60-MONTH POST EELGRASS TRANSPLANT REPORT FOR THE FORMER CAMPBELL SHIPYARD HABITAT CAP AND EELGRASS RESTORATION SITE

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07-161-01

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60-MONTH POST EELGRASS TRANSPLANT REPORT FOR THE FORMER CAMPBELL SHIPYARD HABITAT CAP AND EELGRASS RESTORATION SITE

Merkel & Associates, Inc.
April 2013

INTRODUCTION

This report summarizes the 60-month post transplant survey of the eelgrass transplant at the former Campbell Shipyard (Figure 1). The purpose of the transplant was to offset permanent losses of eelgrass habitat incurred during implementation of the remediation plan to dredge and cap contaminated marine sediments at the former Campbell Shipyard site in San Diego Bay.

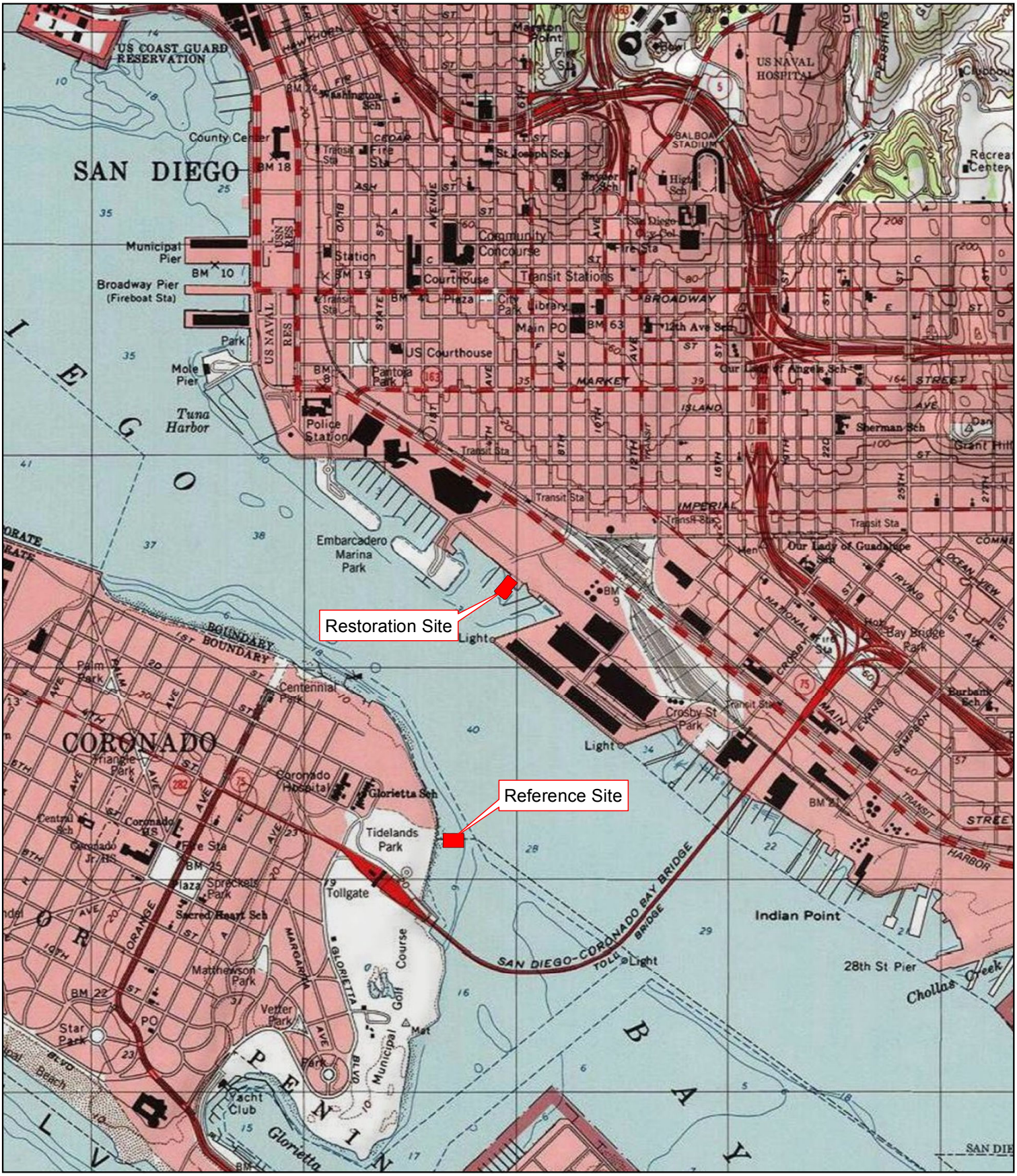
A total of 1,483 m^2 (0.37 ac) of eelgrass was present at the former Campbell Shipyard site prior to project construction activities (Figure 2). All of the pre-existing eelgrass was lost due to dredging and capping of polluted sediments during site remediation (Merkel & Associates 2003). On-site mitigation for eelgrass was part of the project design. A shallow-water habitat cap was created to provide suitable eelgrass habitat at the site. The habitat cap resulted in 6,395 m^2 (1.58 ac) of suitable eelgrass planting area between –4-ft MLLW and –6-ft MLLW (Figure 3). This amount represents approximately 3.6 times the mitigation requirement of 1,780 m^2 (0.44 ac) based on the 1.2:1 mitigation ratio specified by the Southern California Eelgrass Mitigation Policy (SCEMP) (NMFS 1991). The additional area planted over the requirement allows for conservative planning and an ability to place any surplus eelgrass resources within a mitigation bank to be used for future Port of San Diego construction projects.

RESTORATION SITE LAYOUT AND HISTORY

A temporary grid created on the habitat cap was monumented with anchored buoys to mark intersections. Gridlines, delineated by the placement of 5-milimeter nylon rope anchored with rebar stakes, allowed for efficient navigation by divers and allowed for the accurate tracking and placement of eelgrass within the site (Figure 4).

Eelgrass was planted using an anchored bare-root restoration technique with planting bundles placed on 1-meter centers. Bare-root bundles were created by sorting, trimming, and grouping 5-8 turions of eelgrass collected from donor eelgrass beds. Bundles were then tied with degradable twine and attached to a degradable paper stick that served as an anchor during the first few weeks of root growth. Divers planted the eelgrass by digging a small hole and inserting the bundles into the sediment. This technique is the preferred means of transplanting eelgrass in most situations, and anchored bare-root units are the primary-planting units currently used in southern California eelgrass restoration projects. The survival of such planting units has been shown to be quite high when properly prepared (Fonseca *et al.* 1982; Merkel 1987, 1990a). Similarly, bare-root units have shown an ability to rapidly expand and colonize bare substrate (Merkel 1990b).

A total of 6,600 planting units were prepared over a four-day eelgrass harvesting period. This was more than enough eelgrass to fill the 6,395-m^2 (1.58-ac) restoration site. The surplus eelgrass bundles were planted within sediments along the southern edge of the site at a distance of one to three meters from the submerged riprap that supports the habitat cap. This area is most susceptible to



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Project Vicinity Map

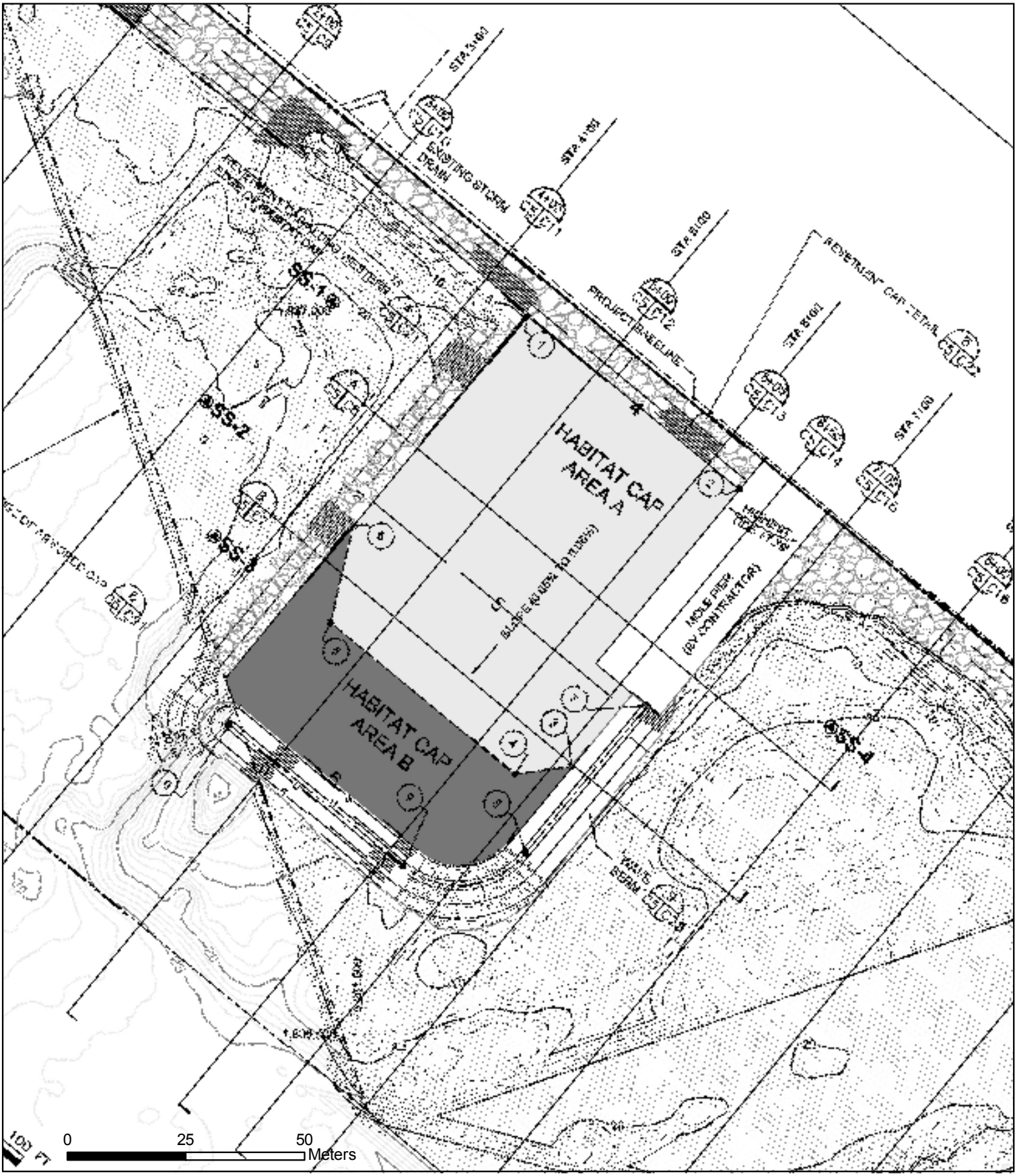
Eelgrass Mitigation and Monitoring
at the Former Campbell Shipyard
Source: USGS 7.5' Point Loma, CA Quadrangle

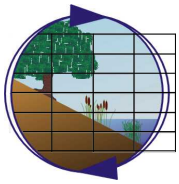
Figure 1

Eelgrass Distribution

Campbell Shipyard Eelgrass Mitigation
Pre-Construction Status October 2002

Figure 2





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As-built Design of Habitat Cap

Campbell Shipyard Eelgrass
Mitigation and Monitoring

Figure 3

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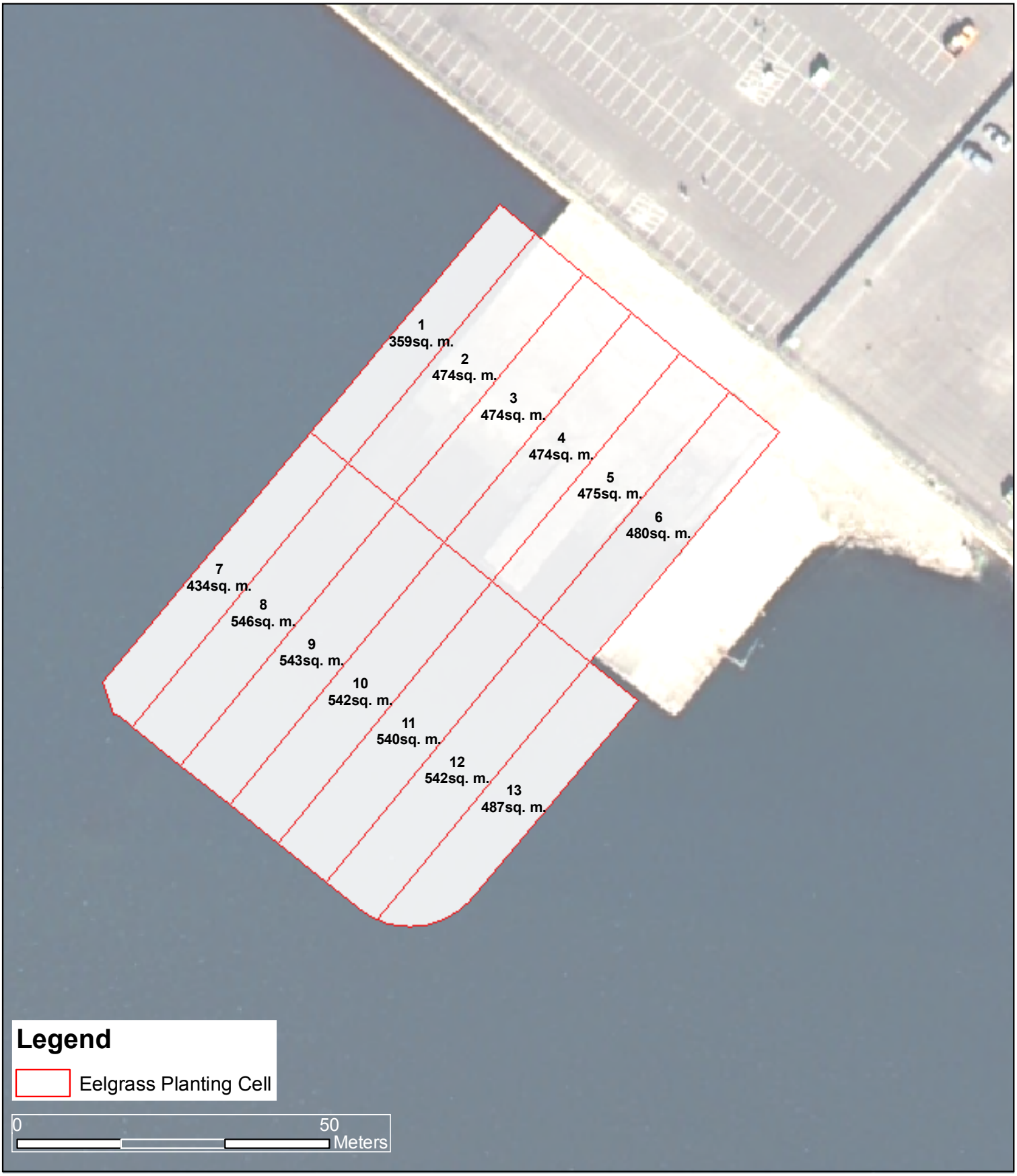

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Eelgrass Planting Location

Eelgrass Mitigation and Monitoring
at the Former Campbell Shipyard

Figure 4

Merkel & Associates, Inc.

erosion from tugboat activities at the adjacent 10th Avenue Marine Terminal. The extra bundles were placed in an effort to facilitate rapid growth of eelgrass that might protect sediments from erosion in this portion of the site.

As outlined in the SCEMP, a reference site was established just offshore of Tidelands Park and Le Meridien Resort, along the eastern shore of Coronado Island. This site was selected based on proximity to, and similarity in, biological characteristics to the restoration site. Monitoring of the reference site has been conducted coincident with the monitoring of the restoration site. Changes in the reference site over time have been considered when evaluating the performance of the restoration site.

MONITORING AND SUCCESS CRITERIA

This eelgrass-monitoring program includes milestone success monitoring to verify that minimum coverage and density requirements are achieved per the requirements of SCEMP. The coverage and leaf shoot density of eelgrass within the restoration and reference sites will be mapped and measured at each monitoring interval. Mitigation is to be deemed successful when it has met the success criteria outlined in the SCEMP. Criteria for determination of transplant success will be based upon a comparison of vegetation coverage (area) and density (leaf shoots per square meter) between the reference site and the restoration site. Extent of vegetation cover is defined as the area where eelgrass is present and where gaps in coverage are less than one meter between individual leaf shoot clusters. Density of shoots is identified as the number of leaf shoots per square meter, as measured from representative areas within the reference or transplanted beds. Key success criteria are as follows:

A) A minimum of 70 percent areal coverage and 30 percent density should be achieved after the first year.

B) A minimum of 85 percent areal coverage and 70 percent density should be achieved after the second year.

C) A minimum of 100 percent areal coverage and 85 percent density should be achieved for the third, fourth, and fifth years.

Should the required eelgrass transplant fail to meet any of the established criteria after 60 months, a Supplementary Transplant Area (STA) shall be constructed and planted.

The monitoring plan was established within the project's eelgrass mitigation plan (M&A 2004). The site has been monitored for 60 months post transplant. Monitoring has been performed using a combination of sidescan sonar surveys and diver ground-truthing. All surveys have adhered to the SCEMP, and findings have been reported in report format and on the short form required under the latest revision of the SCEMP.

METHODS

M&A staff, Keith Merkel, Jordan Volker, and Alan Merkel, conducted the 60-month post transplant survey on April 6, 2013. The field survey consisted of eelgrass areal coverage and density investigations within the restoration site (Figure 5) and the reference site (Figure 6). Eelgrass

Eelgrass Distribution

Campbell Shipyard Eelgrass Mitigation
60-month Post-planting Status April 2013

Figure 5

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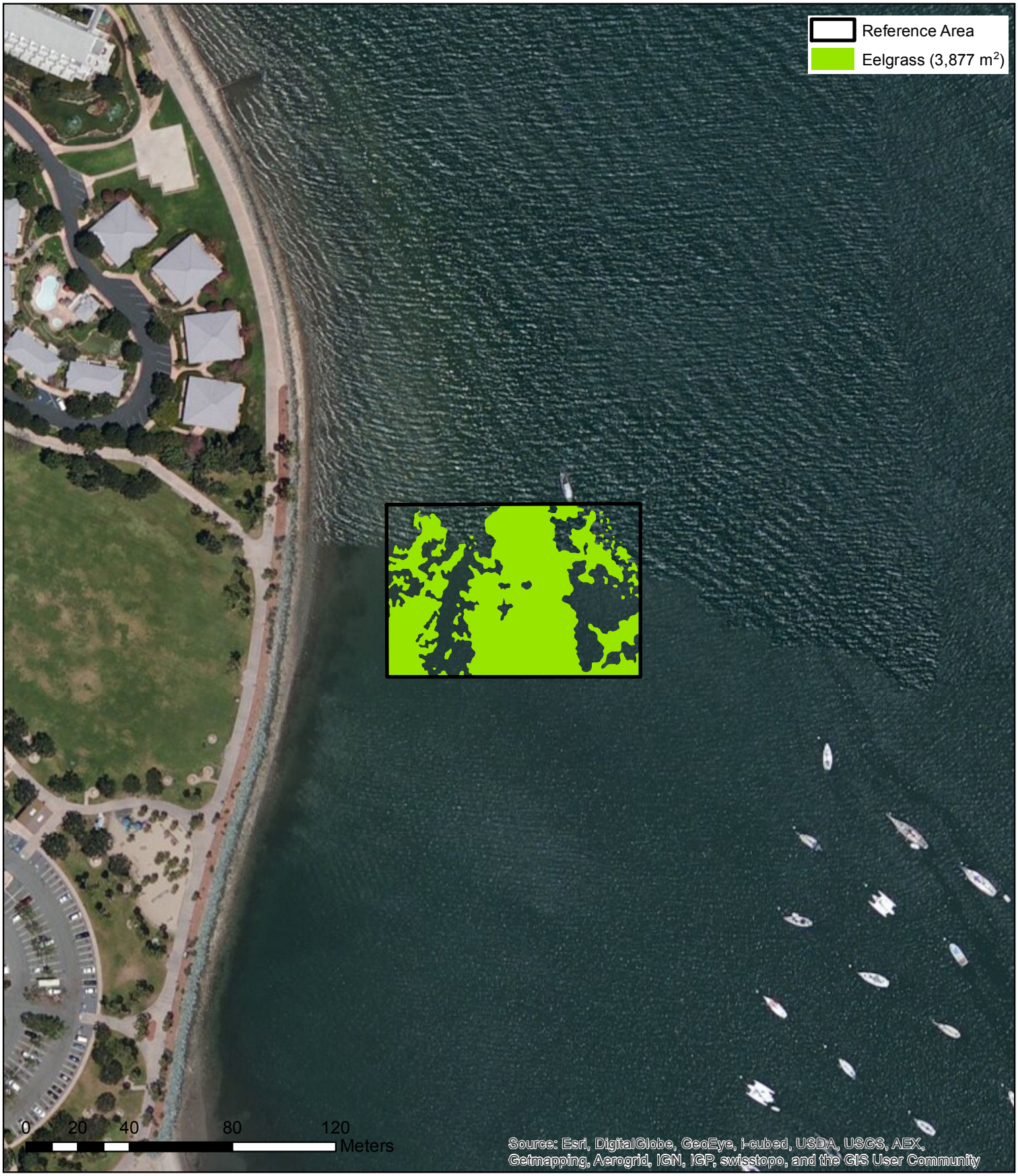

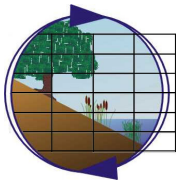

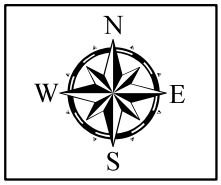

Reference Area Eelgrass Distribution
Campbell Shipyard Eelgrass Mitigation
60-month Post-planting Status April 2013

Figure 6

distribution data were collected using interferometric sidescan sonar that provided an acoustic backscatter image of the seafloor within the project area. Interpretation of the data allowed for an assessment of the distribution of the eelgrass. Sidescan backscatter data were acquired at a frequency of 468 kHz scanning out 35 meters on both the starboard and port channels for a 70-m wide swath. The survey was conducted by running parallel transects that were spaced to allow for overlap between adjoining sidescan swaths. Transect surveys were performed until the entirety of the survey area was covered by sonar swaths. All data were collected in latitude and longitude using the North American Datum of 1983 (NAD 83), converted to the Universal Transverse Mercator system in meters (UTM).

Following completion of the surveys, sidescan sonar traces were joined together and geographically registered. Eelgrass was then digitized as a theme to calculate the amount of eelgrass coverage and show its distribution. This method of eelgrass distribution calculation allows for monitoring eelgrass trends at the project site with a substantial degree of accuracy and repeatability over time.

A SCUBA diver verified the sidescan data and measured the density of actively growing leaf shoots by conducting shoot counts within a 1/16 square meter (m^2) quadrat. Twenty replicate quadrats were randomly placed within the eelgrass beds of the eelgrass restoration site and 20 replicate quadrats were randomly placed within the reference site to obtain a mean shoot density for eelgrass beds.

60-MONTH MONITORING RESULTS

EELGRASS RESTORATION SITE

The current 60-month survey revealed a total of 2,121 m^2 of eelgrass within the restoration site (Figures 5 and 7). Over the course of the 5-year monitoring, eelgrass within the site has expanded to a point where individual planting units are no longer visible; however, large portions of the site remain unvegetated. Patterns of eelgrass growth vary across the site. Eelgrass was observed as a mixture of dense and relatively sparse eelgrass patches within the shallow near-shore portions of the site. In this eastern areas, eelgrass exhibited a low epiphytic loading but beds where intermixed with considerable macroalgae dominated by *Gracilaria* and, to a lesser extent, *Ulva*. Historically, the central portion of the site has supported very dense patches of *Gracilaria* and very little eelgrass. During the April 2013 survey, this area was generally sparsely covered in *Gracilaria* but remained devoid of eelgrass.

Areas near the outer, western end of the site continue to support the majority of the eelgrass present on site, and eelgrass in this area was typically 0.5 to 0.75 meters tall and hosted approximately 30 percent epiphytic loading. Beds were denser than elsewhere on the site and eelgrass appeared robust and healthy. Around the fringes of the site, reef structures and supporting slope rock supports dense algal growth of *Sargassum muticum* and *Colpomenia*. As was noted in the 48-month annual survey, *Gracilaria* appears to be on the decline, while eelgrass is expanding in density while coverage is being maintained.

Eelgrass turion densities (± 1 standard deviation [SD]) within the restoration site were 183.2 ± 82.8 shoots per m^2 (n=20) (Figure 8).

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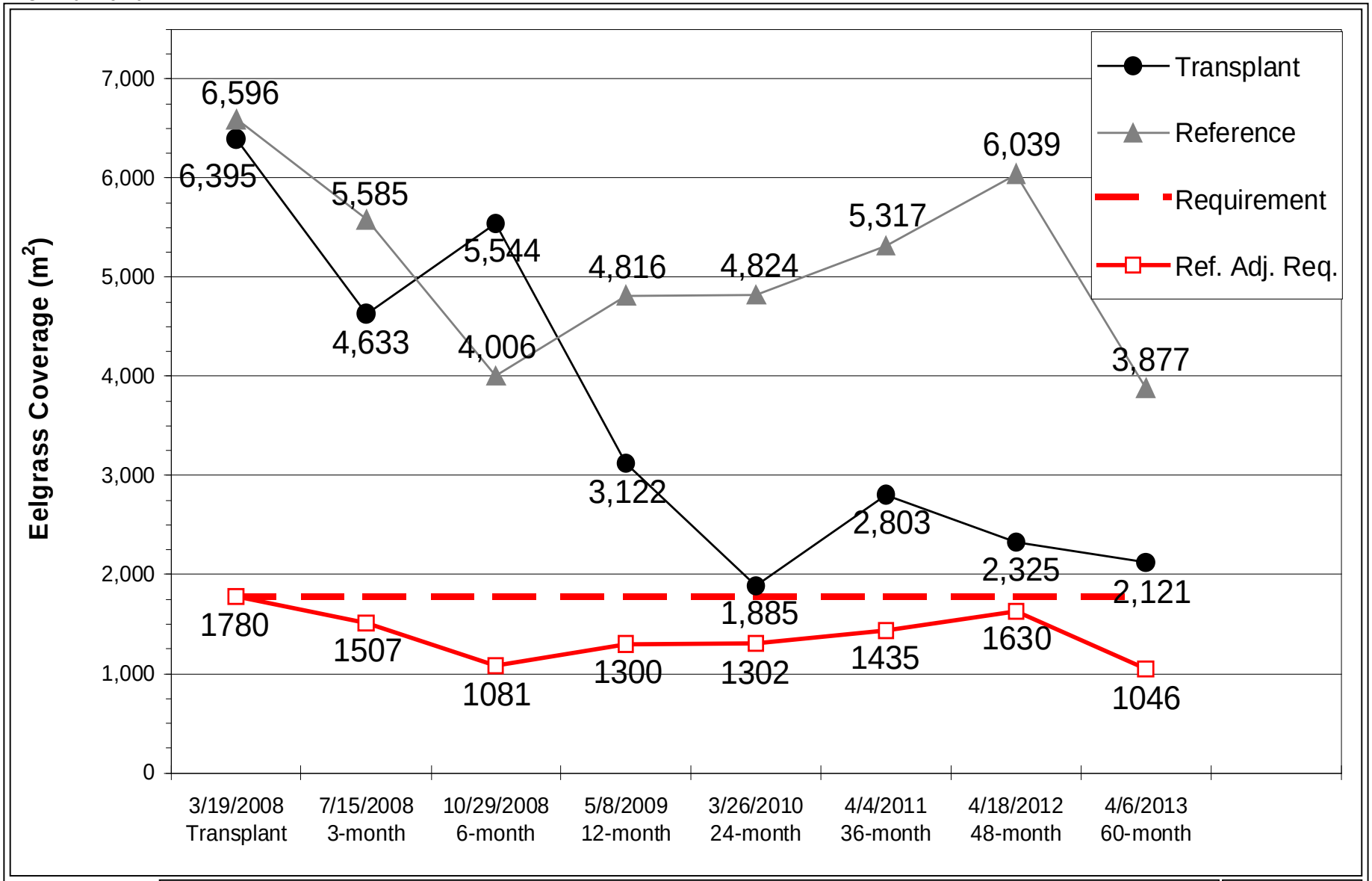

Eelgrass Coverage at Restoration and Reference Sites Relative to Restoration Requirements
Campbell Shipyard Eelgrass Mitigation Project

Figure 7

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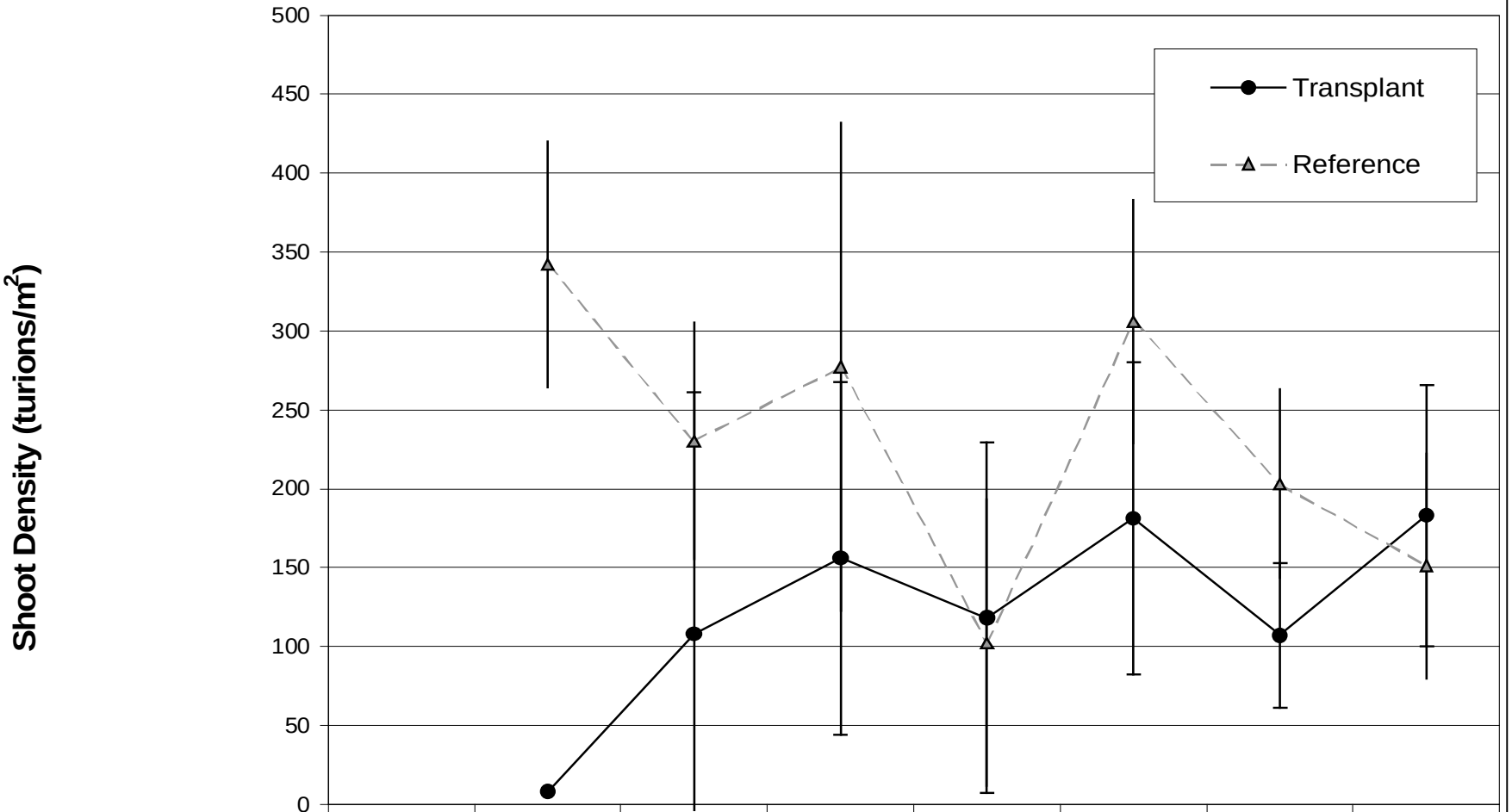

	3/19/2008 Transplant	7/15/2008 3-month	10/29/2008 6-month	5/8/2009 12-month	3/26/2010 24-month	4/4/2011 36-month	4/18/2012 48-month	4/6/2013 60-month
Transplant		8	108	156	118	181	107	183
Reference		342	230	277	102	306	203	151
% Transplant/Reference		2%	47%	56%	116%	59%	53%	121%

Restoration Site Eelgrass Shoot Density Relative to Reference Site Shoot Density
Campbell Shipyard Eelgrass Mitigation Project

Figure 8

REFERENCE SITE

The current 60-month survey revealed a total of 3,877 m^2 of eelgrass within the reference site (Figures 6 and 7). The reference site was covered with healthy eelgrass growing as part of a larger bed with large gaps in the bed. The reference site has declined substantially since the 48-month survey period. Within the reference bed, eelgrass was of similar stature to that found within the Campbell site with areas at the lower elevations of the mitigation site supporting eelgrass of approximately 0.5 to 0.75 m in height while shallower portions of the mitigation site supported eelgrass that was less than 0.5 meters in height. The shortest eelgrass near the upper bed fringe averaged approximately 0.2 meters in height. Epiphytic loading was high in deeper portions of the bed, at approximately 60 percent; while shallow eelgrass exhibited no epiphytic loading, as would be expected given the shoreline energy levels.

Eelgrass turion densities (± 1 SD) within the reference site were 151.2 ± 71.1 shoots per m^2 (n=20) (Figure 8).

DISCUSSION

The eelgrass at the former Campbell Shipyard sediment remediation habitat cap and eelgrass restoration site is performing well 60 months following the transplant effort. At 60 months, eelgrass exceeds the SCEMP required vegetation areal coverage of 1,780 m^2 by 12 percent based on raw coverage numbers and it exceeded the reference adjusted requirement, which takes into account the natural variation in eelgrass cover, by 103 percent (Figure 7). Eelgrass density at 60 months is 121 percent of the turion density relative to the reference area. Both of these metrics exceed the mitigation success standards required at 60 months under the SCEMP. Further, the site has continuously exceeded the milestone requirements through its history.

This is the final monitoring event for the Campbell Shipyard eelgrass mitigation site. The site has met its success requirements relative to eelgrass mitigation. Given the site history, it is expected that eelgrass will continue to expand in the site in future years and will ultimately support much more eelgrass than was required as mitigation.

LITERATURE CITED

Fonseca, Mark S., W. Judson Kenworthy, G. W. Thayer. 1982. A Low-Cost Planting Technique for Eelgrass (*Zostera marina L.*). Coastal Engineering Aid No. 82-6. U. S. Army Engineer Coastal Engineering Research Center, Fort Belvoir, Virginia. 15 pp.

Merkel, Keith W. 1987. Use of a New Bio-Degradable Anchor Unit for Eelgrass (*Zostera marina*) Revegetation. Presented at the First California Eelgrass Symposium, Tiburon, California. 8-9 May 1987. Pages 28-42.

Merkel, Keith W. 1990a. Growth and Survival of Transplanted Eelgrass: the Importance of Planting Unit Size and Spacing. In: K. W. Merkel and R. S. Hoffman, eds. Proceedings of the California Eelgrass Symposium, Chula Vista, California May 27-28, 1988. Pages 70-78.

Merkel, Keith W. 1990b. Eelgrass Transplanting in South San Diego Bay, California. In: K. W. Merkel and R. S. Hoffman, eds. Proceedings of the California Eelgrass Symposium, Chula Vista, California, May 27-28, 1988. Pages 28-42.

Merkel & Associates, Inc. 2004. Eelgrass Mitigation Program in Support of Sediment Remediation and Aquatic Enhancement at the Former Campbell Shipyard Site San Diego Bay, San Diego, California. Report, June 2004. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2008. Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, April 2008. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2008. 3-Month Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, September 2008. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2008. 6-Month Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, December 2008. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2009. 9-Month Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, February 2009. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2009. 12-Month Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, July 2009. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2010. 24-Month Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, April 2010. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2011. 36-Month Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, April 2011. Prepared for San Diego Unified Port District.

Merkel & Associates, Inc. 2012. 48-Month Post Transplant Report for the Former Campbell Shipyard Habitat Cap and Eelgrass Restoration Site. Report, June 2011. Prepared for San Diego Unified Port District.

National Marine Fisheries Service, NOAA. 1991, Revision 11. Southern California Eelgrass Mitigation Policy. R.S. Hoffman, ed.

APPENDIX A.
SCEMP Eelgrass Mitigation Reporting Short Form

Southern California Eelgrass Mitigation Policy
Monitoring and Compliance Reporting Summary

PERMIT DATA:

Permit (Type, Number)	Issuance Date	Expiration Date	Agency Contact
ACOE: 199915203-JLB	11/05/2004	10/28/2009	Joshua L. Burnham
CDP:_____			
Other:_____			

EELGRASS IMPACT AND MITIGATION REQUIREMENTS SUMMARY:

Permitted Eelgrass Impact Estimate	1,483 (m^2)	
Actual Eelgrass Impact,	1,483 (m^2)	No post-con survey performed - all eelgrass lost
Eelgrass Mitigation Requirement	1,780 (m^2)	Mitigation plan is M&A 2004
Impact Site Location	Former Campbell Shipyard, Port of San Diego	
Impact Site Center Coordinates	UTM11 N, WGS84 484959 E, 3618377 N	
Mitigation Site Location	Former Campbell Shipyard Habitat Cap	
Mitigation Site Center Coordinates	UTM11 N, WGS84 484959 E, 3618377 N	

PERMITTEE CONTACT INFORMATION:

Project Name	Former Campbell Shipyard Sediment Remediation and Aquatic Enhancement
Permittee Information	Port of San Diego
	P.O. Box 120488, Phone: 619-686-6254
	San Diego, CA 92112
	Eileen Maher
	619.686.6254, emaher@portofsandiego.org
Mitigation Consultant	Keith W. Merkel, Merkel & Associates, Inc.
	858-560-5465, kmerkelmerkelinc.com

PROJECT ACTIVITY DATA:

Activity	Start Date	End Date	Reference Info.
Eelgrass Impact	10/31/2005	12/17/07	Kristine Kam, Port of San Diego
Installation of Eelgrass Mitigation		03/19/2008	M&A 2008
Initiation of Mitigation Monitoring	03/19/2008	03/19/2013	M&A 2008

MITIGATION STATUS DATA:

Mitigation Milestone	Scheduled Survey	Survey Date	Area (m^2)	Density (turions/m^2)	Reference Info.
Requirement			1,780	Qualitative <100/m^2	M&A 2003
0-month	March 2008	03/19/2008		5	M&A 2008
3-month	July 2008	07/15/2008	4,633	8(approx.)	M&A 2008
6-month	October 2008	10/20/2008	5,544	108	M&A 2008
9-month	January 2009	1/30/2009	4,978	95	M&A 2009
12-month	April 2009	3/13/2009	3,122	156	M&A 2009
24-month	April 2010	03/26/2010	1,885	118	M&A 2010
36-month	April 2011	04/04/2011	2,803	181	M&A 2011
48-month	April 2012	04/18/2012	2,325	107	M&A 2012
60-month	April 2013	04/06/2013	2,121	183	M&A 2013

FINAL ASSESSMENT:

Was mitigation met?	Yes
Were mitigation and monitoring performed timely?	Yes
Was delay penalty required or were supplemental mitigation programs necessary?	NA