater level over time. Upon each visit, the groundwater salinity (ppt) was measured using a YSI Pro2030 Meter. The well at 11 Lagoon South was regularly dry throughout 2023. During well installation, a layer of cobble was found around 4 feet below the soil surface, which may be increasing the drainage at this location, making it unsuitable for milk-vetch. The pressure transducer was removed from this well in early 2024 for use in other projects and the depth was instead measured by hand on each visit. The well continued to run dry throughout 2024 and 2025. Since the milk-vetch struggled at both 9 East Main Channel and 5 West Main Channel, the pressure transducers at both these sites were also removed in August 2025 for use in other projects. The last transducer remained deployed at 7 Dune Pond in order to detect periods of flooding.

In 2025, the water table was not as high as it had been the previous year (Figure 21). The cumulative rainfall in 2024 was more than double that of 2025 (Figure 22). There was a short period of ponding at 5 West Main Channel in February of 2025, but it was not followed by any milk-vetch germination. For the first time since establishment, the site at the Dune Pond did not flood and the depth to groundwater dropped beyond recording limits by the end of the summer. While the lack of flooding allowed several adults to live into their second year at this site, the low water table may account for their poor health later in the year. The stochasticity of the site provides semi-regular disturbance that could help suppress competitive pressure and trigger milk-vetch germination.

Figure 20: A map showing the seeding plots at Lagoon Island established in late 2022/early 2023.

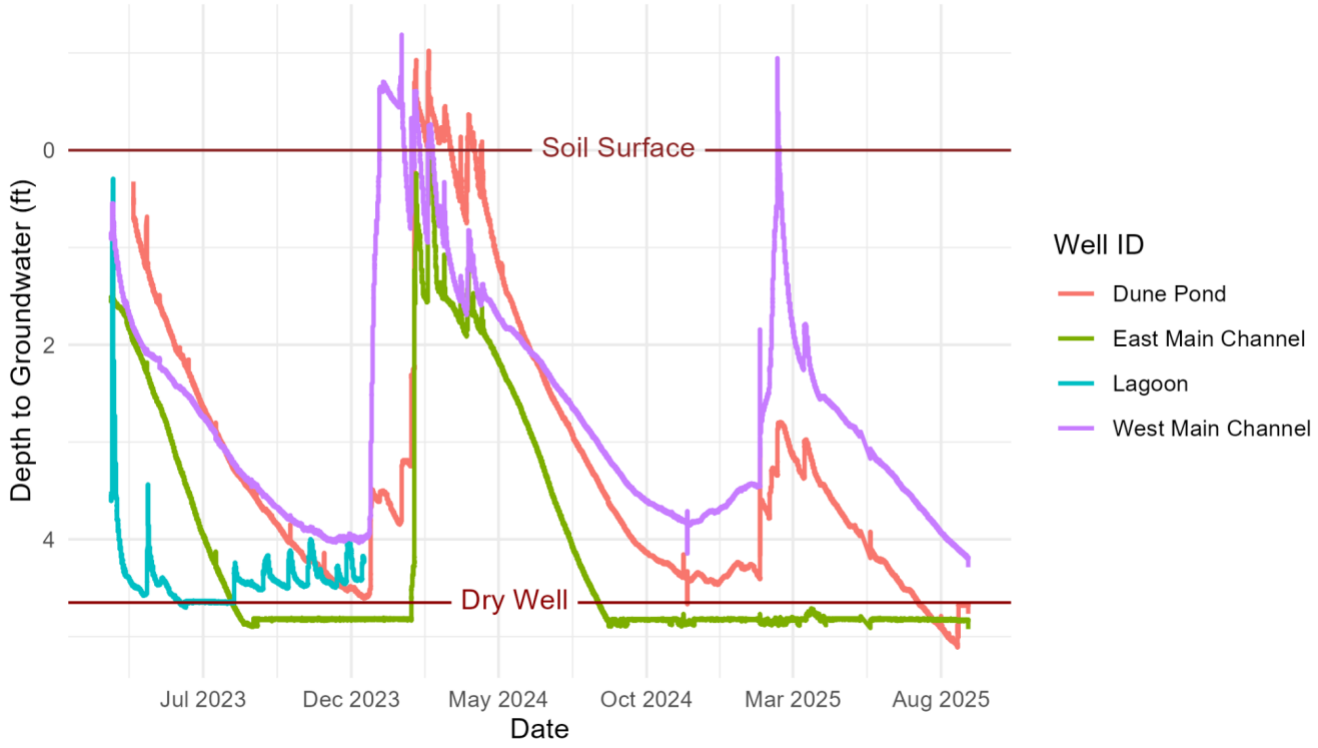

Figure 21: Line graph showing the groundwater level at each index well between March 2023 and August 2025, using data downloaded from the pressure transducers. The data points above the "soil surface" line represent periods of flooding and those below the "dry well" line represent depths to groundwater that exceeded the recording limits of the 5-ft index wells.

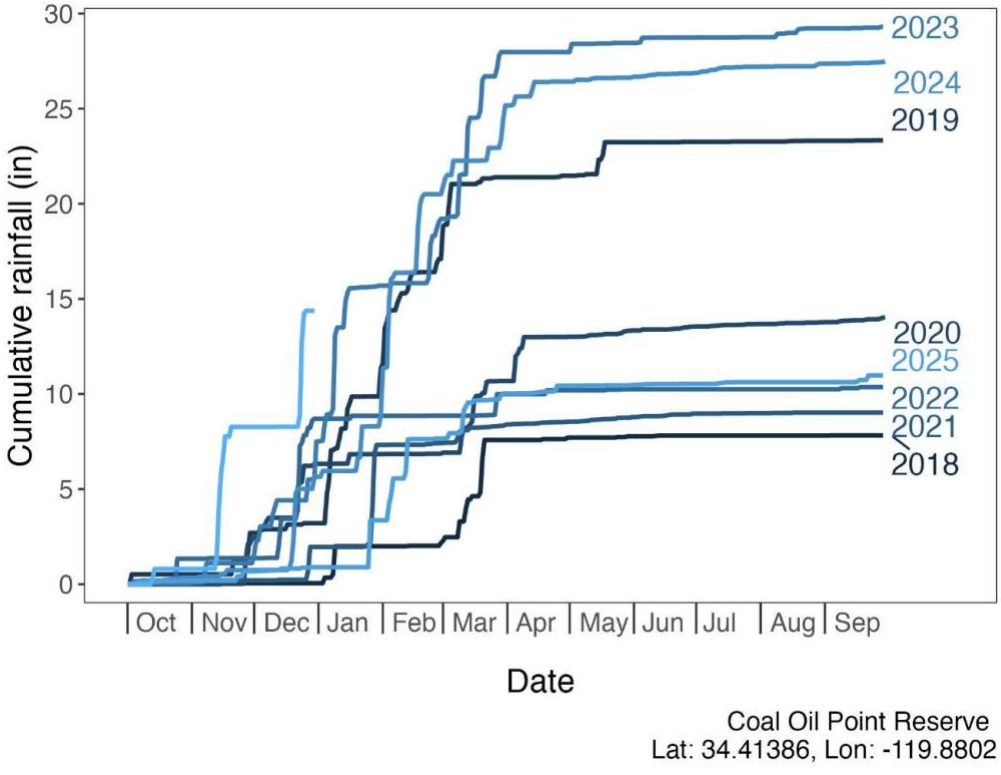

Figure 22: A line graph showing the cumulative rainfall recorded at Coal Oil Point Reserve for each October-September water year from 2018-2025. Figure by Francis Joyce.

Photo Monitoring

Standard photo monitoring points were established around the main population in October 2021 in order to capture visual changes of the population over time. Photos are usually taken once a year during the peak bloom. In 2025, photos were taken in October. A selection of these photos is included in this report. The full photo monitoring dataset is available upon request.

Figure 23: Photo monitoring point 1A capturing the main population from SW corner (August 6, 2021).

Figure 24: Photo monitoring point 1A capturing the main population from SW corner (August 3, 2023). Bright green is horseweed.

Figure 25: Photo monitoring point 1A capturing the main population from SW corner (May 21, 2024). nNote that the plot is more mixed and no longer solid VMMV

Figure 26: Photo monitoring point 1A capturing the main population from SW corner (October 23, 2025). There are patches of VMMV thriving between patches with no VMMV.

Threats and Future Management Plans

As in 2024, the expansion of invasive non-native annual weeds including both rabbit's-foot grass (*Polypogon monspeliensis*), Italian ryegrass *(Festuca perennis),* and sweetclover (*Melilotus indicus*) has been a significant threat to the vetch over all sites. Both *M. indicus* and the milk-vetch are N-fixing plants, allowing *P. monspeliensis* to take advantage of the high N concentration in soil and take over the site. While extremely competitive, preliminary research indicates that *P. monspeliensis* is also allelopathic, and although the exact extent of this and the mechanisms are not well understood, it may inhibit the germination, growth and survival of *A. pycnostachyus* ssp. *lanosissimus.* There is little doubt that dense *Polypogon* sp., at a minimum, inhibits the germination phase of Ventura marsh milk-vetch, and it almost certainly affects its growth in later stages. Likewise, there is little doubt that its dead thatch is also a physical barrier to the germination of Ventura marsh milk-vetch. Further observations indicate that the milk-vetch may not prefer or survive well in N-rich soils, which is especially problematic given the limited footprints of ideal soils and soil moisture on the site, and its propensity to fix nitrogen. One possible factor here appears to be increasing leaf browning, seedling mortality, stunting of growth, reduced vigor, and reduced flowering or fruiting in soils that were previously supporting large, robust plants. A possible explanation for this is the presence of pest species such as thrips and spider mites, which have been observed on the plants in the past and may be worsening through time. Spider mites are known to be especially problematic on plants in soils with high levels of nitrogen. It is possible that the N-fixing abilities of the vetch and its ability to thrive in soils deficient in this important nutrient indicate a strong preference for soils low in nitrogen. It is also possible that increased thrip, spider mite, and other pest damage is related to the Ventura marsh milk-vetch having their vigor affected by the now-higher nitrogen on the site. Many legumes, such as numerous species of *Lupinus sp.,* are often transition species that are especially abundant post-disturbance, such as after fires. These populations often fade away post recovery, and transition into a dormant seed bank. Since one of the most

important features of this population is its high water table, the fact that the lack of phenomena such as alluvial soil deposition after flooding and the subsequent accrual of vegetation and nitrogen, may make both available soil N and pests greater management concerns moving forward.

In June of 2025, an abundance of black aphids was observed on the milk-vetch, being “farmed” by Argentine ants (Figure 27). These were predominately affecting the new apical shoots on some of the more vigorous and otherwise healthy and robust individuals. The phenomenon of Argentine ants and associated infestations of honey dew-producing insects was pronounced on the NCOS site elsewhere in general in the summer of 2025 and was also observed on other taxa such as arroyo willow in conjunction with aphids and mealybugs. The above-average rainfall the site is experiencing at the start of the 2026 water year may set back the Argentine ant colonies, which have been growing in number and prevalence in recent years.

Figure 27: An image of black aphids and Argentine ants on Ventura marsh milk-vetch stems and leaves in June, 2025.

While the entire sandy zone was mostly devoid of vegetation at the site's inception, it has slowly accrued more and more vegetation, both native and non-native. Both the native Ventura marsh milk-vetch and non-native legumes have been steadily adding plant-available nitrogen to the soil, and a subsequent increase in sickle grass *(Parapholis incurva),* rabbit’s foot grass *(P. monspeliensis),* and salt grass *(D. spicata),* in addition to many other broadleaf taxa have been establishing. One notable observation was the increased height, size, and fecundity of both *Polypogon sp.* and cut-leaf plantain *(P. coronopus)* around the bases of individual milk-vetch across the site where milk-vetch grew for one or more years and were killed by flooding (Figure 28). While surrounding areas maintain both of the non-native species at around 2-4” in height quite uniformly, the immediate area around the bases of former milk-vetches supported heights of both weeds exceeding 24”. In some cases, this appears to be clearly associated with Ventura marsh milk-vetch, while in others it may be associated with piles of

Melilotus sp. that were hand-pulled and left in place the previous year. Regardless, N-fixation and the associated growth, mostly of weeds, continues to be a serious and worsening problem.

Figure 28 (left): Two photos showing increased biomass of weeds growing around the bases of dead milk-vetch or spots where sweetclover had been piled the previous year, emphasizing the effects of nitrogen fixation and the associated problematic habitat conversion it creates.

While the entire sandy zone was mostly devoid of vegetation at the site's inception, it has slowly accrued more and more vegetation, both native and non-native. The number of both native species *(Salix sp., Distichlis spicata, Ambrosia psilostachya, etc.)* and non-native *(Plantago coronopus, Polypogon sp., Parapholis incurva, Melilotus sp., etc.)* needing management on the site is becoming more prohibitive over time. A noteworthy number of N-fixers, including the Ventura marsh milk-vetch, are contributing to this establishment of weeds. In spring and summer of 2025, a UCSB student, Lauren Rappa, conducted analyses on *Polypogon monspeliensis* to determine where they were receiving their N enrichment from by comparing rabbit's foot grass biomass collected from milk-vetch substrate, Melilotus substrate, and adjacent areas with other vegetation. The analysis found that *P. monspenliensis* samples taken from areas with milk-vetch substrate had comparatively higher nitrogen content than those associated with other vegetation. This implies that although the *P. monspeliensis* is limited in the amount of nitrogen it is able to retain per unit mass, the higher N availability allows *P. monspeliensis* to grow much larger, ultimately competing with the milk-vetch by shading it out, competing for root space, possible allelopathic effects, and generally overtaking its habitat. See the 2024 report for further detail on this study (Wilhelm-Safian et al., 2024).

The artificial soil disturbance via tractor discussed earlier in this report mitigated the effects of soil nitrogen build up to an extent. While milk-vetch germination was higher and weed cover was lower in the disturbed areas, weedy species were not totally absent. After a year and the start of another rainy season in winter 2025-2026, the berms have become less pronounced, with continued erosion from the slope above the main population depositing clayey soils within it. We are considering a semi-regular artificial disturbance regime every 2-3 winters in conjunction with follow-up weed management throughout the year.

Closing Thoughts

The natural areas on the UCSB campus have demonstrated significant potential for supporting rare plants such as the Ventura marsh milk-vetch. Unsurprisingly, these areas, their soils, and the floras they support through time will require management to maintain these rare plants into the future, just as each rare taxon will. The Ventura marsh milk-vetch poses an especially novel challenge; maintaining what appears to be a stochastic, disturbance-following nitrogen fixer that enriches soils for the succession of other species, in a system that does not have the wider ecosystem-scale disturbances it likely once relied upon. Support for this will be paramount lest these areas transition into more stabilized habitats that support common native and worse, non-native species, and see their abilities to support rare plants diminish.

Acknowledgements

The Cheadle Center would like to thank the following people and agencies for their contributions and collaboration towards the conservation of Ventura marsh milk-vetch:

- US Fish and Wildlife Service, particularly Todd Lemein, Ken Niessen, and Kristie Scarazzo, for funding and collaboration.
- Cris Sandoval, Coal Oil Point Reserve manager, and additional COPR staff, for site access and logistical support.
- Mary Carroll, senior ecologist for Arcadis, for collaboration and site tours of the Oxnard population.
- Dr. Carla D'Antonio, UCSB professor, for collaboration on nitrogen biomass study.
- Lauren Rappa and Bruno Bartalos, UCSB student interns, for data collection, weed management, and nitrogen biomass study.
- Francis Joyce, Cheadle Center research coordinator, for help with data cleaning and analysis

Works Cited

Chapman, W., Stratton, L., & Wilhelm-Safian, C. (2024a). *Ventura Marsh Milk-vetch (Astragalus pycnostachyus var. lanosissimus) 2023 Management and Monitoring Report.* UC Santa Barbara Cheadle Center for Biodiversity and Ecological Restoration. https://escholarship.org/uc/item/0nw9s083

Chapman, W., Stratton, L., & Wilhelm-Safian, C. (2024b). *Ventura Marsh Milk-Vetch (Astragalus pycnostachyus var. lanosissimus) 2023 Experimental Seeding Report*. UC Santa Barbara Cheadle Center for Biodiversity and Ecological Restoration. https://escholarship.org/uc/item/292267fj

Wilhelm-Safian, C., Chapman, W., Stratton, L., & Rappa, L. (2024). *Ventura Marsh Milk-Vetch (Astragalus pycnostachyus var. lanosissimus) 2024 Management and Monitoring Report*. UC Santa Barbara Cheadle Center for Biodiversity and Ecological Restoration. http://escholarship.org/uc/item/2mh5836c

Stratton, L., Chapman, W., & Calderon, C. (2021). *Status of Ventura marsh milk-vetch at North Campus Open Space*. UC Santa Barbara Cheadle Center for Biodiversity and Ecological Restoration. https://escholarship.org/uc/item/91f243kg

U.S. Fish and Wildlife Service [USFWS], Lemein, T., Niessen, K., Darst, C., & Erickson, B. (2020). *Species Status Assessment for Ventura Marsh Milk-Vetch*. U.S. Fish and Wildlife Service. https://ecos.fws.gov/ServCat/DownloadFile/181976