

# Nuttall's Lotus: Final Report

Prepared for: San Diego Association of Governments

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Project Period: 9/14/15 - 9/14/18

SANDAG Contract Number: 5004729



Photo by L. Hedlund

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## EXECUTIVE SUMMARY

San Diego Audubon's Coastal Dune Vegetation Enhancement Project addressed the region's Management Strategic Plan (MSP) goal to maintain and expand extant populations of Nuttall's Lotus, an MSP SO species, within Mission Bay Park, while enhancing associated coastal dune areas that have the potential to support this species in the future. The strategy was two-fold: leveraging volunteer effort to carry out targeted hand removal of nonnative invasive plants, supported by well-timed spot-spraying of herbicides (a relatively novel approach) vs. eliminating nonnative invasive species via mechanized scraping and broadcast herbicide applications (the more traditional method of management at these sites). The use of two different management regimes (scraping vs. hand pulling) allowed for comparisons in efficacy for the enhancement of coastal dune habitat to support native plants such as Nuttall's Lotus. Vegetation monitoring revealed dramatic shifts in native versus non-native plant cover during this time, with hand management resulting in much higher native plant cover and richness than mechanized scraping.

As restored areas increased in habitat value, the opportunity to reintroduce Nuttall's Lotus to appropriate sand dune sites emerged, resulting in the successful establishment of an additional population in Mission Bay. Since 2014, the Nuttall's Lotus population at several of the Mission Bay sites increased dramatically - South Shores saw an increase from 19 plants in 2014 to 100 in 2018, and No Man's Land increased from one plant in 2014 to 236 plants in 2018. Data on the Mariner's Point location is not as accurate, as City staff are unable to survey the entire area due to nesting by California Least Terns, but anecdotal observations indicated that this population remained stable, and may have increased slightly at one point in the project. An additional population was established at Stony Point, where San Diego Audubon staff has observed seven Nuttall's Lotus.

Areas that had been earmarked for potential reintroductions in the future (Stony Point and North Fiesta Island) saw significant reductions in invasive cover. This was especially dramatic at North Fiesta Island, where springtime cover of invasive plants was reduced from over 90% of the vegetative biomass in 2013, to slightly over 20% in 2018. While no Nuttall's Lotus is found at this location yet, native Beach Evening Primrose (*Camissoniopsis cheiranthifolia*) now accounts for nearly 80% of the existing vegetative community, signaling a successful transition away from the nearly total invasive cover that was found here only five years ago. Areas that experienced a transition from mechanized scraping to hand management generally experienced a relatively quick recovery in terms of native vegetative cover, and the average number of nonnative species was reduced by roughly half after 2-3 years of hand pulling. Areas scraped throughout the project had the highest relative percentage of invasive species every year.

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## PROJECT BACKGROUND

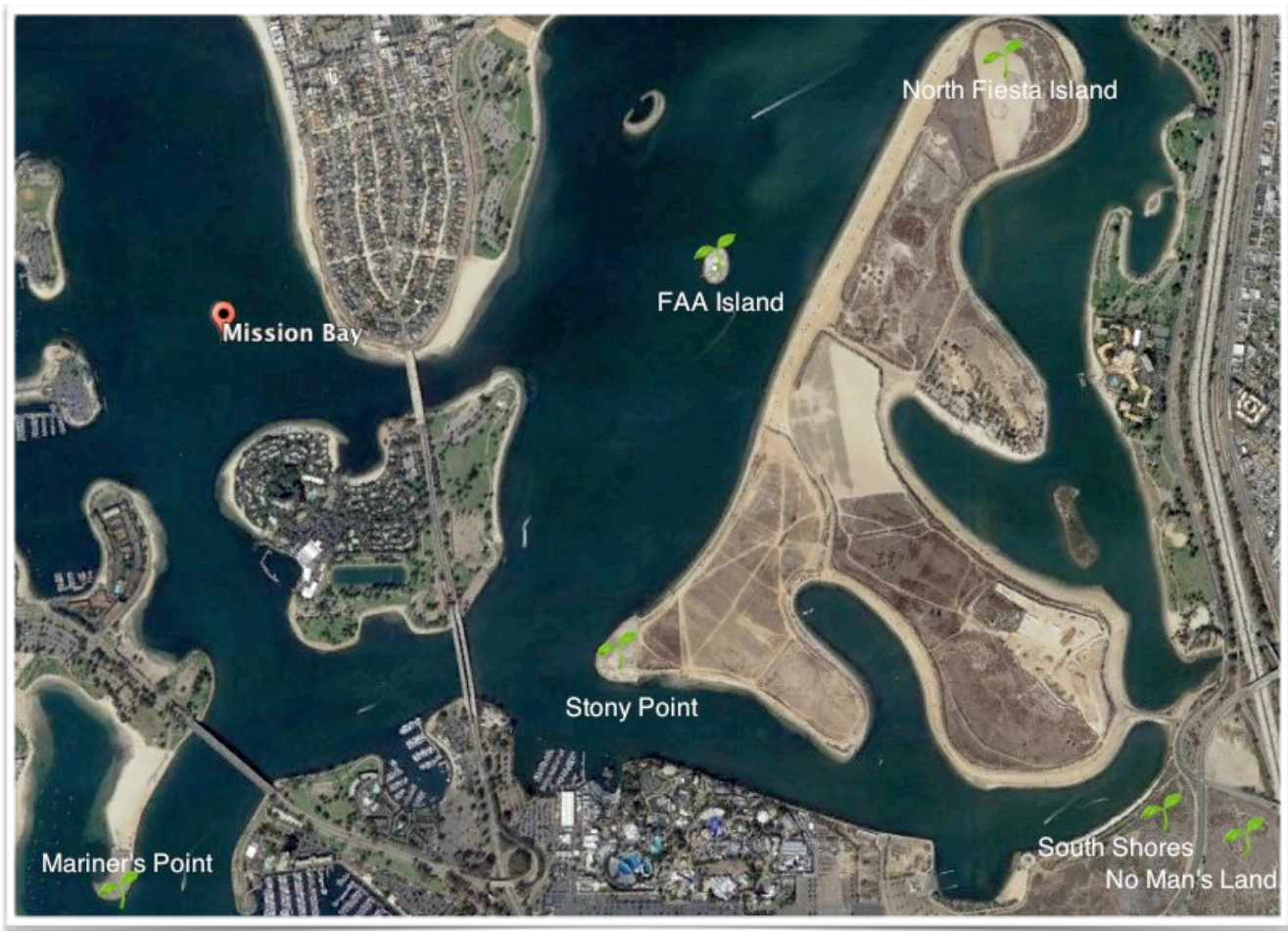
Nuttall's Lotus (NULO), a rare coastal dune plant found only in San Diego and parts of northern Baja, has declined throughout the majority of its original range due to widespread development and dramatic changes to the coastal habitat that remains. Loss of sand, increased nutrient loads, inappropriate substrate, human disturbance and nonnative/invasive species threaten this endangered plant. Recent estimates have found a 50-70% population decline over the last decade, and while SDMMP has identified 7 active NULO sites in Mission Bay, only 3 of these are considered as being in "good condition".

A 2012 *TransNet* grant resulted in a Conservation Action Plan (CAP) for Mission Bay Park, which established priority species and habitat types for future conservation efforts. Due to its narrow geographic range, ongoing decline, and overlap with other threatened and endangered coastal species, NULO was selected as one of these priority species, with the resulting Action Plan providing guidance for future restoration efforts. High on the list of priority actions were removing nonnative invasives to support extant populations and expanding NULO to areas where invasives had been eradicated.

Building off of previous rounds of funding, and leveraging San Diego Audubon's 25+ years of experience with hands-on restoration at Mariner's Point (the largest NULO population in Mission Bay), this project utilized an adaptive management strategy to test the effectiveness of hand management vs. mechanized scraping in controlling invasive plants and supporting and enhancing NULO populations. Quantitative vegetation monitoring, using protocols developed by Prof. Doug Deutschman of San Diego State (see Appendix A), provided opportunities to refine best management practices by examining how the proportion of native to nonnative ground cover reacted to different management types. This quantitative data was collected in spring and fall, from 2012 - 2018, and was analyzed with the help of Kristine Preston, US Geological Survey.

Three restoration sites were mentioned specifically in the Grant Application - Mariner's Point, Stony Point, and South Shores, with other areas of focus determined over the course of the grant, as deemed appropriate by project staff and partners. Restoration efforts were carried out at a total of six sensitive sand dune sites; for a map of these locations, see Figure 1.





**Fig. 1** NULO work sites in Mission Bay.

## PROJECT GOALS AND EXPECTED RESULTS

This project aimed to support the SDMMP Management Strategic Plan (MSP) goal to maintain and expand NULO populations, with a focus on the extant populations within Mission Bay and areas for potential expansion. Specific goals included 1.) evaluating populations of <500 individuals to determine if suitable substrate exists to increase these populations to >10,000 individuals and engage in revegetation efforts as warranted; 2.) eliminate/reduce invasive and/or nonnative plant species at the selected sites to <20% absolute cover; 3.) enhance/establish native plant species that naturally co-occur with NULO at sites with appropriate substrate.

The metrics used to measure success included 1.) number of acres assessed for expansion/enhancement of NULO populations and associated coastal dune plant species; 2.) success rates of invasive and/or nonnative plant control (i.e. percent cover of invasives); 3.) number of NULO plants at each site.

Expected results included 1.) assessment of 23 acres of coastal dune habitat to determine suitable areas to increase NULO populations in Mission Bay Park; 2.) expansion of NULO populations and associated dune plant species via planting or transplanting of seed bank in suitable areas; 3.) reduction of invasive and/or nonnative plant species absolute cover to less than 20% at selected sites; 4.) discussion of the adaptive management project and BMPs learned from the project in the Final Report.

## WORK PERFORMED BY TASK

### TASK ONE: CHEMICAL PLANT CONTROL

Budget: \$18,000.00

Spent: \$13,727.41

Match for Task: \$0.00

Expected results for this task included in original application and/or grant agreement	Achieved? (Notes)
1. Up to 9 acres will be broadcast sprayed and retreated as needed with herbicide in priority coastal dune habitats in Mission Bay.	Yes - see paragraph below
2. Pre-emergent, post-emergent, and spot treating will also be implemented in NULO populated areas as required; these areas will include 23 acres in total.	Yes, per modification

1. The City's Developed Regional Parks Department assisted with broadcast spraying at Stony Point and North Fiesta Island; an average of 9 acres were broadcast sprayed each year. Assistance by City staff allowed for this task to be carried out slightly under budget. Because this task fell under budget, an administrative budget amendment was processed by the EMP Land Management Grant Manager, with funds moved from Task 1 to Task 2 and 3.
2. Kelly and Associates were contracted for the pre-emergent, post-emergent and spot treating at the more sensitive coastal dune sites (i.e. areas with NULO and other protected dune plants). Kelly and Associates sprayed and retreated roughly 18 acres between Mariner's Point and South Shores during this time. The metric of 23 acres was not met as no pre-emergent spraying took place at the other coastal dune site where NULO occurred, No Man's Land. The decision was made to prioritize hand-pulling in the areas immediately surrounding the NULO here; this strategy proved to be very effective in managing Sahara mustard growth, and herbicide applications were not found to be necessary here. Pre-emergent spraying took place in early winter to prevent the first-emerging non-native vegetation, with post-emergent and spot treating taking place from late winter to late spring, as needed.

**TASK TWO: COMMUNITY-BASED HABITAT RESTORATION**

Budget: \$68,442.00

Spent: \$73,014.33

Match for Task: \$234,030.26

Expected results for this task included in original application and/or grant agreement	Achieved? (Notes)
1. Forty-eight habitat restoration events will be conducted over three years (six events per year at Mariner's Point and Stony Point; four events per year at South Shores).	Yes - see paragraph below
2. NULO population at Mariner's Point (2 acres) will be protected/maintained.	Yes - see paragraph below
3. Coastal dune plant species will be seeded in plots at Stony Point (approximately 1 acre) to establish NULO population and seed bank for expansion in the future.	Yes - see paragraph below
4. Extent of ice plant at South Shores will be reduced by 50%, allowing for the expansion of NULO population as appropriate substrate areas are identified	Yes, per modification

1. A total of 86 community-based habitat restoration events took place over the lifetime of this grant – 21 events at Mariner's Point, 22 at Stony Point and 15 at South Shores. An additional 28 events took place at three other sensitive coastal dune areas, namely FAA Island, North Fiesta Island, and No Man's Land. Nuttall's Lotus was either located within the site (as was the case for No Man's Land), or the site was identified as having 1.) associated coastal dune plant species (as was the case for FAA Island) or 2.) the potential to support native coastal dune plants including Nuttall's Lotus in the future (as was the case for North Fiesta Island).

A total of 2,630 volunteers donated over 8,100 hours of time to these efforts, resulting in the removal of over 24,000 pounds of invasive vegetation. The estimated value of this volunteer time exceeded \$230,000, well over the \$54,120 of matching funds that was expected for this task. The number of volunteer hours (8,100) was over three times that of what was laid out in the Grant Application (2,400 hours). A bi-weekly volunteer group, Dune Defenders, was established, which allowed for more precise, targeted restoration work. The creation of the Dune Defenders program complimented one of the NULO priority actions laid out in the 2012 Mission Bay CAP - specifically, the creation of a dedicated NULO volunteer group. In order to recruit volunteers and raise awareness about the need to protect Nuttall's Lotus, an article in San Diego Audubon's newsletter *Sketches* was developed and printed (see Appendix B).

2. Exact trends in the NULO population at Mariner's Point were not entirely clear due to the limited accuracy of the City of San Diego's Rare Plant Survey, with NULO individuals counted only within a 10-meter radius circle instead of the entire site. Despite this, it appears as though the Mariner's Point population remained stable during this time, and may have increased slightly. The City's Rare Plant Survey revealed an increase in the number of NULO within the 10-meter radius circle, increasing from 5 plants in 2014 to 550 plants in 2018. A 2016 survey by staff from the CA Department of Fish and Wildlife found over 12,200 individual plants here,

and while no full-scale survey has been done since then, the population of NULO has remained relatively constant, and is believed to be well over 10,000. Efforts to protect the site from human disturbance (installing signs, repairing fencing and increasing awareness within the surrounding community about the need to respect signage), as well as ongoing removal of invasive weeds, likely had a positive impact on this population.

3. After a Translocation and Management memo was created by Audubon staff and vetted by members of the Nuttall's Lotus Working Group (see Appendix C), NULO seeds were collected from Mariner's Point in February of 2017, and then distributed within a demarcated section in the southern portion of Stony Point in March of 2017, following the established protocols. This area was monitored for any potential growth over the course of the next several months, until the start of the CA Least Tern nesting season in mid-April prevented on-site surveying. It did not appear as though this attempt had been successful, which resulted in a second attempt in January of 2018. Despite these initial observations, later surveys found several healthy NULO individuals within the 2017 plot (see photo in Appendix D) . As of September 2018, there are now 7 individuals occurring here, as well as several Coast Woolly Head (*Nemacaulis denudata*). As this was the first attempt at translocation, the area where the seeds were distributed was smaller than the anticipated 1-acre, but continued success in managing invasive plants and distributing seeds should allow for an expansion of this acreage. Audubon staff will continue to monitor this population and the 2018 plot (which has yet to have any sign of NULO). The portion of Stony Point where these plants occur has ideal substrate and low cover of nonnatives, which greatly increases the likelihood that this population will become self-sustaining in the coming years.
4. While the total cover of ice plant was reduced significantly over the course of the grant (see Appendices E and F for maps of the extent of ice plant in 2012 and 2017, respectively), we did not reach the metric of a 50% reduction in cover, due largely to the decision to focus on areas of high NULO density, rather than the entirety of the site. Nuttall's Lotus responded favorably to the smaller-scale hand management efforts, with the number of individuals at South Shores increasing significantly during this time (see Table 1). The size of South Shores and the intensity of hand pulling required to significantly reduce the overall cover of ice plant has been found to be a limiting factor, and should be taken into account for future projects.

**TASK THREE: GRANT ADMINISTRATION AND REPORTING**

Budget: \$5,000.00

Spent: \$5,164.29

Match for Task: \$0.00

Expected results for this task included in original application and/or grant agreement	Achieved? (Notes)
Quarterly reports and invoices.	Yes
Final Report.	Yes.

San Diego Audubon staff administered all aspects of this grant, including invoicing, reporting, management of subcontractors, and budgeting.

## VEGETATION MONITORING RESULTS

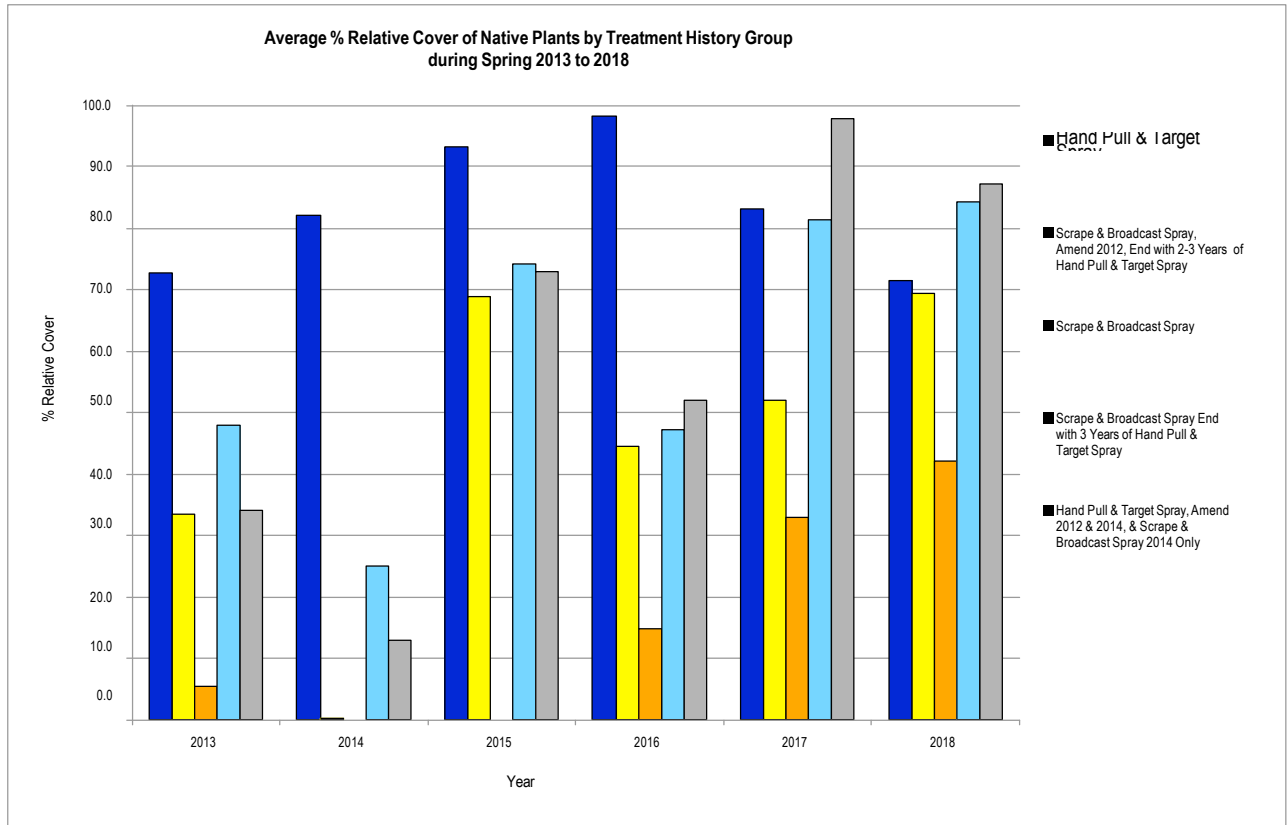
As one of the expected results of this project was a discussion of the BMPs learned over the course of the grant, an overview of the results of our vegetation monitoring project has been included below.

It should be noted that due to adaptive management, five treatment types were employed and studied: hand-management with spot-spraying throughout the project (only Mariner's Point, marked in dark blue in Fig. 2), areas that received only mechanized scraping and broadcast spraying throughout the project (parts of North Fiesta Island, marked in orange in Fig. 2), areas where management switched from scraping to hand-pulling from fall of 2015 onwards (parts of Stony Point and North Fiesta Island, marked in light blue in Fig. 2), portions of Stony Point that were scraped only once, received 6 inches of sand amendment in 2014, and were hand-managed from 2015 onwards (indicated in grey in Fig. 2), and portions of Stony Point and North Fiesta Island which received sand amendment in 2012 and transitioned from scraping to hand management in 2015 onwards (marked in yellow in Fig. 2).

### Nonnative vs. native cover

Average relative percentage cover of native plants increased for all of the treatment types, with spring of 2017 and 2018 being slight exceptions. The treatment that received only hand management increased from an initial native cover of 73% in 2013, to a high of 98% in 2016, before tapering off to 72% in 2018. The slight decrease for 2017 and 2018 was likely due to higher than average precipitation in the winter of 2016-2017, which resulted in nonnative vegetative growth that was difficult to manage with hand pulling alone. The average relative percentage cover of native cover for areas that were managed via mechanized scraping alone remained low, fluctuating from a low of 6% in spring of 2013 to a high of 42% in spring of 2018. The most dramatic increase in native cover was seen for treatments where management switched from scraping to hand-pulling for the last 2-3 years of data collection, which increased from an average of 40% native cover in spring of 2013, to an average of 77% native

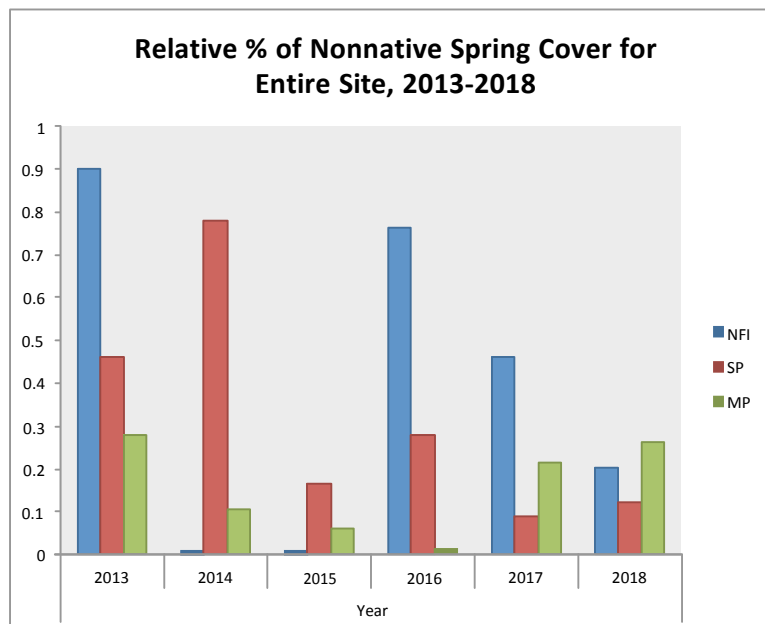
cover in spring of 2018. Portions of Stony Point that received 6 inches of amended sand in 2014 saw consistently high native vegetation cover (after the last scraping in 2014).



**Fig. 2.** Average relative cover of native plants for different treatment groups measured at Mission Bay sites during spring time periods from 2013 through 2018. Note that there was no data collected for the scrape and broadcast spray treatment group in spring 2014 and 2015.

Regardless of treatment type, both Stony Point and North Fiesta Island saw dramatic declines in the relative percentage of nonnative spring cover from the start of the vegetation monitoring through 2018 (see Fig. 3).

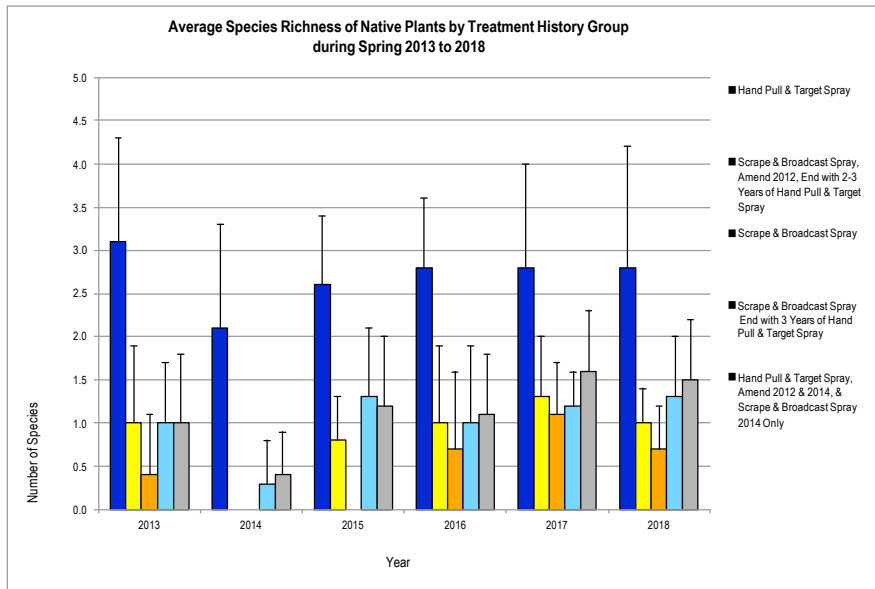




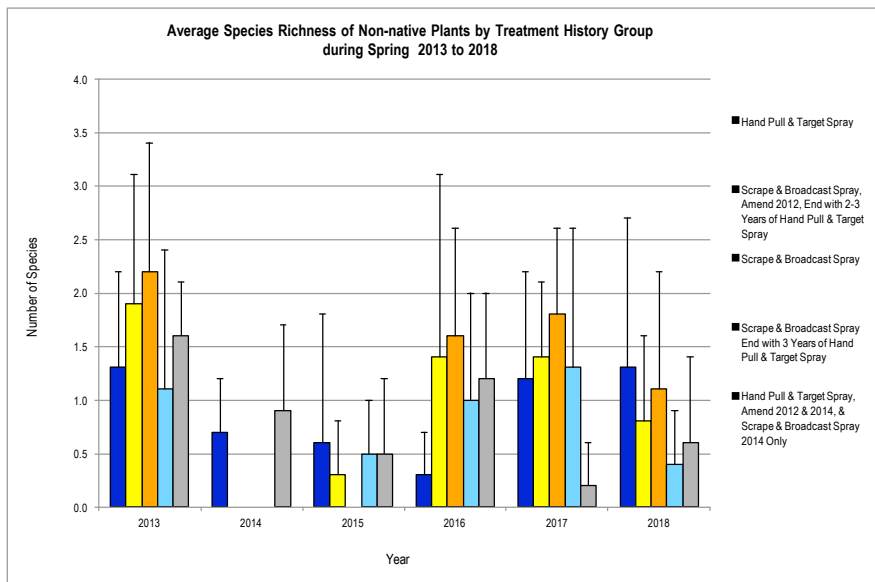
**Fig. 3** Relative percentage cover of nonnative spring time cover for the entire site, without regard for treatment type.

### Richness of natives vs. nonnatives

Native plant richness was significantly higher for hand pulled treatments than for any of the other treatments during this time, and was lowest for scraped treatments (see Fig. 4). Areas that transitioned from mechanized scraping to hand management saw a decline in the number of invasive species (Fig. 4). There was an increase in the number of nonnative species within hand managed areas from 2017-2018, which was likely the result of increased precipitation.



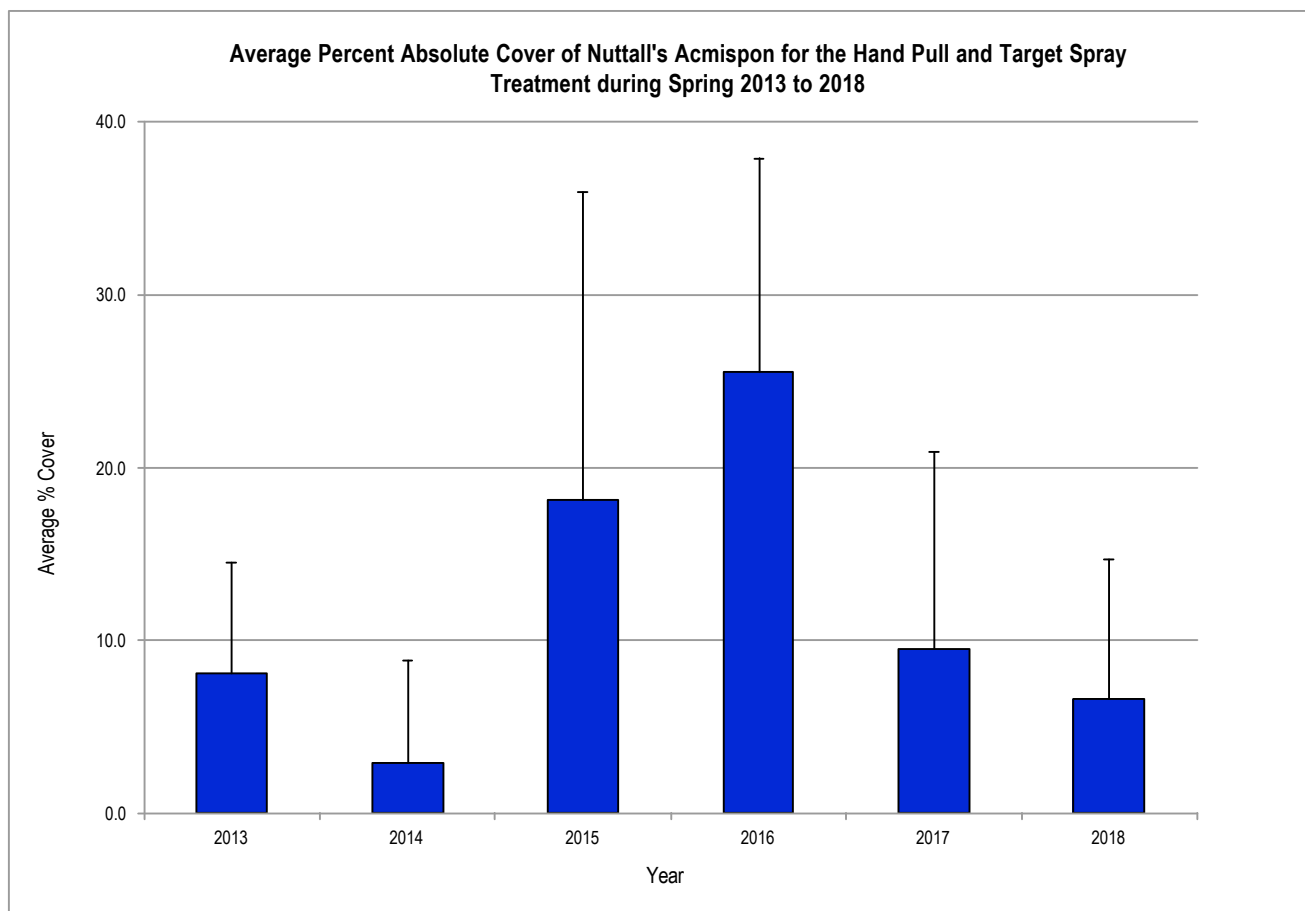
**Fig. 4** Native plant species richness for different treatment groups during spring time periods from 2013 through 2018.



**Fig. 5** Non-native plant species richness for different treatment groups during spring time periods from 2013 through 2018.

### NULO cover and population size

The average percent of absolute cover of NULO at Mariner's Point increased from 8% in spring of 2013 to a high of 26% spring of 2016, after which it began to decline (see Fig. 5). Management techniques did not change during this time, so the drop in percentage of NULO cover is probably explained by the increase in density of other native plant species. Coast Woolly Head (*Nemacaulis denudata*) did especially well here, increasing from <2% of the vegetative cover in spring of 2013 to >18% in spring of 2018. While there were yearly fluctuations in absolute percent cover, there was an overall increase in the total number of observed Nuttall's Lotus individuals at the Mission Bay sites that were the focus of this project (see Table 1).



**Fig. 6** Average percent of absolute cover of NULO at Mariner's Point during Spring 2013-2018.

Location	Year Surveyed	Number of NULO seen
Mariner's Point	2014	5
	2015	Not available
	2016	54
	2017	Not available
	2018	550
No Man's Land	2014	1
	2015	2
	2016	68
	2017	30
	2018	236
South Shores	2014	19
	2015	431
	2016	139
	2017	1355
	2018	100
Stony Point	2018	7
2014 Total		25
2018 Total		893

**Table 1** Number of NULO individuals observed at the Mission Bay sites from 2014-2018

## CONCLUSIONS AND NEXT STEPS

This project was highly successful in its goals to maintain, support and expand existing populations of Nuttall's Lotus within Mission Bay. Restoration efforts were carried out for three of the seven extant Mission Bay populations, two of which were considered to be in poor condition. Populations that have recently supported <500 individuals (i.e. South Shores and No Man's Land) were assessed via site visits, with the primary obstacle to increasing these populations to >500 individuals found to be the widespread growth of invasive plants such as Sahara mustard (*Brassica tournefortii*), and Hottentot-fig ice plant (*Carpobrotus edulis*). Tens of thousands of pounds of these invasive plants were then removed at community led habitat restoration events, resulting in significant increases in the number of NULO individuals. Between the six restoration locations, a total of 39 acres of land were assessed for potential expansion or enhancement of NULO populations and associated coastal dune plant species.

Nuttall's Lotus at Mariner's Point, the stronghold for this species in Mission Bay, benefitted from the continued targeted removal of nonnative vegetation. While the relative percent cover of Nuttall's Lotus fluctuated over the course of the grant, the total number of plants appeared to increase, at least in the section of the site that was surveyed by City staff. There was a decline in relative percent cover from 2017-2018, but this decline may not reflect a drop in the total number of plants, as other native plants were becoming more abundant at this time. Potential explanations for the changing percent of NULO cover (and the implications) could be discussed within the Nuttall's Lotus Working Group, which will hopefully be reconvened in 2019. This will also provide a valuable platform to further explore the results of this adaptive management project with other land managers that oversee NULO populations.

Mariner's Point also served as a seed bank for the successful translocation of NULO to another sand dune area - Stony Point on Fiesta Island. The establishment of the Stony Point population should provide an additional safeguard in case any of the existing populations decline or disappear in the future. The likelihood that this area will continue to receive the vegetation control needed to prevent extirpation by invasive species in the future is very high, as it falls within a managed CA Least Tern nesting site. Now established, this population should be monitored using the SDMMP Rare Plant Monitoring Protocols, which could be coordinated with City staff, or added to the ongoing bi-annual vegetation surveying that SDAS carries out each year. More direct collaboration with City staff should also take place so that Mariner's Point can be surveyed before the Least Terns arrive, allowing for a more accurate report on the size of that population.

Despite year-to-year fluctuations, the average percent of invasive cover was reduced to ~20% for all three of the selected sites (Mariner's Point, Stony Point and North Fiesta Island). This created more open space for Nuttall's Lotus to become established in the future and benefitted other native plant species, including species that naturally co-occur with NULO, such as Coast Woolly Head (*Nemacaulis denudata*), Pink Sand Verbena (*Abronia umbellata*), Silver Beach Bur (*Ambrosia chamissonis*) and Beach Evening Primrose (*Camissoniopsis cheiranthifolia*). Hand managed areas did experience a slight increase in nonnative cover after unusually high rainfall, but this can be prevented in future years with more precisely timed pre-emergent applications.

Analysis of the vegetation data revealed trends in how management strategies affect percent cover and richness of native vs. nonnative plant species, with hand management and spot spraying resulting in a more natural, heterogeneous habitat with thriving native dune plants. Mechanized scraping, while effective in terms of creating open space, resulted in the highest cover of invasive species, and supported very few of the native plants that naturally co-occur with Nuttall's Lotus. It is interesting to note that over the course of the grant the percent of natives did increase in areas of mechanized scraping (although not as significantly as for the hand managed areas). This may be due to "spill-over" effects, whereby the increasing seed bank of native plants in the surrounding hand managed areas "spilled over" into the scraped area.

It is worth noting that this project complimented ongoing restoration efforts to support the CA Least Tern, another priority species within the MSCP. Reduction in total vegetation cover, with a specific focus on high stature invasive plants, creates more appropriate nesting habitat for this endangered bird. On that note, previously collected vegetation data should be analyzed for trends in vegetation height and total amount of unvegetated space in order to better inform management aimed at the Least Tern.

The data also showed that areas where the management regime transitioned from scraping to hand pulling recovered relatively quickly, with native plant cover and richness doubling in 1-2 years. Recovery was especially robust in areas that received 6 inches of amended sand, which was likely due to improved substrate and the burying of the existing invasive seed bank. Future sand amendment at locations within Mission Bay would likely create more ideal habitat for both Nuttall's Lotus and the CA Least Tern, especially at sites with large invasive seed banks such as North Fiesta Island. It is essential that vegetation monitoring continue into the future in order to assess long term effects of management.

With 1,000+ members of the public taking part in restoration events annually, this project allowed for massive public outreach on the importance of Mission Bay's coastal habitats, the threats that native species face here, and the need to protect these sensitive species from disturbance. Increased awareness will serve to benefit Nuttall's Lotus, CA Least Terns, and other sensitive wildlife in Mission Bay well into the future.

Finally, this adaptive management strategy was only possible due to collaborative relationships with a variety of dedicated partners, including the Mission Bay Park Rangers, the City of San Diego's Park and Recreation Department and the San Diego Management and Monitoring Program.



## APPENDICES

### APPENDIX A: VEGETATION MONITORING PROTOCOLS

#### Mission Bay Vegetation Monitoring Protocol

Developed for: SD Audubon

By: SDSU Institute for Ecological Monitoring and Management

A combination of point intercept transects and quadrats will adequately measure % vegetation cover and species composition/richness. A complete census of plant species in each plot should not be necessary using these methods and will avoid excess disturbance to these sites.

#### Transect procedure:

Point intercept data should be read every 0.25 m. At each 0.25 m point, drop the stick perpendicular to the meter tape. All species touching the sampling stick should be recorded, and ground surface should be characterized. Ground cover options include:

- Sand/Shell – sand with shell fragments
- Bare Ground – dirt or dirt with sand (little or no shell fragments)
- Litter – 50% or more organic dead material under stick
- Rock – large rock that is not easily nudged

A height category (0 cm, 1-10 cm, 11-20 cm, 21-30 cm) will be recorded every 0.25 m using tape measure on the point-intercept stick.

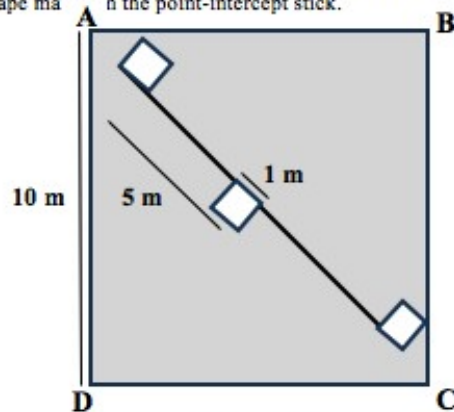


Fig. 1 Transect layout



Fig.2 Example quadrat.

#### Quadrat Procedure:

Place the quadrat at the origin (1 m), on the left side of the tape. This will be repeated at 5 m (right side of tape) and 10 m (left side of tape)

Estimate the percent vegetation cover using the following categories:

- 0 (all bare ground – dirt or sand w/ dirt)
- 1-10%
- 11-25%
- 26-50%
- 51-75%
- 75-100%

## APPENDIX B: NULO PUBLICATION IN MARCH 2017 SKETCHES.

### The Dune Defenders

By Rebecca Schwartz Lesberg, Director of Conservation

*Small, fragmented patches are all that remain of native coastal dune habitat. They are key to the survival of more than the California Least Tern. The lowly but lovely Nuttall's Lotus is another important part of this fragile ecosystem, and the SDAS Dune Defenders are set to make a difference in its survival.*

If you have followed the Conservation Program at San Diego Audubon over the last several years, you are probably aware of the work we do to protect California Least Terns in Mission Bay. We have worked at Mariner's Point since the early 1990s, and in the early 2010s we expanded to Stony Point, North Fiesta Island, and even the otherwise-off-limits FAA Island. Our volunteers have spent thousands of hours pulling weeds, mending fences, and monitoring for predators so this endangered migratory shorebird can nest and raise its young. But at San Diego Audubon we are not only focused on birds. We work to protect birds, other wildlife, and their habitats.

That's why our efforts in Mission Bay include dune habitat restoration, not just nesting site protection. Making sure Least Terns successfully fledge their young each year isn't our only focus. We are making sure the habitat they are using is healthy, protected, and a place where a broad suite of California's native species can thrive.

One of those species, Nuttall's Lotus (*Acmispon prostratus*), has needed a helping hand lately and San Diego Audubon has stepped up to support this endangered dune plant thanks to a TransNet grant from the San Diego Association of Governments (SANDAG).

Nuttall's Lotus (often called NULO by those in the biz) is an annual, low-lying, leafy plant native to southern California dune ecosystems. NULO is part of the "coastal strand" community of southern California and northern Baja, and isn't usually found at elevations above 30 feet. Its species name (*Acmispon prostratus*) comes from the same Latin root word as prostrate, meaning to lie stretched out on the ground, and these mat-like plants help stabilize the sand dunes with their roots, stems, and branches. Their tiny yellow, red, and orange flowers look like miniature snapdragons and provide welcome bursts of color when they bloom in late spring and early summer. You can find NULO alongside Silver Beach Bur, Beach Evening Primrose, and Pink Sand Verbena at several sites in Mission Bay.

Nuttall's Lotus is a key part of a healthy, biodiverse, stable, coastal sand dune ecosystem in Mission Bay. Most importantly from the Least Tern's perspective though, Nuttall's Lotus never gets so tall as to block their view of oncoming predators, one of the biggest threats facing California Least Terns today.

In recent years, populations of Nuttall's Lotus have decreased dramatically. Of the 33 occurrences of NULO throughout the state, only one-third are considered to be in excellent or fair condition. San Diego County is home to 17 of these 33 populations, and they face many of the same threats as our other native plants and animals – habitat destruction and fragmentation from overdevelopment on our coasts, pollution, trampling, and competition from invasive species. In Mission Bay, the six locations of Nuttall's Lotus also face erosion

(since the natural processes that are required to sustain sand dunes have been disrupted) and excess nutrients leaching into the soil from former landfills in the area (invasive plants can also contribute to too many nutrients in the soil). Though this species doesn't have state or federal endangered species protections (for reasons having more to do with politics than ecology), they are listed as Endangered by IUCN Red List due to a 30-70% decline in population over the past 10 years.

Overall, Nuttall's Lotus faces a similar suite of threats as the California Least Tern and is a vital part of a healthy dune ecosystem. Because their population has shrunk significantly over the past few years, San Diego Audubon is working hard to restore them in Mission Bay.



PHOTO BY DUNE STILINGER, PROVIDED COURTESY OF SAN DIEGO AUDUBON SOCIETY

But how?

The most important thing we can do for Nuttall's Lotus is to make sure the existing populations have space to thrive. That means removing invasive, non-native plants that humans have brought in through the years, and even thinning overgrown thickets of native plants that could shade out the few remaining NULO patches in the bay. At Mariner's Point, we clear invasive Filaree and Devil's Thorn and cut back overgrowth of last year's woody Beach Evening Primrose. At South Shores, we pull iceplant that has taken over the site and spray herbicide to reduce cover of invasive mustard.

Given all the rain we've had this winter, controlling invasive weeds at our existing NULO sites will take a lot of work this spring. We will need our habitat restoration volunteers more than ever to make sure our NULO sites are clear (*see side bar for a new, weekly effort called Dune Defenders*).

## APPENDIX C: NULO TRANSLOCATION MEMO PREPARED BY AUDUBON STAFF

### Nuttall's Lotus (*Acmispon prostratus*) – Translocation Protocols for Mission Bay Sites

**Translocation:** Although there exists very little information pertaining to the translocation of *A. prostratus*, best practices of vegetation translocation dictate that efforts should be made to obtain genetic material from the nearest existing population (David Hogan, pers. comm., July 21, 2016). In addition, translocated individuals should come from only one nearby population (i.e. collected samples should not come from a variety of sources) in order to avoid potential genetic exchange between two unique populations (David Hogan, pers. comm., July 21, 2016). In situations where the translocated individuals are entering a habitat with a pre-existing population of the target species, some genetic analysis may be required in order to ensure that hybridization will not be a problem. Concerns over hybridization between distinct populations are likely unfounded for the Mission Bay sites, however, as the distance between sites (roughly 1 mile) almost certainly does not constitute a barrier to pollination and/or dispersal (Elizabeth Milano, pers. comm., December 14, 2016). In addition, care should be taken to translocate *A. prostratus* individuals only to sites where there is no extant population.

Translocation protocols for Mission Bay NULO expansion efforts: Substrate will be collected from below NULO plants at Mariner's Point (or from the Fiesta Island population if it is found to be extant and robust) and dispersed at Stony Point using the following methods:

- Soil directly beneath *A. prostratus* mats (desiccated or flowering) at the Mariner's Point site will be gathered. This will be done as close as possible to seed maturation. Time constraints due to nesting CA Least Terns will mean this will likely occur in fall/winter rather than spring/summer.
- This material will be deposited onto substrate at Stony Point immediately following collection. This will be done in several areas throughout the site, taking care to focus on the flatter areas of the site. These areas will be marked with tongue depressors or flags. Two types of deposition will be attempted: raking directly into the sand and depositing into a pre-dug hole.
- Locations of the deposited seeds and method of deposition will be mapped and recorded.
- Monthly site visits will be carried out in order to monitor the germination and growth of the translocated individuals. Presence of seedlings, number, age class and general health of the plants will be recorded. Photos will be taken for visual documentation. This will continue until early April, at which point the return of the CA Least Terns will prohibit entering the sites. Monitoring will commence again in mid-September.
- Taking an adaptive management approach, future translocation protocols will be dictated on the success of the various translocation locations/dispersal tactics listed above.



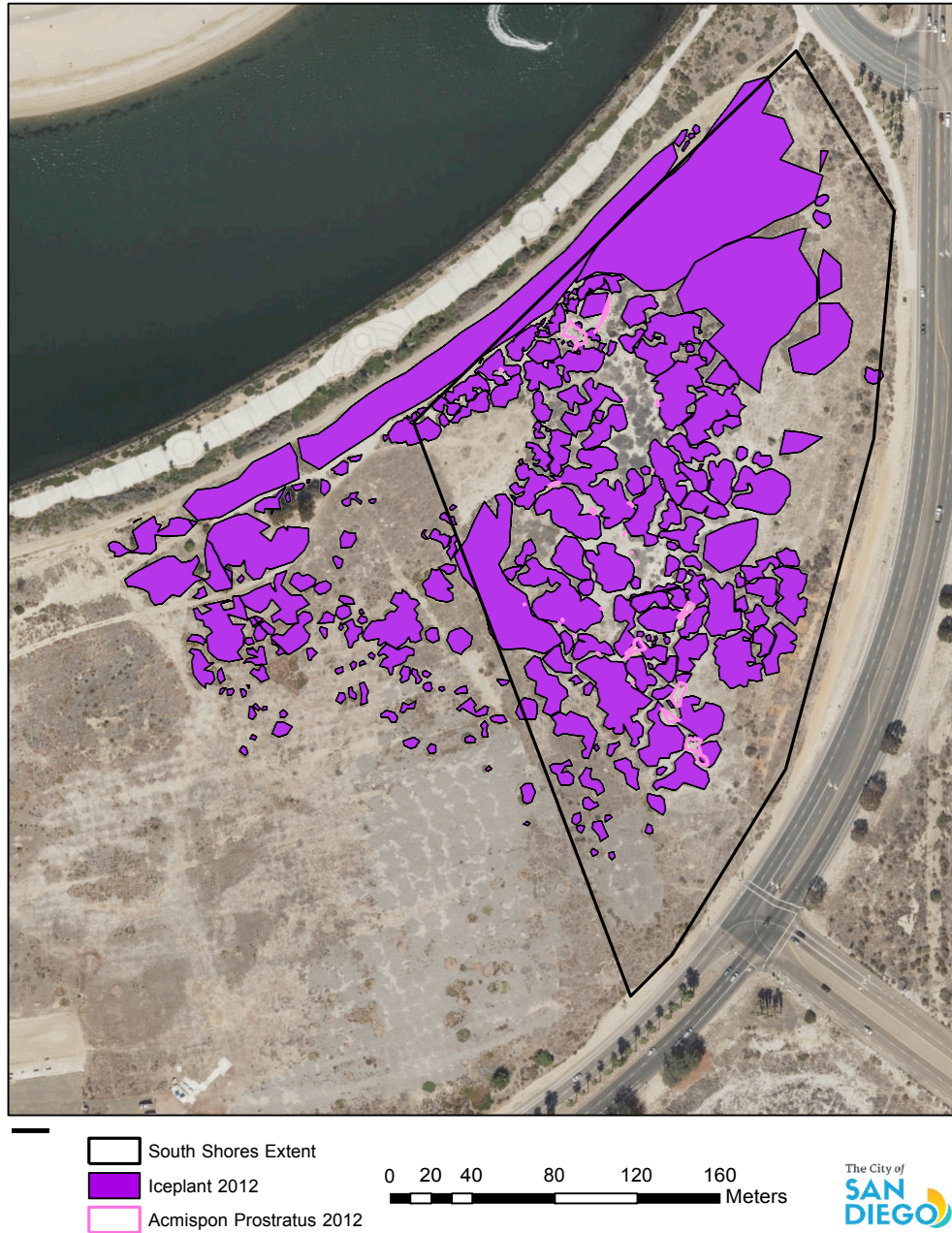
APPENDIX D: NULO GROWTH AT STONY POINT, APRIL 2018





APPENDIX E: NULO AND ICE PLANT, SOUTH SHORES, 2012

Mission Bay South Shores Acmispon and Carpobrotus 2012



APPENDIX E: NULO AND ICE PLANT, SOUTH SHORES, 2017

Mission Bay South Shores Acmispon and Carpobrotus 2017

