San Francisco Estuary Invasive *Spartina* Project 2017-2018 Monitoring and Treatment Report

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1. Introduction

Since the early 1970s, four non-native cordgrasses, including *Spartina alterniflora* (Atlantic smooth cordgrass), *S. densiflora* (Chilean cordgrass), *S. anglica* (English cordgrass), and *S. patens* (salt meadow cordgrass), were introduced to the San Francisco Estuary ('Estuary' or 'Bay' throughout this report). Each of these species is known to be invasive outside of its native range, and each has demonstrated varying degrees of invasiveness since establishing in the Estuary. *Spartina* species are closely related, and both *S. alterniflora* and *S. densiflora* subsequently hybridized with native *S. foliosa* (Daehler and Strong 1996; Ayres, Strong et al. 2003; Ayres, Grotkopp et al. 2008). Offspring of hybrid *S. alterniflora* x *foliosa* back-crossed with the parent species, producing an extremely robust and fertile "hybrid swarm," which invaded habitat throughout the Estuary, threatening the ecological integrity of the existing tidal wetlands and mudflats as well as the potential for future restoration efforts (Daehler and Strong 1996; Goals 1999; Ayres, Strong et al. 2003; State Coastal Conservancy 2003; Ayres, Zaremba et al. 2004; Ayres, Grotkopp et al. 2008). For further detail on each species of *Spartina* found in the Estuary, see **Appendix I**.

The San Francisco Estuary Invasive *Spartina* Project (ISP) was established in 2000 by the California State Coastal Conservancy (Conservancy), in partnership with the U.*S.* Fish and Wildlife Service (USFWS), in response to the invasion of non-native *Spartina*. Non-native *Spartina* had been determined to pose many serious threats to the Estuary, as was described in the ISP's Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR; (State Coastal Conservancy 2003). Predicted impacts of non-native *Spartina* in the Estuary included the destruction or degradation of endangered species habitat, loss of mudflats that are vital for shorebird foraging, loss of urban flood control capacity, creation of mosquito-breeding areas by impounding water, corruption of salt marsh restoration efforts, and the possible eventual extinction of native *Spartina foliosa*. The purpose of the ISP is to implement a regional program to eradicate non-native *Spartina* species from the Estuary. This goal is being accomplished through a highly-coordinated program of inventory mapping and treatment that is planned and supervised by ISP biologists and implemented on-the-ground by a bay-wide network of partners including dozens of landowners, resource agencies, contractors, grantees, and stakeholder groups throughout the nine county Bay Area.

The project has been supported over the years by a combination of state (74%), federal (22%), and local/other funds (4%) totaling $42M. The 2018 expenditure for monitoring and treatment was roughly $1,200,000, which reflects a compounding annual reduction of 20% for the prior three years due to the reduced availability of State of California funds.

Working within limited annual windows of opportunity due to tides, stage of plant development, and presence of endangered species in the work area, the ISP conducts mapping and treatment of invasive *Spartina* annually throughout up to 70,000 acres of potential habitat. Since 2008, inventory efforts have been conducted primarily on the ground or using various boats. Most sites are inventoried each year prior to treatment to allow thorough and focused mapping and potential collection of DNA samples, and to map precise current locations of invasive *Spartina* plants to inform treatment. Having the target plant locations identified and mapped in advance allows treatment crews to work more efficiently without having to hunt for all occurrences of non-native *Spartina* at the same time. It also enhances worker safety, reduces the amount of ground crews must cover, and reduces disturbance to the marsh. A relatively small number of sites with a substantial mudflat component are mapped during airboat treatment

Defining "Area"

The ISP uses the terms "net area" and "treatment area" to define the extent of non-native *Spartina*.

Net area refers to the size of the infestation if the space between stems were subtracted from the overall footprint of the plant or clump of plants. Net area is the metric typically used in botanical surveys.

Treatment area describes the area that will be directly affected by treatment. Treatment area is a separate measurement used for planning, and it is generally five to seven times greater than the net area of a given instance of invasive *Spartina*.

Unless otherwise noted in the text, all references to area in this report are net area.

due to logistical concerns. Biologists map invasive *Spartina* plants they have detected as points, lines, or polygons using rugged handheld tablet PCs with Global Positioning System (GPS), spatially demarcating each feature. A cover class is assigned to each feature to record the density of live invasive *Spartina* within that feature's delineated boundary (see inset: Defining "Area").

During treatment, ISP biologists guide agency personnel or contracted herbicide applicators to each previously mapped invasive *Spartina* feature and update that feature on the tablet to record that day's treatment activity (e.g. "sprayed", "dug", "not treated", "sub-optimally treated" etc.). This methodology has been implemented by ISP since 2009, and it has greatly improved the ability to accomplish thorough treatment of sites in the limited amount of time available with the treatment crew(s) for a given day. For further detail on the methods employed by ISP for treatment, monitoring, and other work, please see **Appendix II**.

The ISP has made tremendous progress toward eradication since 2005 when inventory and treatment began throughout the San Francisco Estuary and in the neighboring coastal areas. Historic infestations have been completely eradicated from the Point Reyes National Seashore, and very nearly eradicated from both Tomales Bay and Bolinas Lagoon. During the 2016 inventory and treatment season, the ISP mapped a total of 27.0 net acres of non-native *Spartina*, a 97% estuary-wide reduction since the peak of the invasion at 805 acres in 2005. Since 2011, treatment restrictions had been in place at fourteen sub-areas[1], and in 2016 a minimum of 21.6 acres of non-native *Spartina* (80% of the Bay-wide total) remained untreated in those fourteen marshes. ISP and its partners treated the remaining 5.4 acres of *Spartina* in the sub-areas where treatment was authorized. For further information on recent inventory and treatment activities, see Section 2 below and for a more complete history of the invasion and treatment activities around the Bay, see the 2012 ISP Monitoring and Treatment Report (Rohmer, Kerr et al. 2014).

[1] Prior to 2018, the fourteen sub-areas with treatment restrictions were consolidated as eleven sub-areas. A few of these sub-areas were split into multiple sub-areas to reflect changes to the treatment restrictions in 2018 per the Project's Section 7 consultation with the United States Fish & Wildlife Service.

2. Treatment and Monitoring Completed 2017-2018

The ISP's activities and progress over the two-year period 2017-2018 are described in this section, first from a bay-wide perspective, and then in more detail for each of 12 reporting regions (see inset this page and **Figure 1**). The reporting regions are based on regions initially defined by USFWS for assessment of California Ridgway's rail (*Rallus obsoletus obsoletus*) populations. The reporting region boundaries also take into consideration natural and political landscape features, similarities in land management, geographic proximity and ecological connectedness of the treatment sub-areas, and general impact of non-native *Spartina* invasion on the region. ISP uses these reporting regions to cohesively present treatment and monitoring data in a manner more suitable for correlation with California Ridgway's rail ("Ridgway's rail") data. Information presented here predominantly reflects data from the 2018 season, though activities from 2017 are included as needed and where specifically identified.

ISP Reporting Regions

Region 1. Marin
Region 2. San Francisco Peninsula
Region 3. San Mateo
Region 4. Dumbarton South
Region 5. Union City
Region 6. Hayward
Region 7. San Leandro Bay
Region 8. Bay Bridge North
Region 9. Suisun
Region 10. Vallejo
Region 11. Petaluma
Region 12. Outer Coast

Since the 2015-2016 Monitoring and Treatment Report, the Project's inventory area has increased by approximately 10,000 acres, and the number of sub-areas has increased to reflect changes in treatment allowances. These will be addressed more specifically in sections 3.3 and 3.4 but are noted here because numbers included in this report reflect acreages and sub-area numbers as they were in 2018. Appendix III shows actual sub-area names and numbers in use each year.

2.1. Bay-wide Inventory

2.1.1. Bay-wide Inventory Methods

There are 70,000 acres of potential *Spartina* habitat within the ISP Project Area. Constraints including but not limited to staff availability, budget, a short growing season (June to November), and appropriate tide windows limit the Project's ability to complete inventory (and treatment) in all areas every year. To make the best use of available resources, ISP Managers begin planning for the upcoming season by setting priorities according to relative invasion pressure or other risk. ISP inventory priorities are established using the following criteria:

- historic presence of non-native *Spartina*,
- proximity to non-native *Spartina* seed sources,
- habitat suitability for colonization by non-native *Spartina,* and
- time since the area was thoroughly surveyed for non-native *Spartina*.

Prioritized sub-areas are assigned to one of four inventory categories: (1) complete inventory, (2) partial inventory, (3) coarse inventory, and (4) no inventory. Sub-areas prioritized for complete inventory typically have historic infestation or high risk of colonization, or several years have passed since the last thorough inventory and the sub-area requires reassessment. Partial inventory is conducted in portions of very large sub-areas where there are known isolated infestations. Coarse inventory is conducted in

sub-areas with heavy infestations, i.e., where treatment is restricted due to permit requirements. Coarse inventory is typically conducted using a grid method[2]. No inventory is conducted in low-priority sub-areas where there has not been historic infestation and risk of colonization is low, or where there has been a recent thorough inventory that concluded the sub-area was low risk.

A second round of inventory is frequently conducted late in the season at select sub-areas that are approaching eradication. This additional assessment is critical to identify invasive *Spartina* plants that may not have been detected in the first round, usually because they were heavily impacted by prior treatment and were not yet sufficiently developed, had emerged after the initial inventory, or had suffered herbivory by geese. Sub-areas chosen for a second round are those approaching eradication. Many of these contain linear stretches of marsh that do not provide habitat for Ridgway's rails, and so they may be given initial treatment earlier in the season (e.g., prior to the end of rail nesting season). The early initial treatment allows enough time for plants to show treatment stress before the second treatment round, allowing for targeted and highly effective second round applications.

The 2017 and 2018 seasons presented additional challenges due to a reduced budget. As a result, reduced inventory was conducted at several large and complex marshes with sizeable hybrid *S. alterniflora* infestations (e.g. Calaveras Marsh [05a.2], B2 North West [02c.1a], and Alviso Slough [15a.4]). Reduced inventory took several forms, including only revisiting detections that had been mapped the prior year and not doing an exhaustive survey over the entire site, mapping only the plants that were readily identifiable (i.e., not spending more time to discern the more cryptic plants), or a combination of these two approaches. In 2018, for example, 90% of two of marshes (B2 North West (02c.1a) and B2 North South (02c.2)), were not inventoried or treated; this was the first time in ISP history that an area with known infestation was intentionally skipped.

Other important factors affecting the 2018 season included changes to treatment authorizations by USFWS and a 10,000-acre expansion of project area due to newly discovered hybrid *S. alterniflora* populations (see Section 3).

Figures 1 and 2 show the location of the ISP reporting regions, inventory boundaries and status of survey completion for 2017 and 2018. **Appendix III** provides the level of inventory conducted at each ISP sub-area in 2017 and 2018. Timing of completed inventory is shown in **Table 1.**

2.1.2. Bay-wide Inventory Results

In 2017, a total of approximately 39,000 acres (56%) of the ISP project area was surveyed and 40.8 acres of invasive *Spartina* was mapped. Inventory in 2017 documented the first Bay-wide increase in hybrid *S. alterniflora* since ISP treatment began in 2005. The increase is believed to be the result of the record rainfalls over the winter of 2016-2017 ending the severe multi-year drought that was then followed by a very wet spring 2017, as discussed in detail in Section 3.1.

[2] The grid method was developed by ISP in 2008. Mapping by grid follows the rationale that detailed locations of plants would neither inform current year treatment nor inventory for the following year, and the time saved mapping by grid can be better allocated to areas that will receive treatment.

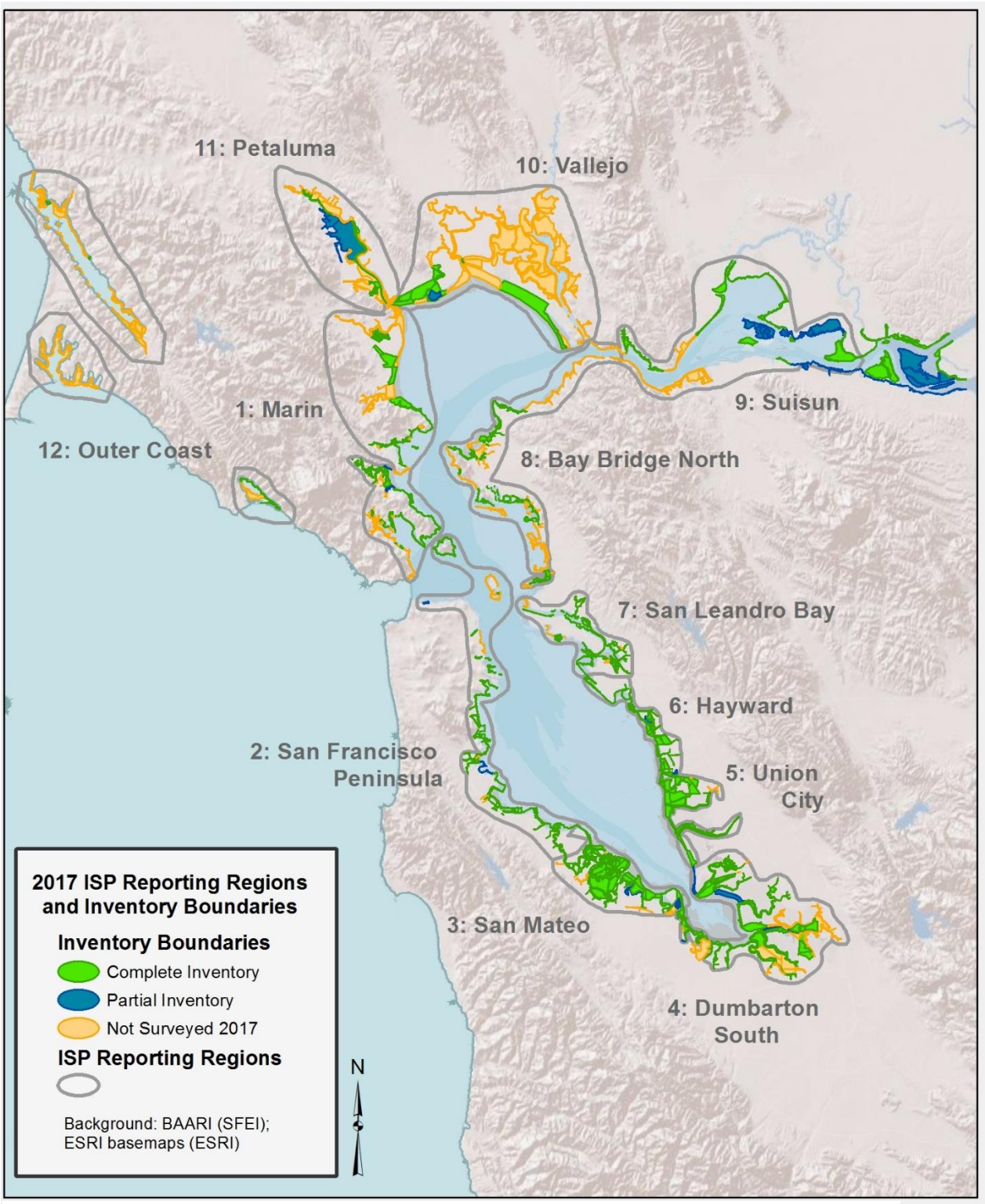

Figure 1. ISP Reporting Regions and 2017 survey efforts throughout San Francisco Bay Estuary.

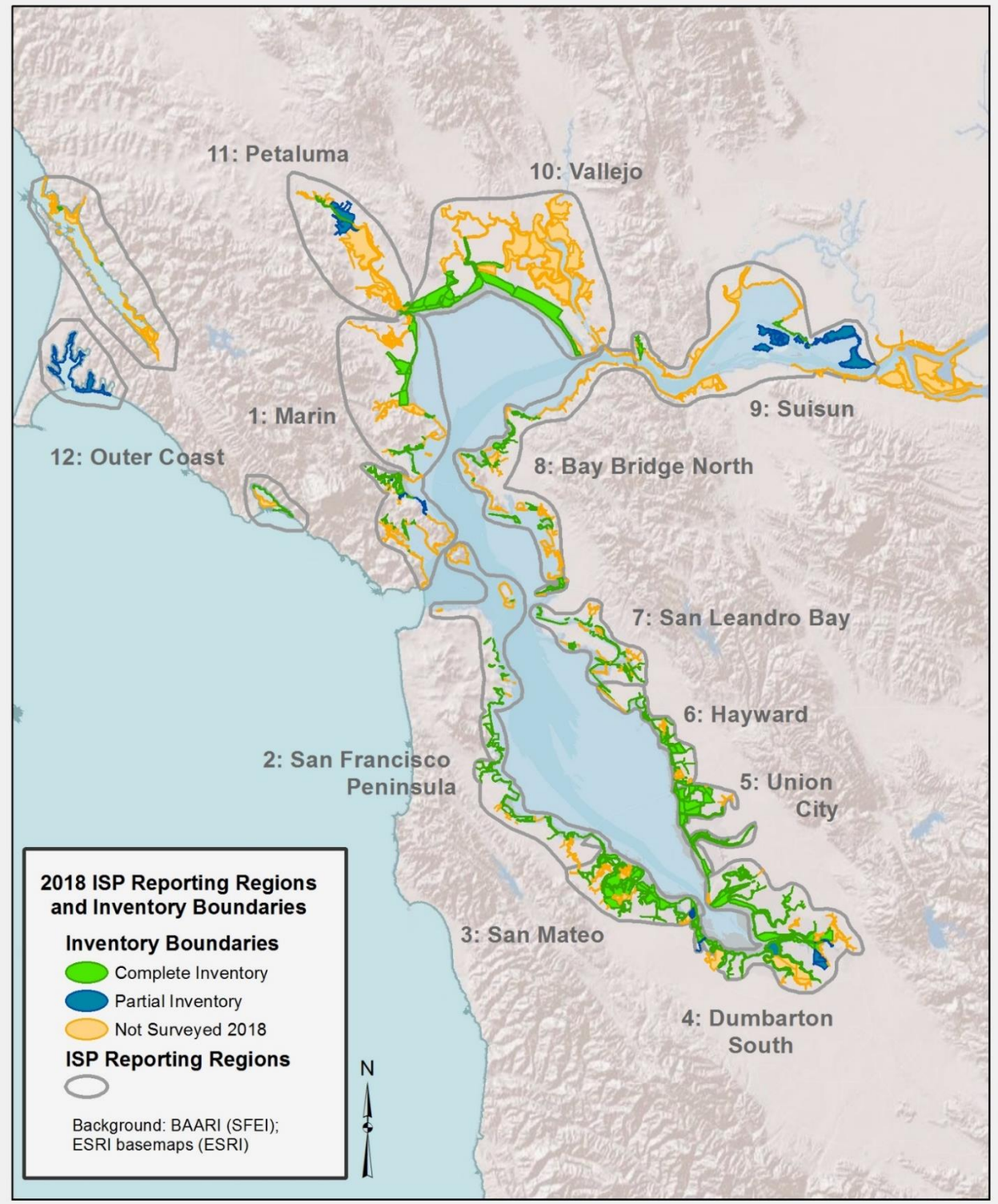

Figure 2. ISP Reporting Regions and 2018 survey efforts throughout San Francisco Bay Estuary.

In 2018, 32,600 acres (47%) were surveyed and 37.9 acres of invasive *Spartina* was mapped. This reflects a 95.3% reduction from peak levels in 2005, and a 7.8% reduction from 2017 levels (**Table 2**) and is comparable to the level detected in 2012 (Rohmer, Kerr et al. 2014).

All but 18 square meters of invasive Spartina mapped in 2018 was hybrid *S. alterniflora* (**Table 3**), 99.5% of which was located in four reporting regions (listed here in decreasing order of cordgrass cover):

- Region 6: Hayward – 20.84 acres
- Region 7: San Leandro Bay – 10.95 acres
- Region 3: San Mateo – 4.53 acres
- Region 4: Dumbarton South – 1.36 acres

The three most infested regions (regions 6, 7, and 3) each contain some sub-areas that had some level of treatment restriction in place until 2018. Regions 6 and 7 continue to have treatment restrictions in place at some sub-areas; infestation in these restricted sub-areas accounts for 26.4 acres (70%) of the Bay total. An additional 7.5 acres of hybrid *S. alterniflora* were found in the sub-areas that were re-authorized for treatment in 2018.

The distribution of non-native *Spartina* species within each reporting region and sub-area is shown in **Figures 3-5**. **Figure 3** shows the widespread distribution of hybrid *S. alterniflora*. The greatest presence (net cover and/or abundance) of hybrid *S. alterniflora* continues to be concentrated in reporting regions 3, 4, 6, and 7 in Central and South Bay; low levels persist in all other reporting regions. Note also in Figure 3 that Region 5 currently supports one of the lowest levels of infestation in the Estuary, even though it was where the original introduction, hybridization, and peak infestation of hybrid S. alterniflora occurred. **Figure 4** shows Region 1, the source of the *S. densiflora* infestation, is where that species population remains the greatest. **Figure 5** is a combined map showing distribution of the remaining two species, *S. patens* and S. *anglica*, as well as hybrid *S. densiflora* x *foliosa*, which occur only as small isolated populations in regions 1 and 9.

Second rounds of inventory were conducted in both 2017 and 2018. In 2017 there were 38 sub-areas with prior invasion history where no non-native *Spartina* was found, and in 2018 there were 49. Invasive *Spartina* was re-detected in three sub-areas in 2018 where none had been found in 2017, though they were all small plants less than 1m^2 and were subsequently treated (**Table 4**). The number of "zero detect" sub-areas has steadily increased since implementation of secondary rounds began in 2014, with 25 sub-areas in 2014, 29 in 2015, 35 in 2016, 38 in 2017, and 49 in 2018.

Table 1. Inventory timing for *Spartina* by species in 2017 and 2018

***Spartina* species**	**Time Frame of Inventory**	
	2017	**2018**
hybrid *S. alterniflora*	June 5, 2017 - November 29, 2017	May 24, 2018 - November 30, 2018
S. patens	March 25, 2017 - April 14, 2017	April 18, 2018 - September, 28 2018
S. densiflora and hybrids (I)	June 15, 2017 - July 24, 2017	June 4, 2018 - June 21, 2018
S. densiflora and hybrids (II)	January 4, 2018 - February 19, 2018	January 10, 2019 - January 31, 2019
S. anglica	July 13, 2017 - July 31, 2017	June 19, 2018 - July 16, 2018

Table 3. Summary of Invasive Spartina Mapped in 2017 and 2018

Number of Sub-Areas in Region	Potential Invasive *Spartina* Habitat (ac)	Portion of Region Acreage Authorized for Full Treatment	Net Cover 2017 (ac)	Net Cover 2018 (ac)	% Change Since 2017	Peak Year	Peak Amount (ac)	% Change Since Peak	% Remaining since Peak
219	69,161	99.6%	41.10	37.9	-7.9%	2005	805	-95.3%	4.7%

* Region has treatment restrictions in multiple sub-areas in 2018. The portion of the region (by area) that is authorized for full treatment is shown in column 5.

Table 3. Summary of invasive Spartina Mapped in 2017 and 2018 by Species and Treatment Authorization Status

Spartina species	Net Cover 2018	Net Cover 2017	% Change Since 2017	Peak Year	Peak Amount	Change Since Peak	% Change Since Peak	% Remaining since Peak
S. alterniflora* x *foliosa								
Sub-areas with 2018 Treatment Authorized	11.51 ac.	14.73 ac.	-21.9%	2005	714.39 ac.	-702.88 ac.	-98%	1.6%
Sub-areas with 2018 Treatment Restrictions	26.35 ac.	26.36 ac.	-0.04%	2005	73.19 ac.	-46.84 ac.	-64.0%	36.0%
***S. alterniflora* x *foliosa* TOTAL**	37.90 ac.	41.09 ac.	-7.8%	2005	787.59 ac.	-749.69 ac.	-95.2%	4.8%
S. densiflora	6.18 m^2	10.99 m^2	-43.8%	2005	4.17 ac.	-4.16 ac.	-99.96%	0.04%
S. densiflora* x *foliosa	2.93 m^2	5.48 m^2	-46.5%	2005	347.82 m^2	-335.34 m^2	-99.2%	0.8%
S. anglica	0.69 m^2	1.48 m^2	-53.4%	2006	382.66 m^2	-374.35 m^2	-99.8%	0.2%
S. patens	8.10 m^2	31.02 m^2	-73.9%	2005	0.65 ac.	-0.64 ac.	-99.7%	0.3%

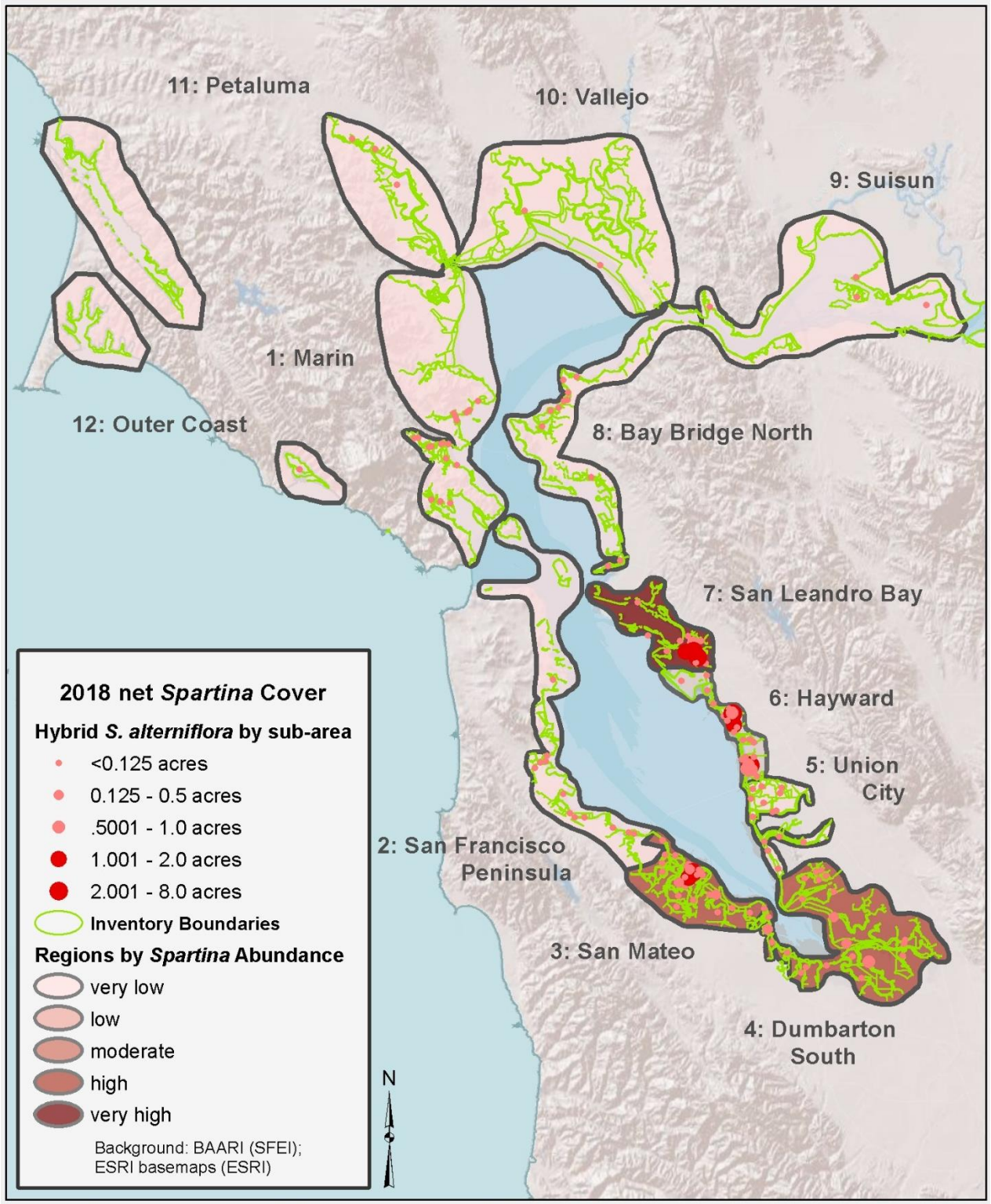

Figure 3. 2018 hybrid Spartina alterniflora x foliosa presence throughout San Francisco Bay Estuary by ISP Reporting Region and sub-area

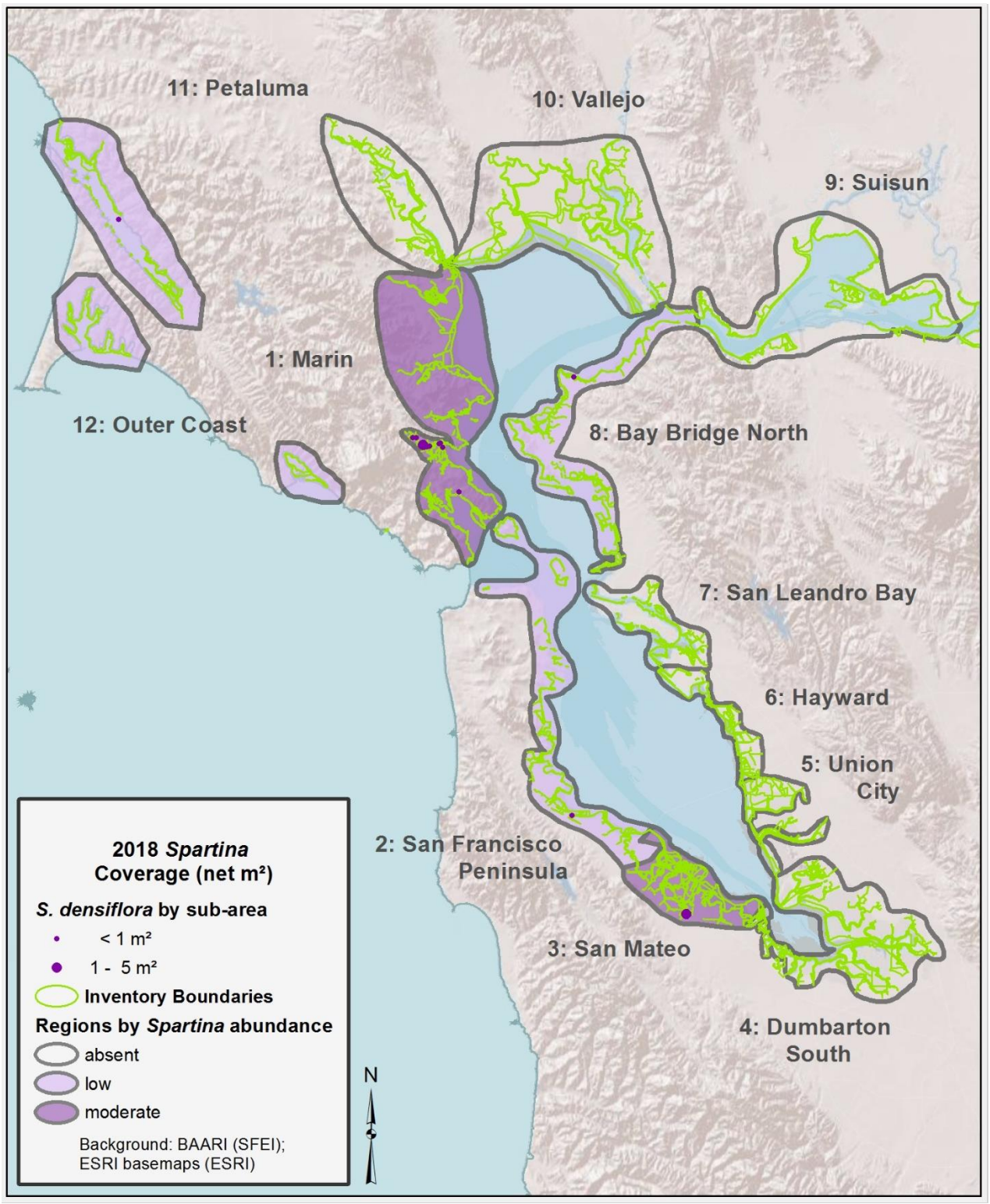

Figure 4. 2018 *Spartina densiflora* presence throughout San Francisco Bay Estuary by ISP Reporting Region and sub-area.

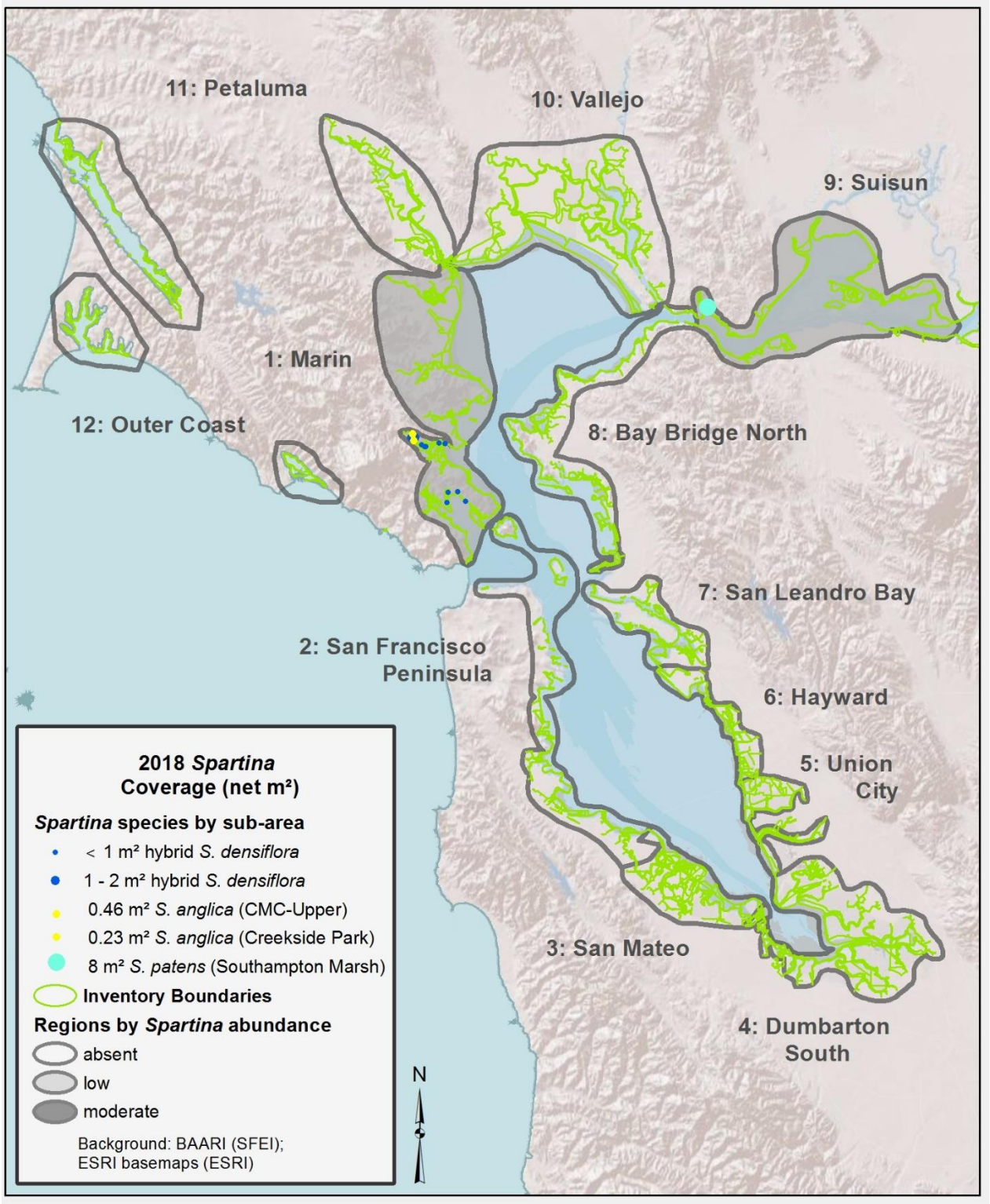

Figure 5. 2018 hybrid *Spartina densiflora* x *foliosa*, *S. anglica*, and *S. patens* presence throughout San Francisco Bay Estuary by ISP Reporting Region and sub-area.

Table 4. Sub-areas with historic infestation in which no invasive Spartina of any kind was detected in either 2017 or 2018

Sub-areas that maintained "Zero-detect" Status for both 2017 and 2018

Region	Code	Sub-area	2017 Net m^2	2018 Net m^2
1	03b	Blackie's Creek Mouth	zero detect	zero detect
	23k	Sausalito	zero detect	zero detect
	23l	Starkweather Park	zero detect	zero detect
	23m	Novato	zero detect	zero detect
	23o	China Camp	zero detect	zero detect
2	12a	Pier 94	zero detect	zero detect
	12c	India Basin	zero detect	zero detect
	12d	Hunters Point Naval Reserve	zero detect	zero detect
	12f	Candlestick Cove	zero detect	zero detect
	12g	Crissy Field	zero detect	zero detect
	12h	Yerba Buena Island	zero detect	zero detect
	12i	Mission Creek	zero detect	zero detect
	18b	Navigable Slough	zero detect	zero detect
	18d	Inner Harbor	zero detect	zero detect
	18f	Confluence Marsh	zero detect	zero detect
	19a	Brisbane Lagoon	zero detect	zero detect
	19b	Sierra Point	zero detect	zero detect
	19c	Oyster Cove	zero detect	zero detect
	19d	Oyster Point Marina	zero detect	zero detect
	19e	Oyster Point Park	zero detect	zero detect
	19m	Fisherman's Park	zero detect	zero detect
	19r	Anza Lagoon	zero detect	zero detect
4	15a.7	Pond 17	zero detect	zero detect
5	01d	Upper Channel - Union City Blvd to I-880	zero detect	zero detect
	01e	Strip Marsh No. of Channel Mouth	zero detect	zero detect
	13a	Old Alameda Creek North Bank	zero detect	zero detect
	13g	Upstream of 20 Tide Gates	zero detect	zero detect
	13h	Eden Landing - North Creek	zero detect	zero detect
8	22e	Hoffman Marsh	zero detect	zero detect
10	26a	White Slough / Napa River	zero detect	zero detect
	26d	Sonoma Baylands	zero detect	zero detect
11	24d	Lower Petaluma River - Downstream of San Antonio Creek	zero detect	zero detect
12	25b	Limantour Estero	zero detect	zero detect
	25c	Drakes Estero	zero detect	zero detect
	25e	Bolinas Lagoon, South	zero detect	zero detect

Sub-areas achieving first year of "Zero detect" in 2018

Region	Code	Sub-area	2017 Net m^2	2018 Net m^2
1	04b	College of Marin Ecological Study Area	0.12568233	zero detect
	23f	Paradise Cay	7.03182978	zero detect
	23g	Greenwood Cove	0.02669684	zero detect
2	12b	Pier 98 / Heron's Head	0.0332996	zero detect
	18a	Colma Creek	0.03769663	zero detect
	19f	Point San Bruno	0.00785403	zero detect
	19g	Seaplane Harbor	0.00942873	zero detect
	19i	Mills Creek Mouth	0.16165541	zero detect
	19n	Coyote Point Marina / Marsh	0.01382135	zero detect
3	02a.4	Redwood Shores Mitigation Bank	0.07917578	zero detect
4	02n	SF2	0.62396311	zero detect
5	13f	Cargill Mitigation Marsh	0.08482793	zero detect
6	20i	Bockmann Channel	1.13960922	zero detect
	20k	Hayward Landing	0.92156561	zero detect

Sub-areas that were "Zero detect" in 2017 but were re-infested in 2018

Region	Code	Sub-area	2017 Net m^2	2018 Net m^2
1	03a	Blackie's Creek (above bridge)	zero detect	0.64277687
2	18c	Old Shipyard	zero detect	0.00848213
6	20w	Triangle Marsh	zero detect	0.30629938

Figure 6 illustrates bay-wide trends of invasive *Spartina* over the years. Since the peak infestation of 805 acres in 2005, cover has dropped to 37.9 acres in 2018. In 2017, inventory was conducted by grid (mentioned above) at all restricted treatment sub-areas, and the results indicated an increase by 11 net acres of invasive *Spartina* between 2016 and 2017. Inventory was not conducted in 2018 at the sub-areas where treatment was not authorized; all 2018 data for these sub-areas is a carryover from 2017 inventory efforts.

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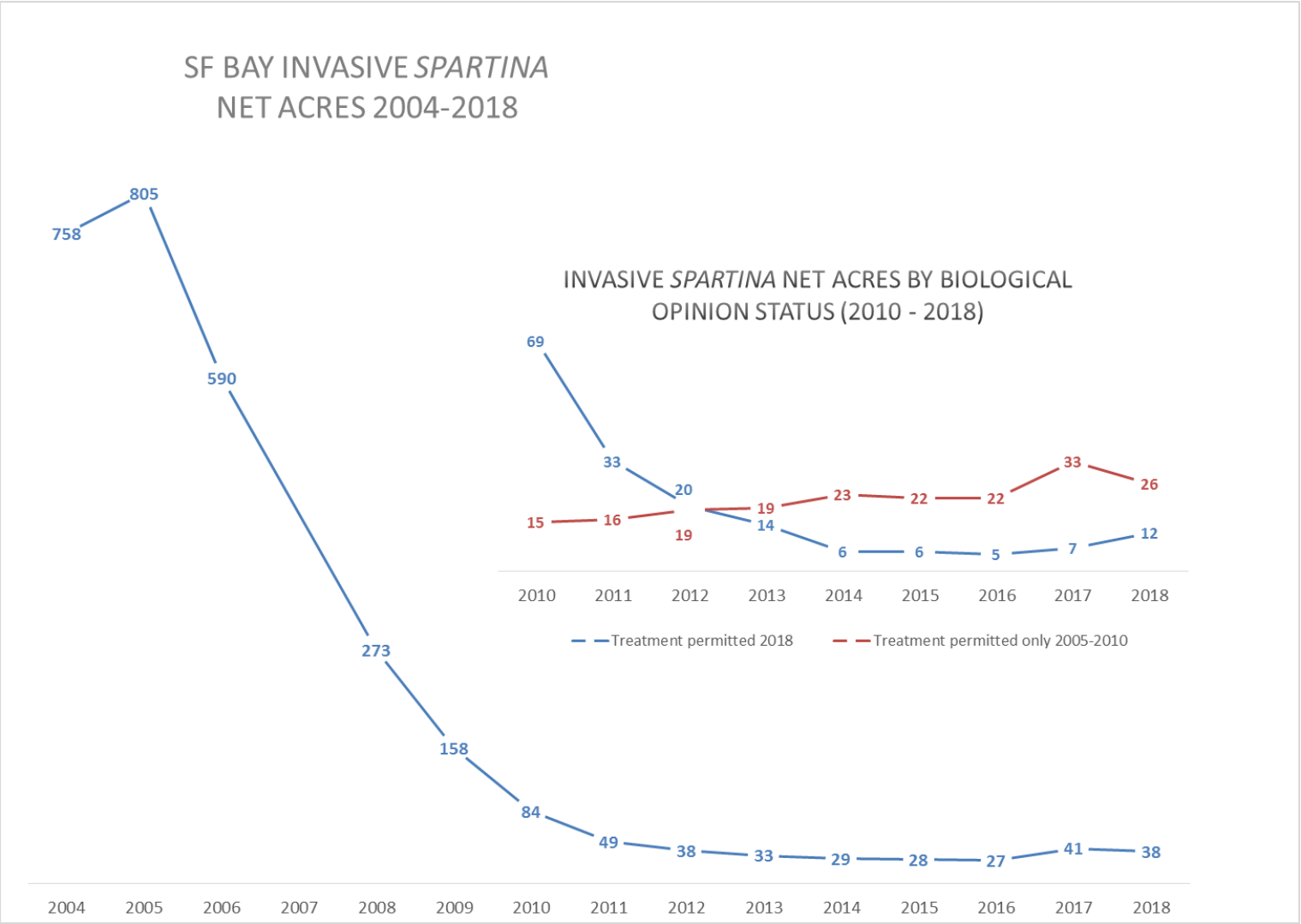

Figure 6. Bay-wide trend of invasive *Spartina* from 2004-2018 by net cover (acres) and treatment authorization since 2010

2.2. Regional Inventory and Treatment

Section 2.1 introduced the ISP Reporting Regions as part of a discussion of bay-wide trends in invasive *Spartina* cover and treatment. This section provides additional detail by Reporting Region. **Table 5** provides a summary by region, and the following sections provide additional details. For more detail on inventory and treatment completed each year, see Appendix III.

Table 5. Summary of 2018 Invasive *Spartina* Cover by Reporting Region

Region #	Region Name	# Sub-Areas	Potential Invasive *Spartina* Habitat (ac)	Proportion of Region Acreage Authorized for Full Treatment	Net Cover 2018 (ac)	% Bay-wide Total	Change Since 2017 (ac)	% Change Since 2017	Peak Year	Peak Amount (ac)	Change Since Peak (ac)	% Change Since Peak	% Remaining since Peak
1	Marin	32	4,150	All	0.02	0.1%	-0.05	-69.7%	2005	6.1	-6.1	-99.6%	0.4%
2	SF Peninsula	35	1,151	All	0.04	0.1%	-0.07	-66.9%	2004	125.5	-125.4	-99.97%	0.03%
3	San Mateo	26	5,630	All	4.53	12.0%	-0.50	-9.9%	2004	134.8	-130.3	-96.6%	3.4%
4	Dumbarton South	25	9,693	All	1.36	3.6%	-2.76	-67.0%	2008	39.5	-38.2	-96.6%	3.4%
5	Union City	21	3,375	All	0.015	0.04%	+0.0057	+62.0%	2004	233.1	-233.1	-99.99%	0.01%
6	Hayward*	30	1,493	86%	20.84	55.0%	+0.1622	+0.8%	2005	225.9	-205.1	-90.8%	9.2%
7	San Leandro Bay*	20	483	85%	10.95	28.9%	+0.0461	+0.4%	2006	84.6	-73.7	-87.1%	12.9%
8	Bay Bridge North	13	1,705	All	0.10	0.3%	+0.0143	+16.4%	2009	6.5	-6.4	-98.4%	1.6%
9	Suisun	4	11,968	All	0.01	0.03%	-0.067	-87.1%	2005	0.65	-0.6	-98.5%	1.5%
10	Vallejo	4	20,789	All	0.0023	0.006%	-0.0004	-14.9%	2009	0.32	-0.3	-99.3%	0.7%
11	Petaluma	4	5,696	All	0.0045	0.012%	-0.012	-72.4%	2007	0.15	-0.1	-97.1%	2.9%
12	Outer Coast	5	3,028	All	0.00001	0.00003%	-0.0002	-93.6%	2007	0.05	-0.05	-99.97%	0.03%
ALL	**SFB Estuary**	**219**	**69,161**	**99.6%**	**37.9**	**100%**	**-3.2**	**-7.9%**	**2005**	**805**	**-767.1**	**-95.3%**	**4.7%**

* This region has treatment restrictions in multiple sub-areas in 2018. The amount of the region that is authorized for full treatment is calculated by area in column 5.

2.2.1. Region 1: Marin

The Marin Region (Region 1) is composed of 32 sub-areas in Marin County, and extends from the Golden Gate Bridge north to the mouth of the Petaluma River. It includes several large, contiguous tracts of marsh, most notably those in the Novato Creek, Corte Madera Creek and Las Gallinas Creek Watersheds. Relative to regions in the Central and South Bays, the Marin Region has never had a very sizeable infestation in terms of acreage, but had many small infestations scattered throughout the marshes and tidal channels. Four non-native *Spartina* species are present (*S. alterniflora* x *foliosa* hybrids, *S. densiflora*, *S. densiflora* x *foliosa* hybrids, and *S. anglica*), the majority occurring in the Corte Madera Creek Watershed. Creekside Park (04g) on upper Corte Madera Creek is the original introduction site for both *S. densiflora* and *S. anglica* to the Estuary. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figures 7 & 8** and **Table 6.** Treatment dates and methods are included in **Table 6.**

The ISP inventoried part or all of the 32 sub-areas in this region in both 2017 and 2018 – on foot when the shoreline was accessible, and supplemented by kayak on difficult shorelines and upstream portions of the watershed. Eight of the sub-areas (e.g. Muzzi/Marta's Marsh [23e], Bothin Marsh [23j], Novato [23m], China Camp [23o], etc.) were only partially inventoried for hybrid *S. alterniflora* in 2018 because of relatively low infestation pressure. Portions of those sub-areas inventoried included areas with instances of hybrid *S. alterniflora* detected within the last three years and those areas with highest invasion pressure. All sub-areas with historic detections of *S. densiflora* were surveyed for that species in both the summer and winter inventory rounds in both 2017 and 2018.

The Novato shoreline received a more intensive and thorough survey in 2018 than it had in several years with the assistance of California Department of Food and Agriculture (CDFA), who provided the ISP with an airboat and pilot for inventory. Secondary rounds of inventory for hybrid *S. alterniflora* were conducted at three sub-areas.

The ISP mapped a total of 89 m² (0.02 acre) of non-native cordgrass of four species in the Marin Region in 2018. This reflects a 0.05-acre (70%) reduction from 2017 inventory and a reduction of 6.1 acres (>99.5%) since peak infestation in 2005 (**Figures 7 & 8, Table 6**).

A total of 80 m^2 of hybrid *S. alterniflora* was mapped throughout 18 sub-areas of the region, with 69% of that detected in just three sub-areas (Brickyard Cove [23a], San Rafael Canal Mouth East [23d.1], and Muzzi & Marta's Marsh [23e]). Only a handful of Marin marshes have ever been heavily infested by hybrid *S. alterniflora*, but eradication efforts are complicated by the landscape of intricate, privately owned shorelines, which also support abundant *S. foliosa*. The ISP and the Friends of Corte Madera Creek Watershed have adapted inventory methods to address these areas, including shifting from kayak surveys conducted from the creek, to ground surveys, which enable more thorough detection, but which require extensive landowner coordination to gain access to private properties. Virtually all the treatment in Region 1 now involves very small-scale spot applications, so work has been conducted by backpack sprayer in recent years. A flare up of hybrid *S. alterniflora* in 2018 within a cove of predominantly *S. foliosa* along San Rafael Canal Mouth East was more effectively and efficiently treated using a spray rig mounted in a truck bed.

One item of note is two years of zero detect at China Camp (23o). A single clone of hybrid *S. alterniflora* was discovered here in 2010, when it was treated and subsequently not detected from 2011 to 2015.

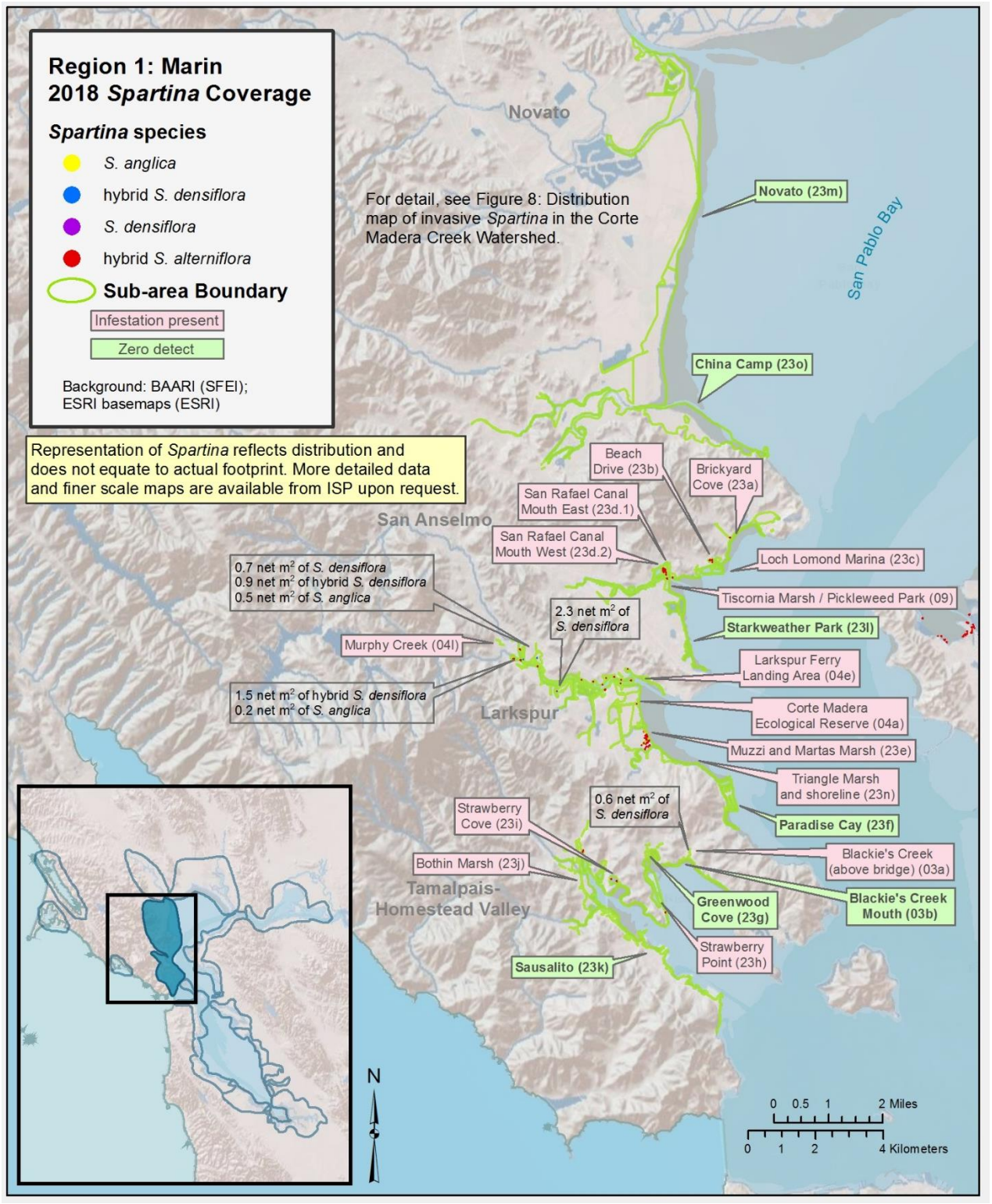

Figure 7. Distribution of invasive *Spartina* in 2018 across the 32 sub-areas of Reporting Region 1: Marin. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

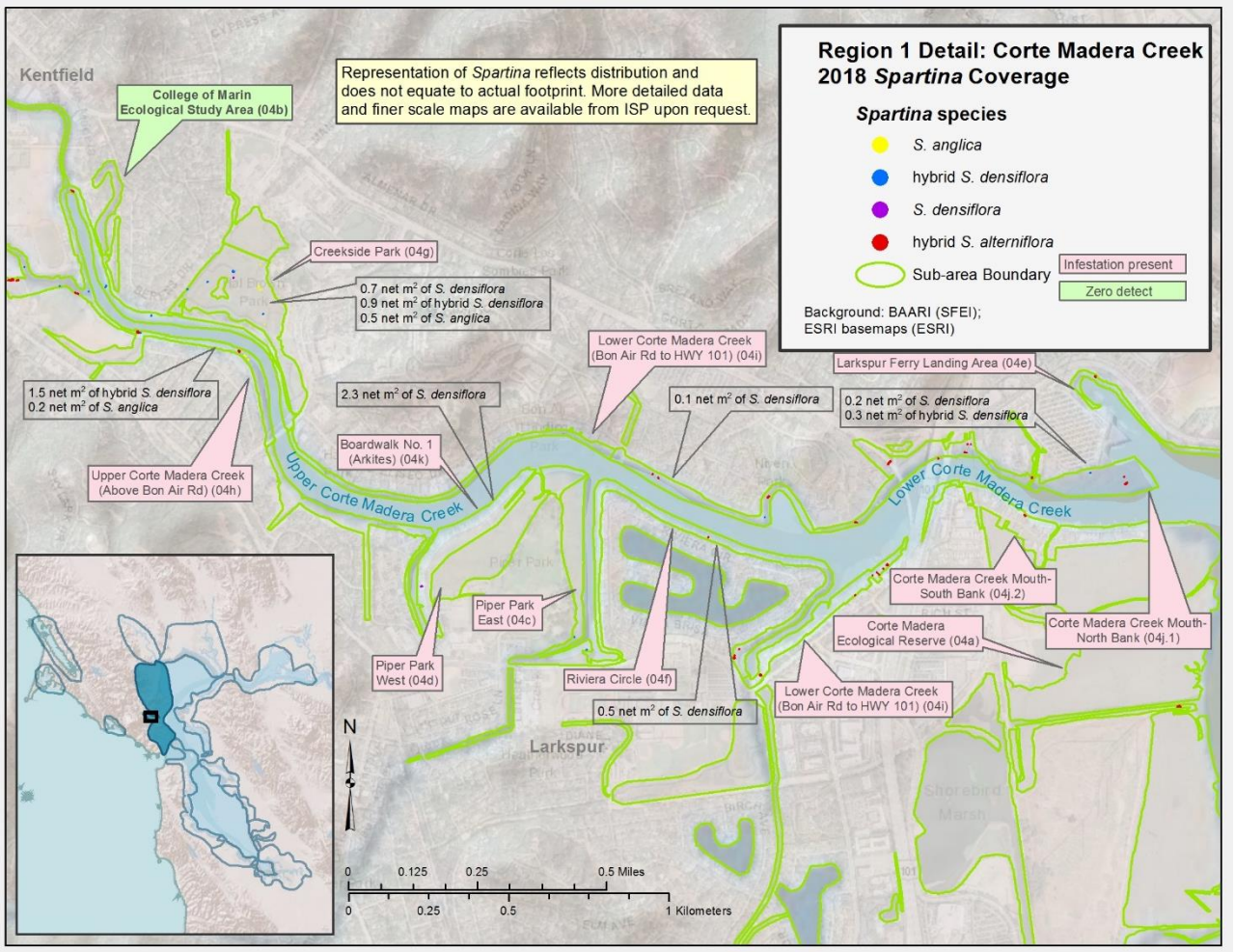

Figure 8. Distribution of invasive *Spartina* in 2018 within the Corte Madera Creek Watershed of ISP's Marin Region

A small patch discovered in 2015 was genetically sampled and verified as hybrid *S. alterniflora*, but it was not treated before senescing that fall. It was subsequently treated in 2016, by which time it had grown to 7 m^2. Since treatment in 2016, no remaining infestation was detected here in 2017 or 2018.

The Marin infestation of *Spartina densiflora* remains the largest in the Estuary, simply because this region was the original introduction site and this species only had a minor presence in other regions. In 2018, *S. densiflora* occurred in 12 of the 32 sub-areas. The ISP mapped a total of 4.8 m^2 cover, which amounts to 78% of the 2018 bay-wide total and reflects a 54% reduction from 2017 inventory. Every instance of *S. densiflora* found in 2018 was subsequently treated by manual removal. Hybrid *S. densiflora* was also found in eight sub-areas totaling 3 m^2 of net cover. All instances were either dug, sprayed, or both in 2018.

Similarly, the Marin Region is the only region where *S. anglica* has ever been detected. It was again found in its two adjacent historical sub-areas (Creekside Park [04g] and Upper Corte Madera Creek [04h]) in 2018, and amounted to 0.7 m^2 net cover, all of which was treated.

Surveys for Ridgway's rails conducted by the ISP and Point Blue Conservation Science (PBCS) have shown a fairly stable population trend in the Marin Region, with a slight decrease in rail detections at surveyed

Table 6. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 1: Marin.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treatment Area	Peak Year	Net Area Decline: Since Peak	Net Area Decline: Since 2017
REGION 1: MARIN												
03a: Blackie's Creek (above bridge)	1/25/19	Dug	0			0	0.6 m²	0.6 m²	1 m²	2005	>99%	Increase (0.6 m²)
03b: Blackie's Creek Mouth	2 years with no Invasive Spartina (2017-2018)		0			0	0	0	0	2005	100%	n/a
04a: Corte Madera Ecological Reserve	6/21; 9/11; 1/14/19	Dug, Backpack	0			0	0.03 m²	0.03 m²	0.07 m²	2005	>99%	78%
04b: College of Marin Ecological Study Area	No Invasive Spartina 2018		0			0	0	0	0	2004	100%	100%
04c: Piper Park East	6/4; 1/17/19	Dug	0.21 m²			0	0.02 m²	0.2 m²	2 m²	2005	>99%	24%
04d: Piper Park West	1/17/19	Dug	0			0	0.02 m²	0.02 m²	0.6 m²	2005	>99%	94%
04e: Larkspur Ferry Landing Area	7/6; 8/14	Dug, Backpack	0			0.09 m²	0	0.09 m²	7 m²	2005	>99%	Increase (0.07 m²)
04f: Riviera Circle	6/13; 10/22; 1/23/19	Dug, Backpack	0.02 m²			0.3 m²	0.5 m²	0.8 m²	17 m²	2005	>99%	53%
04g: Creekside Park	6/18; 7/16; 1/10/19	Dug, Backpack	0.46 m² 0.71 m²			0.02 m²	0.9 m²	2 m²	22 m²	2005	>99%	48%
04h: Upper Corte Madera Creek (Above Bon Air Rd)	6/19; 7/6; 7/16; 9/26; 1/11/19	Dug, Backpack	0.23 m² 2 m²			5 m²	0.08 m²	7 m²	93 m²	2006	>99%	53%
04i: Lower Corte Madera Creek (Bon Air Rd to HWY 101)	6/20; 7/16; 8/14; 9/26; 11/5; 1/11/19;	Dug, Backpack	0.15 m²			3 m²	0.1 m²	3 m²	57 m²	2005	>99%	83%
04j.1: Corte Madera Creek Mouth - North Bank	6/4; 8/29; 1/15/19; 1/30/19	Dug, Backpack	0.28 m²			0.9 m²	0.2 m²	1 m²	32 m²	2006	>99%	76%
04j.2: Corte Madera Creek Mouth - South Bank	9/11	Dug, Backpack	0			0.5 m²	0.05 m²	0.5 m²	10 m²	2007	99%	87%
04k: Boardwalk No. 1 (Arkites)	6/20; 1/14/19	Dug	0.0003 m²			0	2 m²	2 m²	2 m²	2004	>99%	Increase (2 m²)
04l: Murphy Creek	6/19	Dug	0.03 m²			0	0	0.03 m²	0.2 m²	2008	>99%	58%
09: Tiscornia Marsh / Pickleweed Park	9/11	Backpack	0			7 m²	0	7 m²	209 m²	2006	>99%	Increase (6 m²)
23a: Brickyard Cove	7/18	Backpack	0			21 m²	0	21 m²	61 m²	2004	96%	Increase (20 m²)
23b: Beach Drive	7/18; 9/11	Backpack	0			5 m²	0	5 m²	158 m²	2007	98%	92%
23c: Loch Lomond Marina	11/5	Backpack	0			0.06 m²	0	0.06 m²	0.7 m²	2004	>99%	96%
23d.1: San Rafael Canal Mouth East	10/1	Backpack	0			21 m²	0	21 m²	891 m²	2007	96%	80%
23d.2: San Rafael Canal Mouth West	7/18	Backpack	0			0.1 m²	0	0.1 m²	5 m²	2005	>99%	97%
23e: Muzzi and Martas Marsh	8/29; 9/24; 11/5 (R2)	Dug, Backpack	0			13 m²	0	13 m²	504 m²	2006	91%	62%
23f: Paradise Cay	No invasive Spartina 2018		0			0	0	0	0	2005	100%	100%
23g: Greenwood Cove	No invasive Spartina 2018		0			0	0	0	0	2007	100%	100%
23h: Strawberry Point	8/14; 1/25/19	Dug, Backpack	0			0.03 m²	0.001 m²	0.03 m²	0.8 m²	2006	>99%	81%
23i: Strawberry Cove	7/18	Backpack	0			0.7 m²	0	0.7 m²	38 m²	2004	>99%	96%
23j: Bothin Marsh	8/14; 9/26	Backpack	0			2 m²	0	2 m²	13 m²	2006	99%	75%
23k: Sausalito	4 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2006	100%	n/a
23l: Starkweather Park	3 years with no invasive Spartina (2016-2018)		0			0	0	0	0	2007	100%	n/a
23m: Novato	3 years with no invasive Spartina (2016-2018)		0			0	0	0	0	2010	100%	n/a
23n: Triangle Marsh and shoreline	10/22	Dug	0			0.1 m²	0	0.1 m²	11 m²	2005	>99%	Increase (0.1 m²)
23o: China Camp	2 years with no invasive Spartina (2017-2018)		0			0	0	0	0	0	n/a	n/a
REGION 1 TOTAL			**0.69 m²** **3 m²**			**80 m²**	**5 m²**	**89 m²**	**0.5 acres**	**2005**	**>99%**	**70%**

sub-areas between 2017 and 2018, but an overall increase over five years at the same sub-areas (Wood 2017, 2018; McBroom 2018).

The Marin Region contains several large intact native marshes that support Ridgway's rail populations that are not expected to be impacted by the removal of the remaining 89 m^2 of non-native *Spartina*. As a result, the ISP has not targeted Region 1 for significant habitat enhancement, with the exception of nine constructed high tide refuge islands at the Corte Madera Ecological Reserve for sea level rise resiliency. In addition, ISP and partner Friends of Corte Madera Creek have planted *Grindelia stricta* for nesting substrate and cover at Creekside Park, where the large infestation of multiple non-native *Spartina* species had displaced many native marsh plants.

ISP control efforts have reduced non-native *Spartina* in the Marin Region to very low levels. The low invasion pressure in this region and the abundant *S. foliosa* has allowed the ISP to harvest plant material for amplification in nursery propagation beds and outplanting to other regions that do not have extensive native cordgrass propagule sources. To date, the ISP has collected and genetically verified *S. foliosa* from four Marin County marshes: Strawberry Cove (23i), Coyote Creek (a part of Bothin Marsh [23j]), Starkweather Park (23l), and Upper Gallinas Creek (a part of Novato [23m]). These plants have been outplanted into the four Reporting Regions where the ISP has been actively planting *S. foliosa*: Region 2: San Francisco Peninsula, Region 5: Union City, Region 6: Hayward, and Region 7: San Leandro Bay.

2.2.2. Region 2: San Francisco Peninsula

The San Francisco Peninsula Region (Region 2) extends from the Golden Gate Bridge south to the San Mateo Bridge and includes 35 sub-areas. Once very heavily infested by hybrid *S. alterniflora*, successful treatment has predominantly returned the shorelines to mudflat, as they were prior to invasion. The three most prominent marsh habitats in the region are found at the confluence of Colma Creek and San Bruno Creek (site 18) in South San Francisco, the shoreline of the San Francisco International Airport (SFO, 19h), and the mouth of Seal Slough (19p) in San Mateo. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 9** and **Table 7**. Treatment dates and methods are included in **Table 7.**

All of the sub-areas in this region were surveyed in 2017, and all but two (Yerba Buena Island [12h] and Fisherman's Park [19m]), were surveyed in 2018; Yerba Buena has not had any infestation since 2014 and Fisherman's Park has not since 2012. The remaining 33 sub-areas were surveyed on foot in 2018 and 0.04 acre of non-native cordgrass of two species was mapped. This is a reduction of 0.07 acre (67%) from 2017 infestation and amounts to 0.03% of the footprint (125.5 acres) at the peak in 2004 (**Table 7**).

Hybrid *S. alterniflora* is now scarce or absent in the majority of sub-areas in the San Francisco Peninsula Region, with 23 of the sub-areas being "zero detect" (**Table 5**) in 2018, and with 96% of the remaining population occurring in only two sub-areas (**Figure 9, Table 7**). These two sub-areas, SFO (19h) and Sanchez Marsh (19k), are the only ones that contained greater than 2 m^2 net cover. Sanchez Marsh still has the largest remaining infestation but is steadily decreasing due to intensified inventory and treatment efforts over the last several years. Both sites require airboat treatment; access to Sanchez Marsh is complicated by the need to get an airboat cage under a footbridge at the eastern end of the hydrologically connected Burlingame Lagoon. Morning tides are only low enough to allow this access with sufficient time to treat early in the treatment season. Sanchez has also been known for many cryptic hybrids over the years. Therefore, the slower progress towards local eradication at this site may be related to early inventory (and treatment) not allowing full detection of some cryptic morphologies.

Sanchez Marsh is the only remaining location in Region 2 where *S. densiflora* was found. A total 0.1 m^2 net cover was detected in 2018. Sanchez Marsh also historically contained hybrid *Spartina densiflora × foliosa*, but this had not been detected since 2015. No hybrid *S. densiflora* was found anywhere in the San Francisco Peninsula Region in 2017 or 2018.

The urban shoreline in the San Francisco Peninsula Region offers little habitat for Ridgway's rails. A total of five rails were detected in the region in 2018, within two sub-areas: Seal Slough and SFO. In 2017, a total of seven rails were detected, all within a single sub-area: SFO. The major reduction in hybrid *S. alterniflora* in the San Francisco Peninsula Region since 2005 resulted in reduced numbers of California Ridgway's rails, which had little native habitat available after the successful control effort. Most areas that were invaded by hybrid *S. alterniflora* in the region were at low elevations that did not support native tidal marsh vegetation prior to invasion and have now transitioned back to mudflats.

The San Francisco Peninsula bay edge is heavily urbanized with very few opportunities to enhance habitat that could support sustainable Ridgway's rail populations. The ISP's habitat enhancement efforts have been limited to three sub-areas within the Colma Creek/San Bruno complex. ISP partnered with an SFSU graduate student (Whitney Thornton) to reintroduce *S. foliosa* along Colma Creek (18a) and in San Bruno Marsh (18g) from 2011-13, and has continued planting efforts at San Bruno Marsh and at

Confluence Marsh (18f) from 2016-18. The planting effort focuses on re-establishing the narrow fringe of native *S. foliosa* that was present at appropriate elevations prior to hybrid *S. alterniflora* invasion.

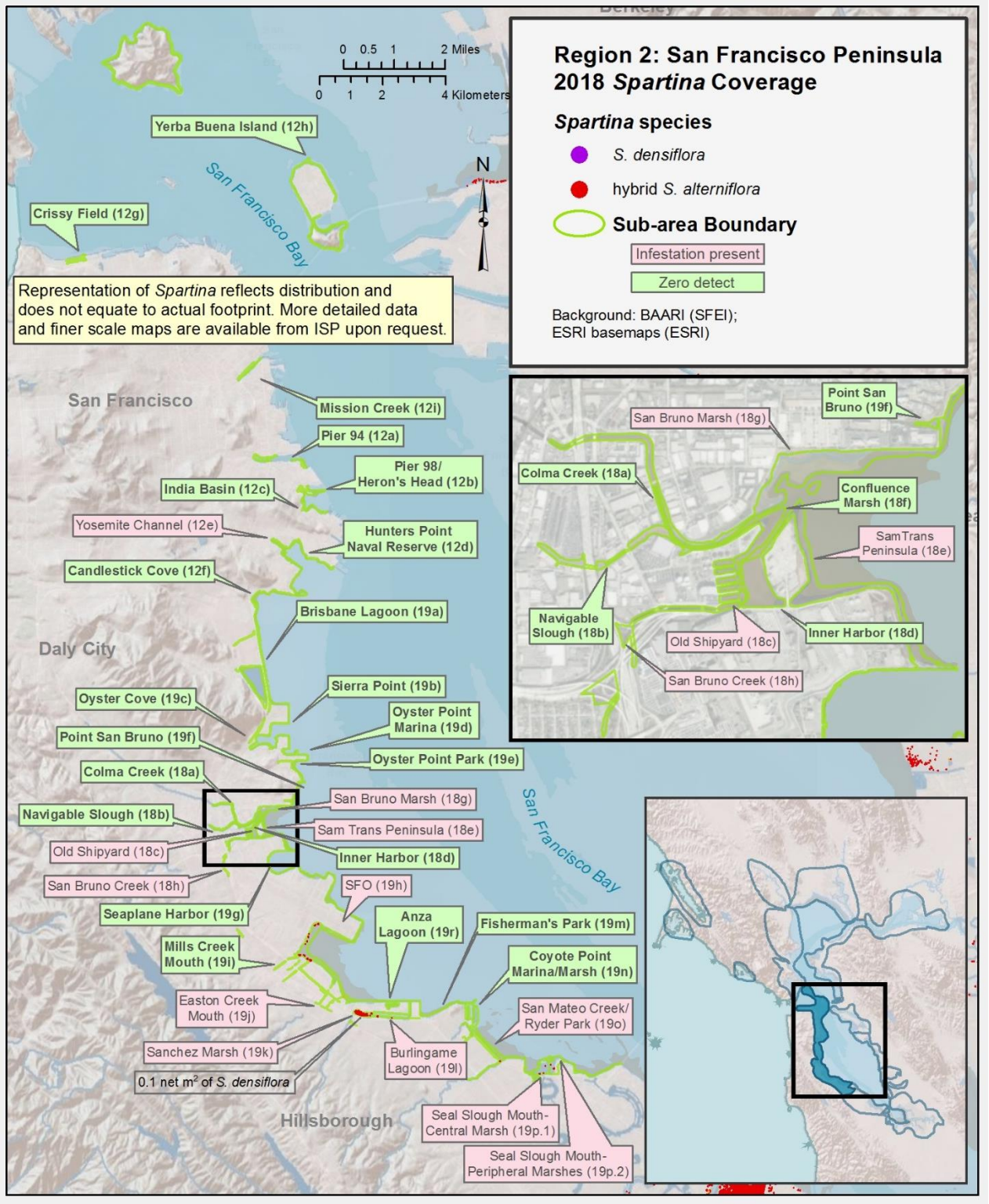

Figure 9. Distribution of invasive *Spartina* in 2018 across the 35 sub-areas of Reporting Region 2: San Francisco Peninsula. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 7. Summary of 2018 invasive Spartina area by sub-area within Reporting Region 2: San Francisco Peninsula.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			angilica	*patens*	*densiflora x foliosa*	*alterniflora x foliosa*	*densiflora*	2018 Net Area	2018 Treatment Area	Peak Year	Since Peak	Since 2017
REGION 2: SAN FRANCISCO PENINSULA												
12a: Pier 94	3 years with no invasive Spartina (2016-2018)		0			0	0	0	0	2005	100%	n/a
12b: Pier 98 / Heron's Head	No Invasive Spartina 2018		0			0	0	0	0	2008	100%	100%
12c: India Basin	5 years with no invasive Spartina (2014-2018)		0			0	0	0	0	2005	100%	n/a
12d: Hunters Point Naval Reserve	2 years with no invasive Spartina (2017-2018)		0			0	0	0	0	2008	100%	n/a
12e: Yosemite Channel	9/18	Backpack	0			0.8 m²	0	0.8 m²	25 m²	2004	>99%	Increase (0.7 m²)
12f: Candlestick Cove	4 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2006	100%	n/a
12g: Crissy Field	4 years with no invasive Spartina (2014-2017)		0			0	0	0	0	2008	100%	n/a
12h: Yerba Buena Island	4 years with no invasive Spartina (2014-2017)		0			0	0	0	0	2006	100%	n/a
12i: Mission Creek	5 years with no invasive Spartina (2014-2018)		0			0	0	0	0	2009	100%	n/a
18a: Colma Creek	No invasive Spartina 2018		0			0	0	0	0	2005	100%	100%
18b: Navigable Slough	2 years with no invasive Spartina (2017-2018)		0			0	0	0	0	2006	100%	n/a
18c: Old Shipyard	10/31	Backpack	0			0.008 m²	0	0.008 m²	0.2 m²	2006	>99%	Increase (0.008 m²)
18d: Inner Harbor	5 years with no invasive Spartina (2014-2018)		0			0	0	0	0	2006	100%	n/a
18e: Sam Trans Peninsula	10/31	Backpack	0			0.002 m²	0	0.002 m²	0.2 m²	2004	>99%	Increase (0.002 m²)
18f: Confluence Marsh	2 years with no invasive Spartina (2017-2018)		0			0	0	0	0	2004	100%	n/a
18g: San Bruno Marsh	7/25	Backpack	0			0.02 m²	0	0.02 m²	0.6 m²	2004	>99%	58%
18h: San Bruno Creek	8/10	Backpack	0			0.02 m²	0	0.02 m²	0.3 m²	2006	>99%	95%
19a: Brisbane Lagoon	4 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2006	100%	n/a
19b: Sierra Point	4 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2004	100%	n/a
19c: Oyster Cove	3 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2006	100%	n/a
19d: Oyster Point Marina	4 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2006	100%	n/a
19e: Oyster Point Park	3 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2005	100%	n/a
19f: Point San Bruno	No invasive Spartina 2018		0			0	0	0	0	2005	100%	100%
19g: Seaplane Harbor	No invasive Spartina 2018		0			0	0	0	0	2004	100%	100%
19h: SFO	10/3	Backpack, Airboat	0			40 m²	0	40 m²	574 m²	2004	>99%	25%
19i: Mills Creek Mouth	No invasive Spartina 2018		0			0	0	0	0	2005	100%	100%
19j: Easton Creek Mouth	9/18	Backpack, Airboat	0			0.001 m²	0	0.001 m²	0.03 m²	2004	>99%	96%
19k: Sanchez Marsh	6/5; 8/14	Dug, Backpack, Airboat	0			98 m²	0.1 m²	98 m²	0.6 acres	2004	98%	71%
19l: Burlingame Lagoon	8/14	Dug, Backpack	0			1 m²	0	1 m²	106 m²	2004	>99%	83%
19m: Fisherman's Park	7 years with no invasive Spartina (2012-2018)		0			0	0	0	0	2005	100%	n/a
19n: Coyote Point Marina / Marsh	No invasive Spartina 2018		0			0	0	0	0	2004	100%	100%
19o: San Mateo Creek / Ryder Park	7/20	Backpack	0			0.02 m²	0	0.02 m²	2 m²	2006	>99%	>99%
19p.1: Seal Slough Mouth - Central Marsh	8/17	Backpack, Airboat	0			2 m²	0	2 m²	59 m²	2004	>99%	92%
19p.2: Seal Slough Mouth - Peripheral Marshes	8/17	Backpack, Airboat	0			2 m²	0	2 m²	33 m²	2004	>99%	66%
19r: Anza Lagoon	3 years with no invasive Spartina (2016-2018)		0			0	0	0	0	2004	100%	n/a
REGION 2 TOTAL			**0**			**143 m²**	**0.1 m²**	**144 m²**	**0.8 acres**	**2004**	**>99%**	**67%**

2.2.3. Region 3: San Mateo

The San Mateo Region (Region 3) consists of 26 sub-areas on the western South Bay shoreline between the San Mateo and Dumbarton Bridges. Control of hybrid *S. alterniflora* in this region is essential to protect some large historic tracts of native marsh (Greco Island [02f, 02h]), extensive tracts of restored marsh (Bair Island [02c, 02d, 02k, 02m, 02o]), and remaining large commercial salt ponds that are slated for restoration to tidal activity. This region was heavily impacted by hybrid *S. alterniflora* invasion, which colonized the shoreline and marshes, and quickly invaded newly breached areas undergoing restoration to tidal marsh. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 10** and **Table 8**. Treatment dates and methods are included in **Table 8**.

All 26 sub-areas in the San Mateo Region were inventoried in 2017, but in 2018, three sub-areas were only partially inventoried and one was not inventoried due to budget and resource constraints. B2 North West (02c.1a), B2 North South (02c.2), and Redwood Creek and Deepwater Slough (02k) were thoroughly inventoried on 50%, 21%, and 70% of their area, respectively. The remainder of these sub-areas were neither inventoried nor treated in 2018 but had been inventoried and treated in 2017. B2 North East (02c.1b) was mapped by grid in 2017 only and treated in 2018 based on the 2017 data. 2018 was the first year of full treatment of B2 North East since 2010, after which treatment was restricted under the project's Biological Opinion (see **Section 3.3** for more information on resuming treatment at formerly restricted sites).

2018 inventory was conducted primarily on foot, often with assistance from boats (kayak, Whaler, Achilles inflatable boat, or airboat) for access. Two sub-areas (Pond B3 [02m] and Central Bair [02o]) were surveyed solely by airboat with assistance from Solitude Lake Management and San Mateo County Mosquito and Vector Control District, respectively. Inventory and treatment occurred simultaneously, resulting in coarser inventory data than normally collected during a purely inventory-focused survey due to the speed at which inventory must be conducted.

A total of 4.53 net acres of hybrid *S. alterniflora* was mapped in the San Mateo Region, which reflects a 0.5-acre (9.9%) reduction since 2017 (**Figure 10, Table 8**). Region 3 has the third largest remaining infestation in the Estuary behind Regions 6: Hayward and 7: San Leandro Bay, where there continue to be treatment restrictions on most of the remaining hybrid *S. alterniflora* infestations.

Over 55% (2.5 net acres) of the remaining infestation in the San Mateo Region is in a single sub-area (B2 North East [02c.1b]). This sub-area was restricted from full treatment between 2012 and 2017, being permitted only one sub-lethal aerial application of herbicide annually to curb seed production (the intent being to maintain aboveground vegetation for Ridgway's rail habitat). B2 North East was authorized to resume full treatment in 2018, which will substantially reduce propagation of the infestation within this region (see **Section 3.3** for more details) and lessen the annual treatment burden at neighboring Bair and Greco Island locations.

The majority of invasive *Spartina* within the San Mateo Region is located on the remnant islands of Bair and Greco, where treatment must normally be conducted using airboats, either applying the herbicide directly from the spray rig or deploying personnel with backpack sprayers for areas beyond the reach of the hose. ISP partners conducted 21 days of airboat treatment within the San Mateo Region in 2018, even with several areas of Bair Island not receiving inventory or treatment due to budget constraints.

After several years of no detection of *S. densiflora* in this region, a new patch was found in in 2017 at Maple Street Channel (19s), one of the only sub-areas in San Mateo Region to have had an historical infestation of this species. Due to the plant being on the edge of a homeless encampment, conditions were unsuitable for ISP staff to access the plant in 2017 to remove it. Staff returned in 2018 and removed the plant manually.

Annual surveys for Ridgway's rails by the ISP and Don Edwards National Wildlife Refuge (DENWR) have shown an increasing trend in the number of rails detected at surveyed sub-areas in the San Mateo Region. The number of rails detected in the region between 2017 and 2018 increased by over 50% and by 10% since 2013 (5-year trend).

With abundant *S. foliosa* within most sub-areas and persisting hybrid *S. alterniflora* throughout the region, native cordgrass has not been considered for planting in this region. Habitat enhancements to date have included construction of high tide refuge islands and planting extensive *Grindelia stricta*. Both types of enhancement are intended to provide Ridgway's rails with taller vegetative cover for protection from predators. High tide refuge islands, intended to provide cover during extreme tide events, were constructed at seven sub-areas: two along Belmont Slough (02a.1-2), one on Bird Island (02a.3), four in Corkscrew Slough (02b.1), four within B2 North Quadrant (02c.1a-b), and four in Deepwater Slough (02k). Additionally, the ISP has installed approximately 34,000 *Grindelia stricta* plants across seven sub-areas.

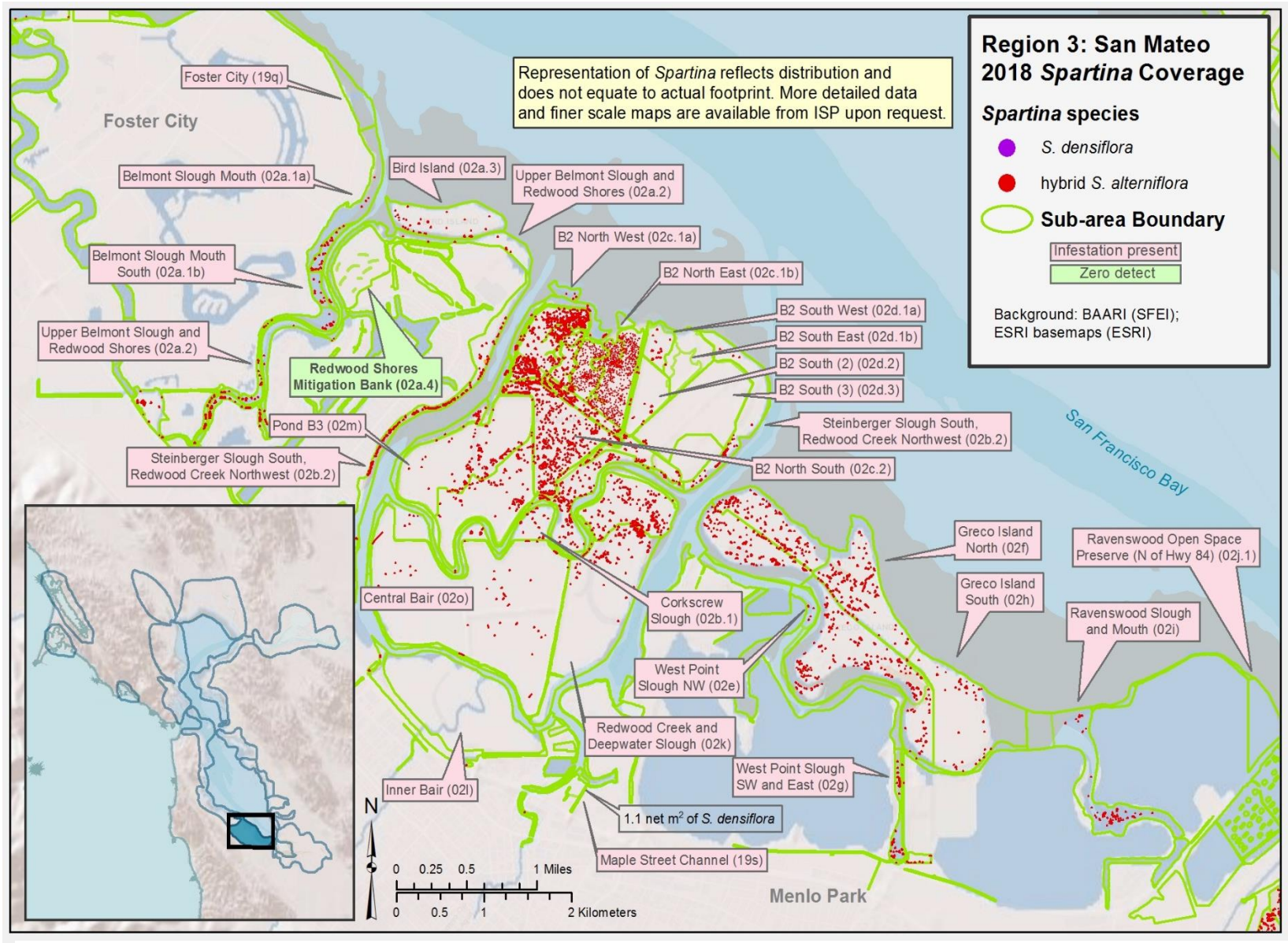

Figure 10. Distribution of invasive *Spartina* in 2018 across the 26 sub-areas of Reporting Region 3: San Mateo. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 8. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 3: San Mateo.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treatment Area	Peak Year	Net Area Decline Since Peak	Net Area Decline Since 2017
REGION 3: SAN MATEO												
02a.1a: Belmont Slough Mouth	9/13-9/14	Truck, Backpack, Airboat	0			20 m²	0	20 m²	661 m²	2004	>99%	37%
02a.1b: Belmont Slough Mouth South	9/13	Truck, Backpack, Airboat	0			9 m²	0	9 m²	237 m²	2004	>99%	63%
02a.2: Upper Belmont Slough and Redwood Shores	9/13- 9/14	Truck, Backpack, Airboat	0			171 m²	0	171 m²	1.3 acres	2004	>99%	36%
02a.3: Bird Island	9/13	Backpack, Airboat	0			19 m²	0	19 m²	570 m²	2006	>99%	56%
02a.4: Redwood Shores Mitigation Bank	No invasive Spartina 2018		0			0	0	0	0	2015	100%	100%
02b.1: Corkscrew Slough	8/16-8/17; 10/31	Backpack, Airboat	0			385 m²	0	385 m²	1.3 acres	2004	92%	15%
02b.2: Steinberger Slough South, Redwood Creek Northwest	8/30-8/31; 9/28; 10/4; 11/6 (R2)	Backpack, Airboat	0			420 m²	0	420 m²	1.9 acres	2004	99%	1%
02c.1a: B2 North West [1]	9/17; 9/28; 10/17; 10/31; 11/14	Backpack, Airboat	0			0.3 acres	0	0.3 acres	5.6 acres	2005	98%	Increase (27 m²)[1]
02c.1b: B2 North East [2]	10/16	Aerial: Broadcast	0			2.5 acres	0	2.5 acres	21.9 acres	2005	89%	n/a[2]
02c.2: B2 North South [3]	8/17; 8/30; 9/28; 10/17; 10/31; 11/14	Backpack, Airboat	0			1 acres	0	1 acres	16 acres	2006	90%	12% [3]
02d.1a: B2 South West	10/17; 11/14	Backpack, Airboat	0			3 m²	0	3 m²	179 m²	2004	>99%	82%
02d.1b: B2 South East	10/17	Backpack, Airboat	0			0.03 m²	0	0.03 m²	0.7 m²	2004	>99%	95%
02d.2: B2 South (2)	10/17	Backpack, Airboat	0			4 m²	0	4 m²	362 m²	2006	>99%	39%
02d.3: B2 South (3)	11/14	Backpack	0			12 m²	0	12 m²	251 m²	2009	>99%	Increase (9 m²)
02e: West Point Slough NW	8/1; 10/31; 11/14	Airboat	0			5 m²	0	5 m²	93 m²	2005	>99%	52%
02f: Greco Island North	9/17; 10/1; 10/3; 10/17; 10/31	Backpack, Airboat	0			790 m²	0	790 m²	3.6 acres	2008	98%	5%
02g: West Point Slough SW and East	8/3; 9/17; 10/1	Backpack	0			37 m²	0	37 m²	0.4 acres	2005	>99%	Increase (19 m²)
02h: Greco Island South	9/17; 10/1	Backpack, Airboat	0			29 m²	0	29 m²	971 m²	2005	>99%	75%
02i: Ravenswood Slough and Mouth	9/17	Truck, Backpack, Airboat	0			30 m²	0	30 m²	799 m²	2004	>99%	80%
02j.1: Ravenswood OS Preserve (N of Hwy 84)	8/2	Backpack, Airboat	0			0.02 m²	0	0.02 m²	0.7 m²	2006	>99%	91%
02k: Redwood Creek and Deepwater Slough [4]	7/20; 8/16-8/17; 8/30-8/31	Backpack, Airboat	0			333 m²	0	333 m²	1.8 acres	2009	97%	37% [4]
02l: Inner Bair	7/27	Backpack	0			1 m²	0	1 m²	67 m²	2006	>99%	37%
02m: Pond B3	6/21-6/22; 7/21	Airboat	0			634 m²	0	634 m²	0.9 acres	2014	58%	55%
02o: Central Bair	7/16; 8/1	Airboat	0			31 m²	0	31 m²	683 m²	2016	70%	59%
19q: Foster City	7/20	Backpack	0			0.005 m²	0	0.005 m²	0.06 m²	2004	>99%	59%
19s: Maple Street Channel	6/29	Dug	0			0	1 m²	1 m²	3 m²	2011	98%	Increase (1 m²)
REGION 3 TOTAL			**0**			**4.5 acres**	**1 m²**	**4.5 acres**	**55.9 acres**	**2004**	**97%**	**10% increase within area mapped**

Footnotes: 1. 50% inventoried in 2018, 2017 data is shown and may be an overestimate 2. Not inventoried in 2018, treated in 2018 based on 2017 data shown
3. 21% inventoried in 2018, 2017 data is shown and may be an overestimate 4. 70% inventoried in 2018, 2017 data is shown and may be an overestimate

Note that B2 North East (02c.1b) was inventoried by grid in 2017 only and not all in 2018. Inventory data for 2018 reported here reflects that of 2017 hybrid *S. alterniflora* that was not treated in 2017. B2 North West (02c1.a) and B2 North South (02c.2), were only partially inventoried in 2018. Inventory data for 2018 for these two sub-areas includes 2017 hybrid *S. alterniflora* that was treated in 2017 but not remapped in 2018.

2.2.4. Region 4: Dumbarton South

The Dumbarton South Region (Region 4) includes 25 sub-areas and is comprised of all tidal wetlands south of the Dumbarton Bridge. The region includes newly breached restoration sites, salt evaporator ponds that are slated for restoration to tidal marsh, large expanses of marsh protected and managed by the USFWS as part of San Francisco Bay Don Edwards National Wildlife Refuge (DENWR), and fringe marsh that provides connectivity between the larger habitat areas. Much of this region is a focus for restoration by the South Bay Salt Pond Restoration Project (SBSPRP), and control of invasive *Spartina* here is key to the SBSPRP achieving its long-term goals. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 11** and **Table 9**. Treatment dates and methods are included in **Table 9**.

All 25 sub-areas of the Dumbarton South Region were inventoried in 2017 and in 2018, with some limitations in both years due to budget and resource constraints. In 2017, only the lower marsh fringe of Mowry Marsh (part of 05a.1) was inventoried, concurrent with airboat treatment there early in the season. In 2018, several other sub-areas, including Dumbarton/Audubon (05b), Island Ponds (05i), Guadalupe Slough (05a.3), and Coyote Creek to Artesian Slough (05a.5), were fully inventoried on a coarser level, focusing on historic areas of infestation. Dumbarton/Audubon was inventoried along all major channels, which is where the vast majority of the infestation in this sub-area has been found. Of the Island Ponds, only A21 was surveyed, and no hybrid *S. alterniflora* has ever been detected in the other two ponds, A19 and A20. The upper reaches of Guadalupe Slough were not surveyed where it becomes more brackish and no hybrid *S. alterniflora* has previously been detected. Similarly, within the Coyote Creek to Artesian Slough sub-area, only the lower reaches of the watershed were inventoried, and not the upper brackish reaches where hybrid *S. alterniflora* has never been detected. Several other sub-areas received coarser inventory concurrent with treatment, including LaRiviere Marsh (05d), Mayhew's Landing (05e), and Coyote Creek-Alameda County (05f).

Hybrid *S. alterniflora* is the only species of non-native cordgrass that has been found in the Dumbarton South Region, and in 2018 ISP mapped a total of 1.36 acres, a 2.8-acre (67%) reduction since 2017. The hybrid *S. alterniflora* infestation in the Dumbarton South Region amounts to 3.6% of the Estuary total, placing this region as the fourth most infested behind Hayward, San Leandro Bay, and San Mateo Regions. **(Figure 11, Table 9)**.

The Dumbarton South Region includes some of the highest quality Ridgway's rail habitat in the Estuary, and surveys conducted by ISP, PBCS, and DENWR have shown an increasing trend in the number of rails detected over the last five years (Wood, 2013, 2018; McBroom 2018). Marshes in this region generally have abundant *S. foliosa*, however, there is opportunity to enhance available habitat cover with *G. stricta* plantings and high tide refuge islands. ISP and partners have constructed two high tide refuge islands at Cooley Landing (16.2), eight at Palo Alto Baylands (08), six at Dumbarton/Audubon (05b), and planted *G. stricta* at Dumbarton/Audubon (05b).

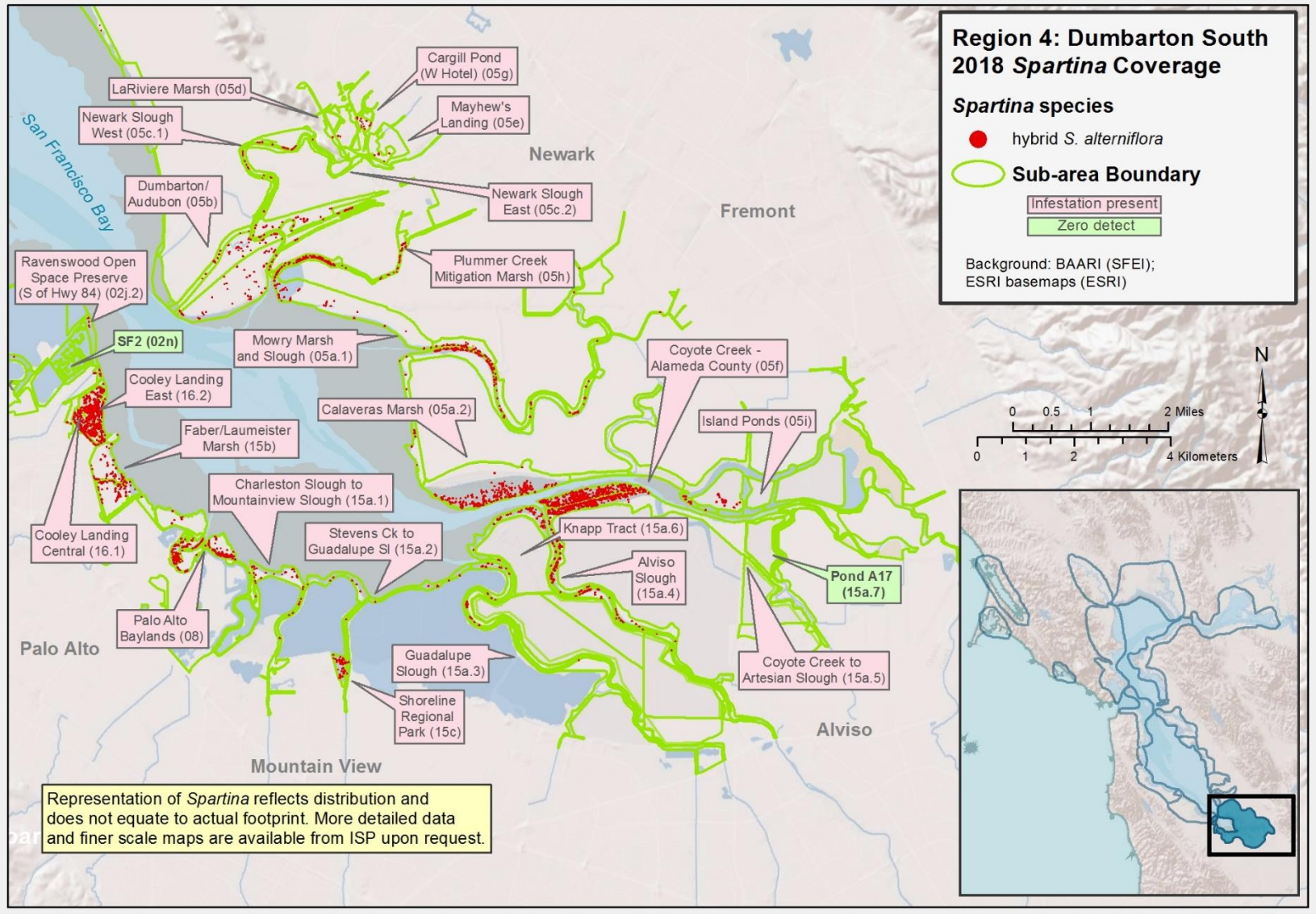

Figure 11. Distribution of invasive *Spartina* in 2018 across the 25 sub-areas of Reporting Region 4: Dumbarton South. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 9. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 4: Dumbarton South.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	Net Area	Treat-ment Area	Peak Year	Net Area Decline Since Peak	Net Area Decline Since 2017
REGION 4: DUMBARTON SOUTH												
02j.2: Ravenswood Open Space Preserve (S of Hwy 84)	8/2	Backpack	0			14 m²	0	14 m²	348 m²	2006	>99%	21%
02n: SF2	No Invasive Spartina 2018		0			0	0	0	0	2013	100%	100%
05a.1: Mowry Marsh and Slough	8/3; 8/15; 9/28	Backpack, Airboat	0			489 m²	0	489 m²	1.7 acres	2008	97%	Increase (14 m²)
05a.2: Calaveras Marsh	7/20; 10/12; 10/18-10/19; 11/13	Backpack, Amphibious vehicle, Airboat	0			681 m²	0	681 m²	2 acres	2007	98%	71%
05b: Dumbarton/Audubon	8/3; 8/17; 8/31; 9/3; 9/27; 10/12	Backpack, Airboat	0			339 m²	0	339 m²	1.5 acres	2006	99%	41%
05c.1: Newark Slough West	8/15; 9/3	Backpack, Airboat	0			38 m²	0	38 m²	0.3 acres	2004	>99%	72%
05c.2: Newark Slough East	10/12	Backpack, Airboat	0			0.02 m²	0	0.02 m²	0.6 m²	2005	>99%	98%
05d: LaRiviere Marsh	10/3	Backpack	0			3 m²	0	3 m²	78 m²	2006	>99%	65%
05e: Mayhew's Landing	10/3; 11/13 (R2)	Backpack	0			7 m²	0	7 m²	125 m²	2004	>99%	Increase (1 m²)
05f: Coyote Creek - Alameda County	10/19	Backpack, Airboat	0			11 m²	0	11 m²	480 m²	2008	93%	Increase (4 m²)
05g: Cargill Pond (W Hotel)	11/13	Backpack	0			7 m²	0	7 m²	315 m²	2010	>99%	65%
05h: Plummer Creek Mitigation Marsh	10/15	Backpack	0			3 m²	0	3 m²	178 m²	2011	98%	43%
05i: Island Ponds	8/22; 9/28	Airboat	0			69 m²	0	69 m²	0.4 acres	2017	59%	59%
08: Palo Alto Baylands	8/30-8/31; 9/4; 9/27	Truck, Backpack, Airboat	0			254 m²	0	254 m²	1.3 acres	2009	95%	79%
15a.1: Charleston Slough to Mountainview Slough	8/29; 9/5; 9/26	Backpack	0			20 m²	0	20 m²	777 m²	2004	>99%	83%
15a.2: Stevens Ck to Guadalupe Sl	9/26	Backpack	0			11 m²	0	11 m²	416 m²	2008	>99%	34%
15a.3: Guadalupe Slough	10/29	Airboat	0			72 m²	0	72 m²	0.3 acres	2008	98%	49%
15a.4: Alviso Slough	8/1-8/2; 8/22; 8/31; 9/13-9/14; 9/17-9/18; 9/28; 10/4	Backpack, Airboat	0			0.6 acres	0	0.6 acres	9.3 acres	2007	76%	68%
15a.5: Coyote Creek to Artesian Slough	7/11; 8/22; 9/18	Backpack, Airboat	0			154 m²	0	154 m²	0.7 acres	2017	81%	81%
15a.6: Knapp Tract	8/1; 8/31	Airboat	0			4 m²	0	4 m²	52 m²	2017	80%	80%
15a.7: Pond 17	n/a		0			0	0	0	0	2001	n/a	n/a
15b: Faber / Laumeister Marsh	8/18; 8/20; 9/27 (R2)	Backpack	0			181 m²	0	181 m²	1 acres	2008	90%	3%
15c: Shoreline Regional Park	9/5	Backpack	0			59 m²	0	59 m²	0.4 acres	2006	98%	16%
16.1: Cooley Landing Central	8/30-8/31; 9/12	Truck, Backpack, Airboat	0			261 m²	0	261 m²	1.3 acres	2008	98%	68%
16.2: Cooley Landing East	8/31; 9/4; 9/12; 9/19	Truck, Backpack, Airboat	0			480 m²	0	480 m²	3.3 acres	2008	99%	80%
REGION 4 TOTAL			**0**			**1.4 acres**	**0**	**1.4 acres**	**24.1 acres**	**2008**	**97%**	**67%**

2.2.5. Region 5: Union City

The Union City Region (Region 5) extends along the East Bay shoreline from the San Mateo Bridge to the Dumbarton Bridge, and includes 21 sub-areas. This region includes the original introduction site for *S. alterniflora* to San Francisco Bay – Pond 3 adjacent to the north bank of the Alameda Flood Control Channel (AFCC; 01f, also known as Ecology Marsh). Planted *S. alterniflora* later hybridized with native *S. foliosa* and eventually resulted in the bay-wide spread of their highly invasive progeny. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 12** and **Table 10**. Treatment dates and methods are included in **Table 10**.

All 21 sub-areas were inventoried in 2017 and only one (Upstream of 20 Tide Gates [13g]) was not inventoried in 2018, omitted because it has not had any infestation since 2015 and the salinity there favors brackish vegetation. Many sub-areas in this region had increases to the infestation area ranging from 0.01 to 16 m^2 in net cover (**Table 10**). Increases are attributed to the region's location directly south of, and hydrologically connected to, the Cogswell Complex (Region 6), where two sub-areas were restricted from treatment between 2011 and 2018, and now harbor five acres of hybrid *S. alterniflora*. Many detections in the Union City Region in 2018 were of newly colonized plants on previously unvegetated mudflats, which, incidentally, is the same phenomenon seen when these sites were first breached for restoration in the mid-2000s. Each of the sub-areas still contains open mudflat where sediment hasn't sufficiently accreted to support native vegetation, and it appears that the substantial rainfall of 2017-2018 may have assisted hybrid *S. alterniflora* to colonize the mudflats, most likely from seed dispersed from the Cogswell Complex.

The sub-areas of the Union City Region have experienced the most dramatic reduction in invasive *Spartina* in the Estuary. This region harbored 233 acres of hybrid *S. alterniflora* before treatment began in 2005. Extensive surveys on foot and by airboat in 2018 mapped a total of 60.4 m^2 (0.015 acre), 0.006% of the peak amount (**Figure 12, Table 10**). This small infestation does, however, represent a 62% increase over the amount inventoried in 2017, which also had a 24% increase over 2016.

Annual surveys for California Ridgway's rails have shown a declining trend in the number of rails detected at sub-areas surveyed by ISP and DENWR in the Union City Region (McBroom 2018). To date, the ISP Restoration Program has installed more than 220,000 plantings across thirteen sub-areas along the Alameda Flood Control Channel (1a, 1b, 1c, 1f) and within the Eden Landing Ecological Reserve (13b, 13d, 13e, 13f, 13h, 13j, 13k, 13l, 13m), to establish native rail habitat where control efforts have removed or precluded hybrid *S. alterniflora*. Planted *S. foliosa* has established and expanded extensively in this region, now covering acres of tidal wetlands at appropriate elevations. The amount of *S. foliosa* present in the region resulting from plantings is now orders of magnitude greater than the minor amount of remaining hybrid *S. alterniflora*.

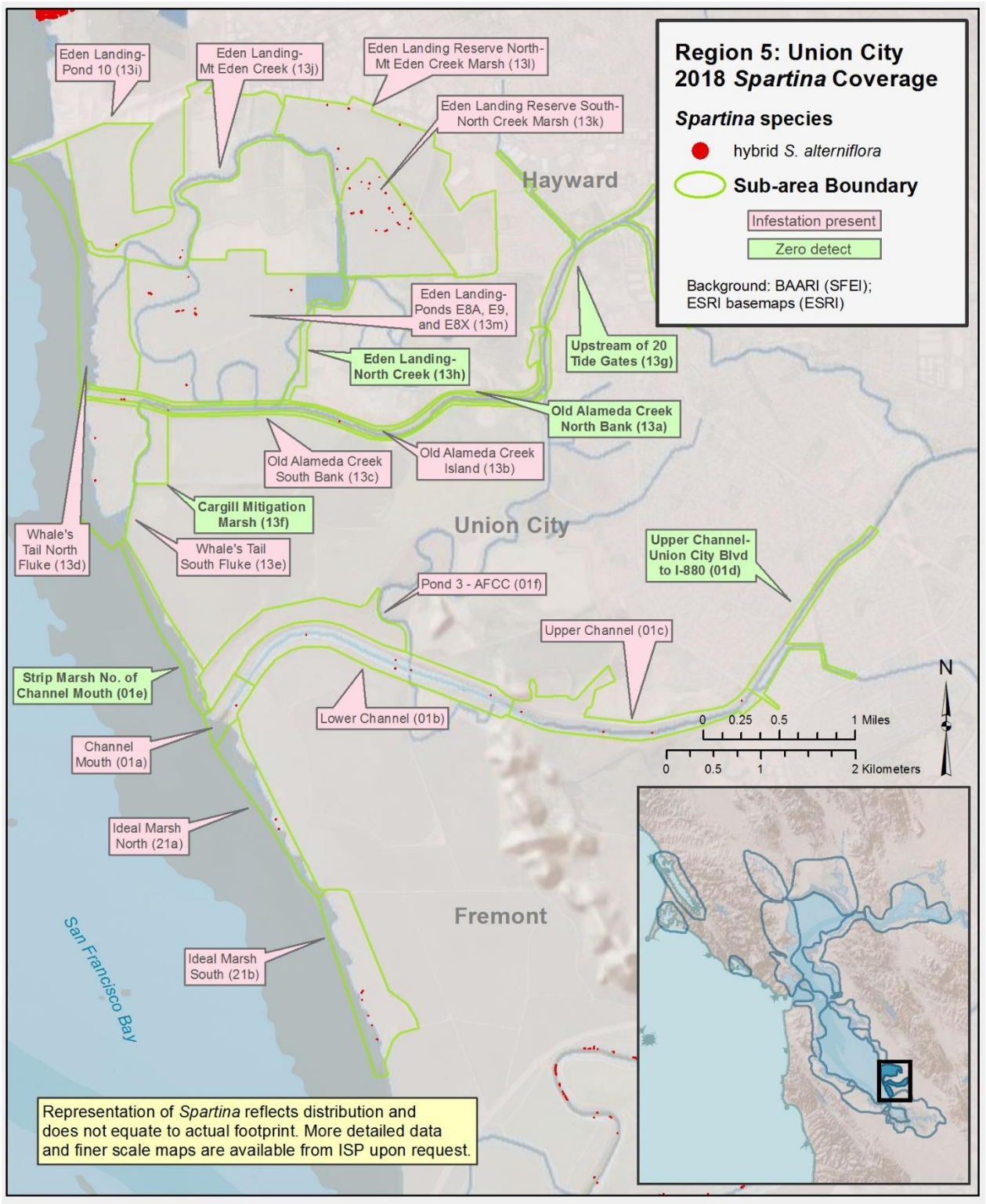

Figure 12. Distribution of invasive *Spartina* in 2018 across the 21 sub-areas of Reporting Region 5: Union City. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 10. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 5: Union City

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treat-ment Area	Peak Year	Since Peak	Since 2017
REGION 5: UNION CITY												
01a: Channel Mouth	8/2; 8/6	Backpack	0			0.3 m²	0	0.3 m²	12 m²	2004	>99%	78%
01b: Lower Channel	8/28	Backpack	0			3 m²	0	3 m²	79 m²	2004	>99%	Increase (2 m²)
01c: Upper Channel	8/2; 8/6	Backpack	0			2 m²	0	2 m²	19 m²	2004	>99%	Increase (0.4 m²)
01d: Upper Channel - Union City Blvd to I-880	2 years with no invasive Spartina (2017-2018)		0			0	0	0	0	2005	100%	n/a
01e: Strip Marsh No. of Channel Mouth	2 years with no invasive Spartina (2017-2018)		0			0	0	0	0	2004	100%	n/a
01f: Pond 3 - AFCC	8/2	Backpack	0			0.0002 m²	0	0.0002 m²	0.008 m²	2005	>99%	>99%
13a: Old Alameda Creek North Bank	4 years with no invasive Spartina (2015-2018)		0			0	0	0	0	2005	100%	n/a
13b: Old Alameda Creek Island	9/17	Backpack	0			1 m²	0	1 m²	48 m²	2005	>99%	Increase (0.6 m²)
13c: Old Alameda Creek South Bank	9/17	Backpack	0			0.1 m²	0	0.1 m²	1 m²	2005	>99%	Increase (0.01 m²)
13d: Whale's Tail North Fluke	8/16; 9/28	Backpack	0			0.1 m²	0	0.1 m²	4 m²	2005	>99%	90%
13e: Whale's Tail South Fluke	9/19; 11/5 (R2)	Backpack	0			6 m²	0	6 m²	76 m²	2005	>99%	Increase (5 m²)
13f: Cargill Mitigation Marsh	No Invasive Spartina 2018		0			0	0	0	0	2004	100%	100%
13g: Upstream of 20 Tide Gates	3 years with no invasive Spartina (2016-2018)		0			0	0	0	0	2005	100%	n/a
13h: Eden Landing - North Creek	3 years with no invasive Spartina (2016-2018)		0			0	0	0	0	2007	100%	n/a
13i: Eden Landing - Pond 10	11/1	Backpack	0			0.5 m²	0	0.5 m²	7 m²	2008	>99%	Increase (0.4 m²)
13j: Eden Landing - Mt Eden Creek	8/16; 11/1 (R2)	Backpack	0			2 m²	0	2 m²	41 m²	2009	>99%	Increase (1 m²)
13k: Eden Landing Reserve South - North Creek Marsh	8/9; 8/16; 10/12 (R2); 11/1 (R2)	Backpack	0			22 m²	0	22 m²	453 m²	2009	95%	Increase (16 m²)
13l: Eden Landing Reserve North - Mt Eden Creek Marsh	8/16; 9/21; 9/27; 10/12; 11/1 (R2)	Backpack	0			7 m²	0	7 m²	156 m²	2010	96%	Increase (7 m²)
13m: Eden Landing - Ponds E8A, E9, and E8X	10/22; 11/1	Backpack, Airboat	0			14 m²	0	14 m²	227 m²	2014	59%	Increase (3 m²)
21a: Ideal Marsh North	8/6	Backpack	0			0.3 m²	0	0.3 m²	24 m²	2005	>99%	87%
21b: Ideal Marsh South	9/18	Backpack	0			0.7 m²	0	0.7 m²	49 m²	2006	>99%	89%
REGION 5 TOTAL			**0**			**60 m²**	**0**	**60 m²**	**0.3 acres**	**2004**	**>99%**	**62% increase (23 m²)**

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2.2.6. Region 6: Hayward

The Hayward Region (Region 6) extends from the San Mateo Bridge to Oakland Airport on the east side of the San Francisco Bay. It is heavily urbanized and consists of 30 sub-areas clustered around three relatively young but sizeable restoration marsh complexes: Robert's Landing, Oro Loma, and Cogswell Marsh. Cogswell Marsh (20m-o) is the oldest and was restored in 1980. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 13** and **Table 11**.

A particular challenge in this region is that treatment was prohibited at nine out of 30 of the sub-areas between 2011 and 2018 (**Figure 13**). This has allowed unchecked expansion of the hybrid *S. alterniflora* populations there, with spread into adjacent marshes and beyond. Treatment was permitted to resume at most of the sub-areas beginning in 2018, as described below and in Section 3.3 ("Restricted Treatment Sites"), but the lapse in treatment caused progress toward eradication to be reversed in some areas and has required modifications in the way inventory is conducted.

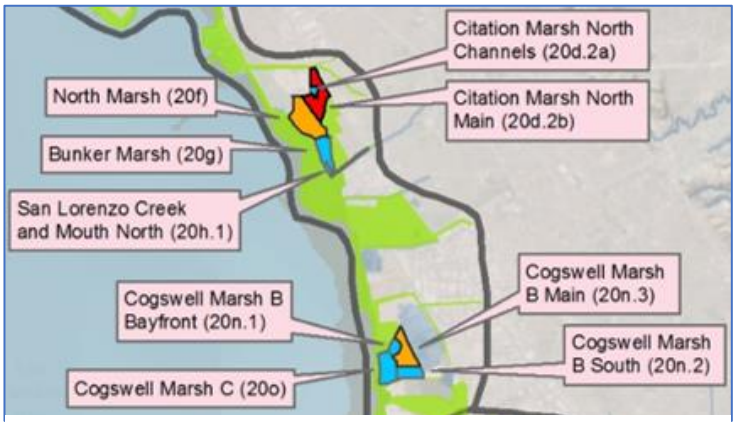

Figure 13. Detail showing nine sub-areas in the Hayward Region that were precluded from invasive Spartina treatment between 2011 and 2018. (See Section 3.3 for more information on restricted treatment sites)

Twenty-one of the 30 sub-areas in the Hayward Region were inventoried on foot in both 2017 and 2018, with restricted marshes with very tall, dense infestations being surveyed by grid. Six sub-areas were not inventoried in 2018 and one was partially inventoried, and 2017 data was carried over and reported in 2018 (**Table 11**). A total of 20.8 acres of non-native cordgrass, all hybrid *S. alterniflora*, was detected (**Figure 14**). This places Region 6 as the most heavily infested region, a fact largely due to the number of restricted-treatment sites, and accounts for 55% of the Estuary total. The bay-wide increase between 2016 and 2017 was largely driven by an 80% (>10-acre) increase in hybrid *S. alterniflora* in the restricted treatment zones of Region 6.

Other sub-areas in the region maintain relatively low levels of infestation (some even approaching or reaching zero detect), though they receive an annual barrage of propagules from the neighboring marshes where treatment has been restricted. Ultimately this necessitates annual inventory and treatment in order to keep these marshes and mudflats from rapidly becoming hybrid *S. alterniflora* meadows and further impacting the Estuary with increased propagules. Similarly, the large amount of seed dispersed from the Cogswell Marsh Complex is the likeliest source for the increase in infestation observed in Eden Landing Ecological Reserve in Region 5 to the South.

The biggest changes to the ISP Treatment Program in 2018 occurred in the Hayward Region, when a new Biological Opinion (BO) was issued in October. The new BO allowed treatment to resume at eight of nine sub-areas that had been precluded from treatment since 2011, including Citation Marsh North Channels (20d.2a), North Marsh (20f), Bunker Marsh (20g), San Lorenzo Creek Mouth North (20h.1), Cogswell Marsh B Bayfront (20n.1), Cogswell Marsh B South (20n.2), Cogswell Marsh B Main (20n.3), and Cogswell C (20o). Of these eight sub-areas, two, Cogswell Marsh B Main (20n.3) and North Marsh (20f),

were only authorized for treatment by seed suppression. One additional sub-area, Citation Marsh North Main (20d.2b), remained restricted. In 2018, the ISP and partner East Bay Regional Park District fully treated the previously-restricted Cogswell Marsh B South (20n.2) and Cogswell C (20o), with a combination of Marshmaster amphibious vehicle and hauling hose from a truck for the perimeter. Due to time constraints and contractor availability, the only other previously-restricted site where treatment was resumed in 2018 was the small, linear San Lorenzo Creek and Mouth North (20h.1).

The number of California Ridgway's rail detected in the Hayward Region has increased by 14% since 2017 and by 26% over the last five years (McBroom 2018). Most of these increases are in the restricted marshes where rails remain dependent on hybrid *S. alterniflora* for cover, as there is little other vegetation to provide habitat. Because of this, the potential impacts of future treatment in this region on local rail populations remain high.

The large amount of invasive *Spartina* remaining in this region has delayed the reintroduction of *S. foliosa* at sub-areas with treatment restrictions. The ISP Restoration Program has cautiously tested planting *S. foliosa* at sub-areas with relatively less invasion pressure near restricted treatment sub-areas with the goal of enhancing suitable habitat in anticipation of resuming control efforts in the future. Sub-areas that have undergone some level of *S. foliosa* planting include Oro Loma Marsh-East (07a), H.A.R.D. Marsh (20s), Triangle Marsh (20w), and Cogswell Marsh A (20m). Habitat enhancements in this region have also included planting *Grindelia stricta* and constructing high tide refuge islands. To date, over 40,000 *Grindelia* plants have been installed (sometimes paired with *Distichlis spicata*), across twelve sub-areas, and a total of eight high tide refuge islands have been installed in Cogswell Marsh B South (20n.2), Cogswell Marsh B Main (20n.3), Cogswell Marsh C (20o), and Bunker Marsh (20g).

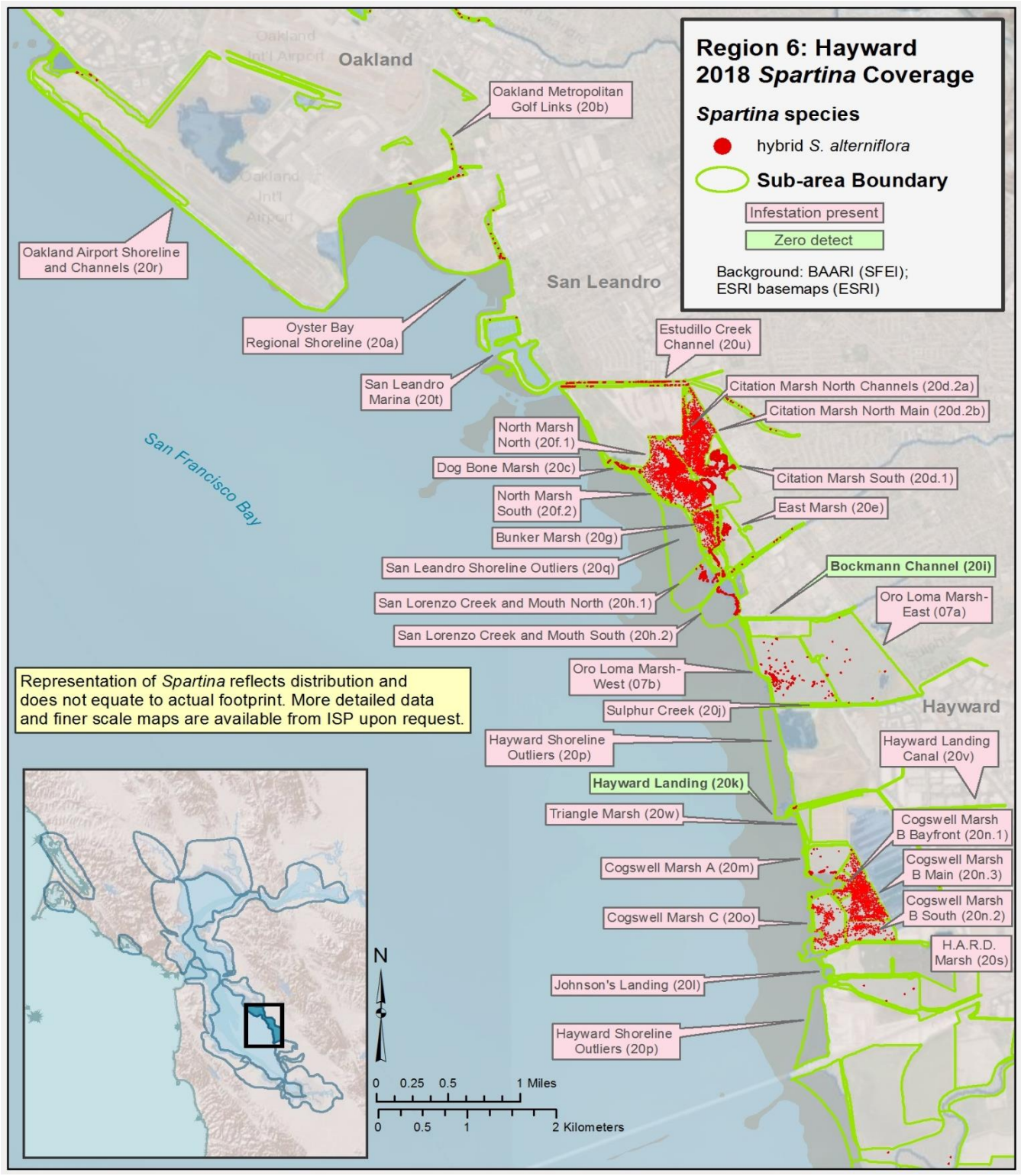

Figure 14. Distribution of invasive *Spartina* in 2018 across the 30 sub-areas of Reporting Region 6: Hayward. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 11. Summary of 2018 invasive Spartina area by sub-area within Reporting Region 6: Hayward

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treat-ment Area	Peak Year	Since Peak	Since 2017
REGION 6: HAYWARD												
07a: Oro Loma Marsh - East	10/1	Backpack, Airboat		0		4 m²	0	4 m²	152 m²	2008	>99%	25%
07b: Oro Loma Marsh - West	10/1; 10/29	Backpack, Airboat		0		23 m²	0	23 m²	541 m²	2005	>99%	45%
20a: Oyster Bay Regional Shoreline	7/17	Backpack, Airboat		0		10 m²	0	10 m²	257 m²	2004	>99%	Increase (8 m²)
20b: Oakland Metropolitan Golf Links	7/5	Backpack		0		0.8 m²	0	0.8 m²	29 m²	2009	>99%	59%
20c: Dog Bone Marsh	10/2	Backpack		0		15 m²	0	15 m²	334 m²	2006	>99%	Increase (13 m²)
20d.1: Citation Marsh South	10/15-10/16	Truck, Backpack		0		485 m²	0	485 m²	2.2 acres	2004	89%	Increase (445 m²)
20d.2a: Citation Marsh North Channels	Not Treated in 2018			0		0.8 acres	0	0.8 acres	4.9 acres	2006	60%	n/a (Not mapped 2018)
20d.2b: Citation Marsh North Main	No Treatment Authorized since 2010			0		5.2 acres	0	5.2 acres	32.8 acres	2006	51%	n/a (Not mapped 2018)
20e: East Marsh	10/16	Backpack		0		25 m²	0	25 m²	899 m²	2006	99%	Increase (18 m²)
20f: North Marsh	Not Treated in 2018			0		8.1 acres	0	8.1 acres	45.8 acres	2006	55%	n/a (Not mapped 2018)
20g: Bunker Marsh	Not Treated in 2018			0		1.5 acres	0	1.5 acres	11.4 acres	2004	89%	n/a (Partially mapped 2018)
20h.1: San Lorenzo Creek and Mouth North	11/5; 12/13	Backpack		0		28 m²	0	28 m²	290 m²	2004	>99%	Increase (25 m²)
20h.2: San Lorenzo Creek and Mouth South	7/19	Backpack		0		42 m²	0	42 m²	967 m²	2004	>99%	Increase (25 m²)
20i: Bockmann Channel	No invasive Spartina 2018			0		0	0	0	0	2004	100%	100%
20j: Sulphur Creek	7/19	Backpack		0		0.08 m²	0	0.08 m²	8 m²	2004	>99%	40%
20k: Hayward Landing	No invasive Spartina 2018			0		0	0	0	0	2004	100%	100%
20l: Johnson's Landing	7/19	Backpack		0		0.1 m²	0	0.1 m²	3 m²	2005	>99%	44%
20m: Cogswell Marsh A	9/6	Backpack		0		7 m²	0	7 m²	282 m²	2005	>99%	37%
20n.1: Cogswell Marsh B Bayfront	Not Treated in 2018			0		0.5 acres	0	0.5 acres	4.8 acres	2005	93%	n/a (Not mapped 2018)
20n.2: Cogswell Marsh B South	10/17; 12/12	Truck, Amphibious vehicle		0		0.6 acres	0	0.6 acres	6.6 acres	2005	97%	n/a (Not mapped 2018)
20n.3: Cogswell Marsh B Main	Not Treated in 2018			0		3.1 acres	0	3.1 acres	32.2 acres	2005	91%	n/a (Not mapped 2018)
20o: Cogswell Marsh C	10/15-10/16	Truck, Backpack, Amphibious vehicle		0		0.8 acres	0	0.8 acres	8.4 acres	2005	96%	n/a (Not mapped 2018)
20p: Hayward Shoreline Outliers	7/19	Backpack		0		0.2 m²	0	0.2 m²	12 m²	2008	>99%	25%
20q: San Leandro Shoreline Outliers	11/5	Backpack		0		2 m²	0	2 m²	56 m²	2006	>99%	Increase (2 m²)
20r: Oakland Airport Shoreline and Channels	7/31; 9/12	Backpack		0		3 m²	0	3 m²	99 m²	2006	>99%	89%
20s: H.A.R.D. Marsh	7/19; 9/6; 10/17 (R2)	Backpack		0		8 m²	0	8 m²	72 m²	2006	96%	Increase (7 m²)
20t: San Leandro Marina	7/31	Backpack		0		0.6 m²	0	0.6 m²	19 m²	2009	99%	Increase (0.4 m²)
20u: Estudillo Creek Channel	6/5	Truck, Backpack		0		76 m²	0	76 m²	0.4 acres	2010	90%	Increase (58 m²)
20v: Hayward Landing Canal	7/19	Backpack		0		3 m²	0	3 m²	73 m²	2006	>99%	Increase (2 m²)
20w: Triangle Marsh	7/19	Backpack		0		0.3 m²	0	0.3 m²	9 m²	2007	98%	Increase (0.3 m²)
REGION 6 TOTAL				**0**		**20.8 acres**	**0**	**20.8 acres**	**150.5 acres**	**2005**	**90%**	**1% increase (656 m²) within area mapped**

.NOTE: Inventory data for 2018 reported for the following sub-areas reflect those of 2017 hybrid *S. alterniflora* that was not treated in 2017 due to restrictions: Citation Marsh North Channels (20d.2a), Citation Marsh North Main (20d.2b), North Marsh (20f); Bunker Marsh (20g), Cogswell Marsh B Bayfront (20n.1), Cogswell Marsh B Main (20n.3), Cogswell Marsh B South (20n.2), and Cogswell Marsh C (20o).

2.2.7. Region 7: San Leandro Bay

The San Leandro Bay Region (Region 7) is an exceptionally urbanized portion of the East Bay that extends north from the Oakland Airport to the Bay Bridge. Its 20 sub-areas consist of long, thin tidal areas along rip-rap shorelines and open mudflats, punctuated by fragmented areas of marsh habitat. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 15** and **Table 12**. Treatment dates and methods are included in **Table 12.**

All sub-areas in this region were mapped on foot or by boat. Four sub-areas were inventoried in 2017 and not in 2018, and in those cases, 2017 data has been carried over and reported in 2018 for summary. Hybrid *S. alterniflora* was the only non-native cordgrass species found in Region 7, with a net cover of 10.95 acres in 2018, which reflects a 0.4% increase over 2017 cover and a 9% increase over 2016 levels.

Ninety-eight percent of hybrid *S. alterniflora* found in Region 7 is located in the five sub-areas where treatment has not been authorized since 2010. The limited increase in infestation at treatment-restricted sites suggests that hybrid *S. alterniflora* levels may be plateauing here. In 2018, two of these marshes, Damon Marsh (17d.4) and Fan Marsh Wings (17j.1), were re-authorized and were fully treated in October that year.

The infestation in Region 7 comprises 28.9% of the total amount of invasive *Spartina* remaining in the Estuary. Every sub-area in the San Leandro Bay Region contains invasive *Spartina*. Annual inventory and treatment in the San Leandro Bay Region allow the ISP to control the proliferation of hybrid *S. alterniflora* but constant establishment of new plants from the nearby seed sources makes it unlikely that any sub-area will achieve zero detect status while treatment restrictions remain in place.

Ridgway's rail surveys conducted in 2018 show that the rail population has been steadily increasing over the past five years. Rail detections at the same subset of sub-areas in Region 7 have increased by 17% since 2017 and 28% since 2013. Note that this analysis excludes Arrowhead Marsh, which was only surveyed using a transect point count for the first time in 2018. The high level of hybrid *S. alterniflora* infestation in San Leandro Bay marshes has supported a local high-density Ridgway's rail population for the past couple decades, and the lack of appropriate native marsh structure in these marshes makes the rails here dependent upon hybrid *S. alterniflora*.

Opportunities for rail habitat enhancement are limited by treatment restrictions at three key marshes, Arrowhead West (17c.1), MLK New Marsh (17h), and Damon Marsh (17d.4). In the absence of treatment at these marshes, any newly planted *S. foliosa* would likely be overwhelmed by hybrid *S. alterniflora* pollen, resulting in invasive hybrid offspring. As a result, the ISP Restoration Program has limited efforts to enhance habitat in this region. From 2011 to 2016, more than 3,000 *Grindelia* plantings were installed at the key marshes. *Spartina foliosa* was recently planted at Elsie Roemer (17a), with caution due to the high risk of re-infestation. Additionally, a total of five high tide refuge islands were constructed within MLK New Marsh and Arrowhead West to provide potential protective cover for rails during extreme high tides when they are most exposed to predators.

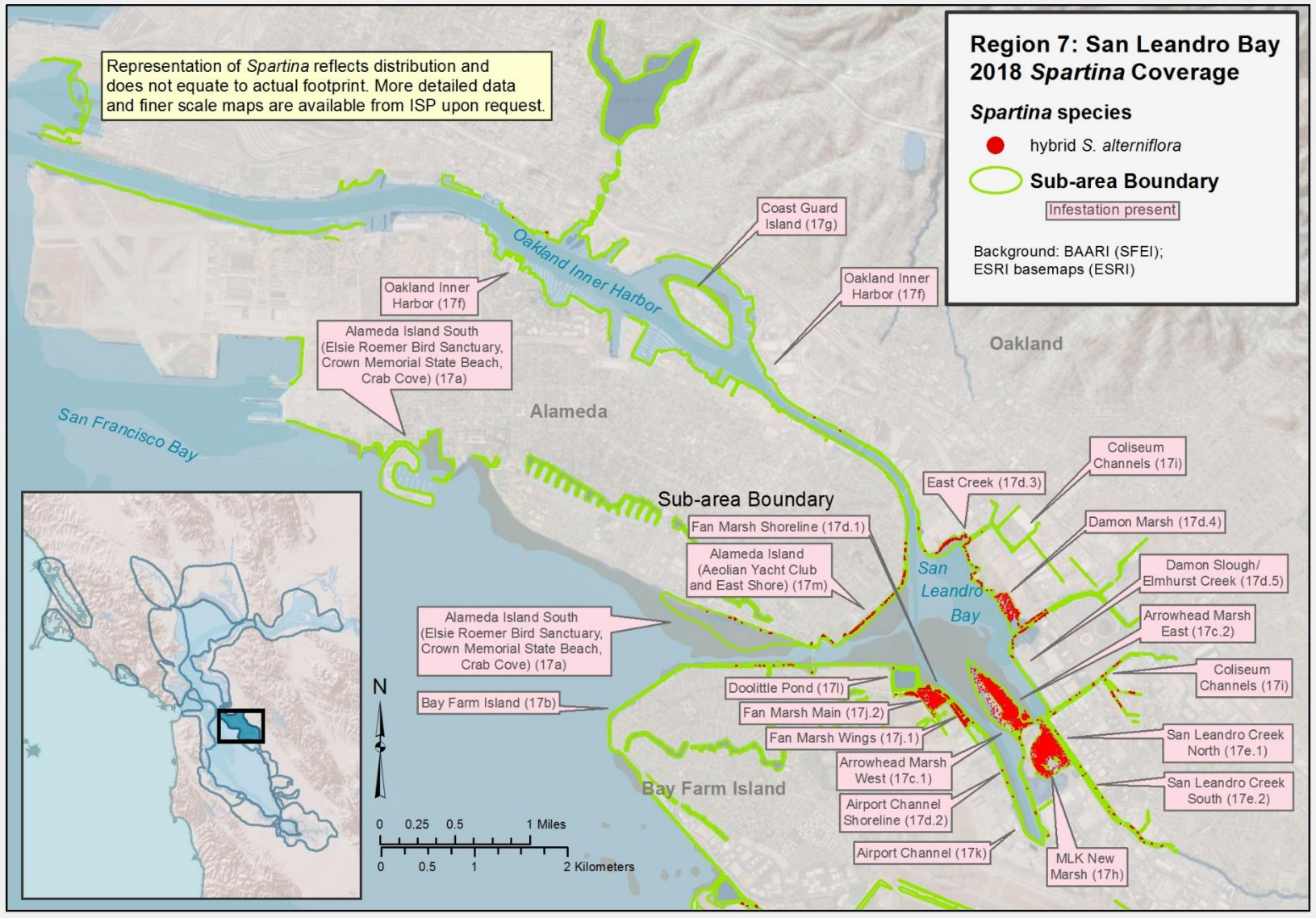

Figure 15. Distribution of invasive *Spartina* in 2018 across the 20 sub-areas of Reporting Region 7: San Leandro Bay. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 12. Summary of 2018 invasive Spartina area by sub-area within Reporting Region 7: San Leandro Bay

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			angilica	*patens*	*densiflora x foliosa*	*alterniflora x foliosa*	*densiflora*	2018 Net Area	2018 Treatment Area	Peak Year	Since Peak	Since 2017
REGION 7: SAN LEANDRO BAY												
17a: Alameda Island South (Elsie Roemer Bird Sanctuary, Crown Memorial State Beach, Crab Cove)	7/19; 10/12 (R2)	Backpack	0			5 m²	0	5 m²	262 m²	2006	>99%	Increase (4 m²)
17b: Bay Farm Island	7/19	Backpack	0			3 m²	0	3 m²	59 m²	2005	>99%	Increase (2 m²)
17c.1: Arrowhead Marsh West	12/3	Backpack, Airboat	0			914 m²	0	914 m²	2.8 acres	2005	98%	Increase (58 m²)
17c.2: Arrowhead Marsh East	No Treatment Authorized since 2010		0			4 acres	0	4 acres	20 acres	2006	75%	n/a (Not mapped 2018)
17d.1: Fan Marsh Shoreline	7/18	Airboat	0			8 m²	0	8 m²	385 m²	2004	>99%	Increase (2 m²)
17d.2: Airport Channel Shoreline	7/18	Backpack	0			12 m²	0	12 m²	497 m²	2005	>99%	Increase (2 m²)
17d.3: East Creek	7/18-7/19	Backpack	0			29 m²	0	29 m²	935 m²	2004	>99%	Increase (16 m²)
17d.4: Damon Marsh	10/30	Amphibious vehicle, Airboat	0			0.6 acres	0	0.6 acres	7.1 acres	2006	89%	n/a (Not mapped 2018)
17d.5: Damon Slough / Elmhurst Creek	7/19	Backpack	0			7 m²	0	7 m²	135 m²	2005	>99%	49%
17e.1: San Leandro Creek North	7/18	Backpack	0			0.9 m²	0	0.9 m²	9 m²	2005	>99%	47%
17e.2: San Leandro Creek South	7/18	Backpack	0			10 m²	0	10 m²	114 m²	2005	>99%	Increase (2 m²)
17f: Oakland Inner Harbor	8/6; 9/26; 10/17	Backpack, Airboat	0			1 m²	0	1 m²	35 m²	2007	>99%	Increase (0.5 m²)
17g: Coast Guard Island	n/a		n/a			n/a	n/a	n/a	n/a	2007	n/a	n/a
17h: MLK New Marsh	No Treatment Authorized since 2010		0			4.8 acres	0	4.8 acres	24.2 acres	2006	35%	n/a (Not mapped 2018)
17i: Coliseum Channels	10/17	Backpack	0			18 m²	0	18 m²	195 m²	2005	>99%	66%
17j.1: Fan Marsh Wings	10/30	Truck, Backpack	0			241 m²	0	241 m²	0.6 acres	2005	94%	Increase (150 m²)
17j.2: Fan Marsh Main	No Treatment Authorized since 2010		0			1.1 acres	0	1.1 acres	8.6 acres	2006	84%	n/a (Not mapped 2018)
17k: Airport Channel	7/18	Backpack, Airboat	0			0.5 m²	0	0.5 m²	12 m²	2005	>99%	54%
17l: Doolittle Pond	7/18	Backpack	0			0.7 m²	0	0.7 m²	27 m²	2004	>99%	76%
17m: Alameda Island (Aeolian Yacht Club and East Shore)	7/19	Backpack	0			14 m²	0	14 m²	540 m²	2006	>99%	9%
REGION 7 TOTAL			**0**			**11 acres**	**0**	**11 acres**	**64 acres**	**2006**	**87%**	**<1% increase (186 m²) within area mapped**

Note: several sub-areas in this Region were inventoried by grid in 2017 only and not all in 2018. Inventory data for 2018 reported for the following sub-areas reflect those of 2017 hybrid *S. alterniflora* that was not treated in 2017: Arrowhead Marsh East (17c.2), Damon Marsh (17d.4), MLK New Marsh (17h), and Fan Marsh Main (17j.2).

2.2.8. Region 8: Bay Bridge North

The Bay Bridge North Region (Region 8) is composed of 13 sub-areas including all East Bay shoreline marshes north of the Bay Bridge and southwest of the Carquinez Strait. This region is typified by riprap shorelines and fragmented marshes with little or no room for expansion due to urban development to their upland edge. The exceptions are intact historic Whittell Marsh (10a) and Giant Marsh (10c), and the large and partially brackish Wildcat Marsh (22a) and San Pablo Marsh (22b). The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 15** and **Table 13**. Treatment dates and methods are included in **Table 13**.

ISP surveyed all 13 sub-areas in either 2017 or 2018. Only zones with historic invasive Spartina were surveyed at Wildcat Marsh (22a) and Richmond/Albany/Pinole Shoreline (22f), and Hoffmann (22e) was surveyed only in 2017. All inventory was completed on foot, except for the shorelines and ponds adjacent to Wildcat Marsh (22a), which were surveyed by kayak. In 2018 a total of 40 m^2 of hybrid *S. alterniflora* was found in Region 8, which represents 0.3% of the Estuary total and a 16.4% increase over 2017 levels (**Figure 15, Table 11**).

The increase observed in 2018 is driven almost entirely by a 204 m^2 increase in net cover at Wildcat Marsh, which contains 60% of the Region's infestation. This increase comes on the heels of a 50% reduction in 2017 from 2016 levels across the Region, however that had been after two consecutive years of increase in 2016 and 2015. The increases in 2015 and 2016 were along the western shoreline of Point Pinole (Southern [10b], Giant [10c], Rheem Creek [22c]), and those infestations have been greatly reduced and contained a combined total of 68 m^2 in 2018, more than 90% of which was at Rheem Creek. The increase at Wildcat necessitates a more thorough survey in 2019, and one in which the entire interior marsh will be surveyed and not just the historic areas along the bayfront and channels.

Spartina densiflora has been present in this region since it was first detected here in 2004, having been manually removed from four sub-areas: Whittell Marsh (10a), Southern Marsh (10b), Giant Marsh (10c), and Richmond/Albany/Pinole Shoreline (22f). The 2014 inventory season marked the first year that *S. densiflora* was not detected in any sub-area in the Bay Bridge North Region, though it returned in alternating years since. A single plant totaling 0.10 m^2 net cover was found along the shoreline of Whittell Marsh (10a) in 2018 and removed by digging. Persistent inventory monitoring will be required to achieve local eradication of *S. densiflora* considering that its seed bank can remain viable for an estimated five years.

Surveys for California Ridgway's rails conducted by PBCS and ISP have shown an increasing trend in rail detections in the Bay Bridge North Region since 2017 (+14%) and over the last five-years (+1%) (Wood 2013, 2017; McBroom 2018). Most of this region is highly urbanized, riprap shoreline or steep upland edge with few opportunities for tidal marsh habitat enhancement. The two largest marshes in this region, Wildcat Marsh (22a) and San Pablo Marsh (22b), support about half of the rails detected during annual surveys. These two marshes have high quality habitat and extensive *S. foliosa* and *G. stricta* throughout. Consequently, to date, the ISP Restoration Program has not planned any restoration projects in this region.

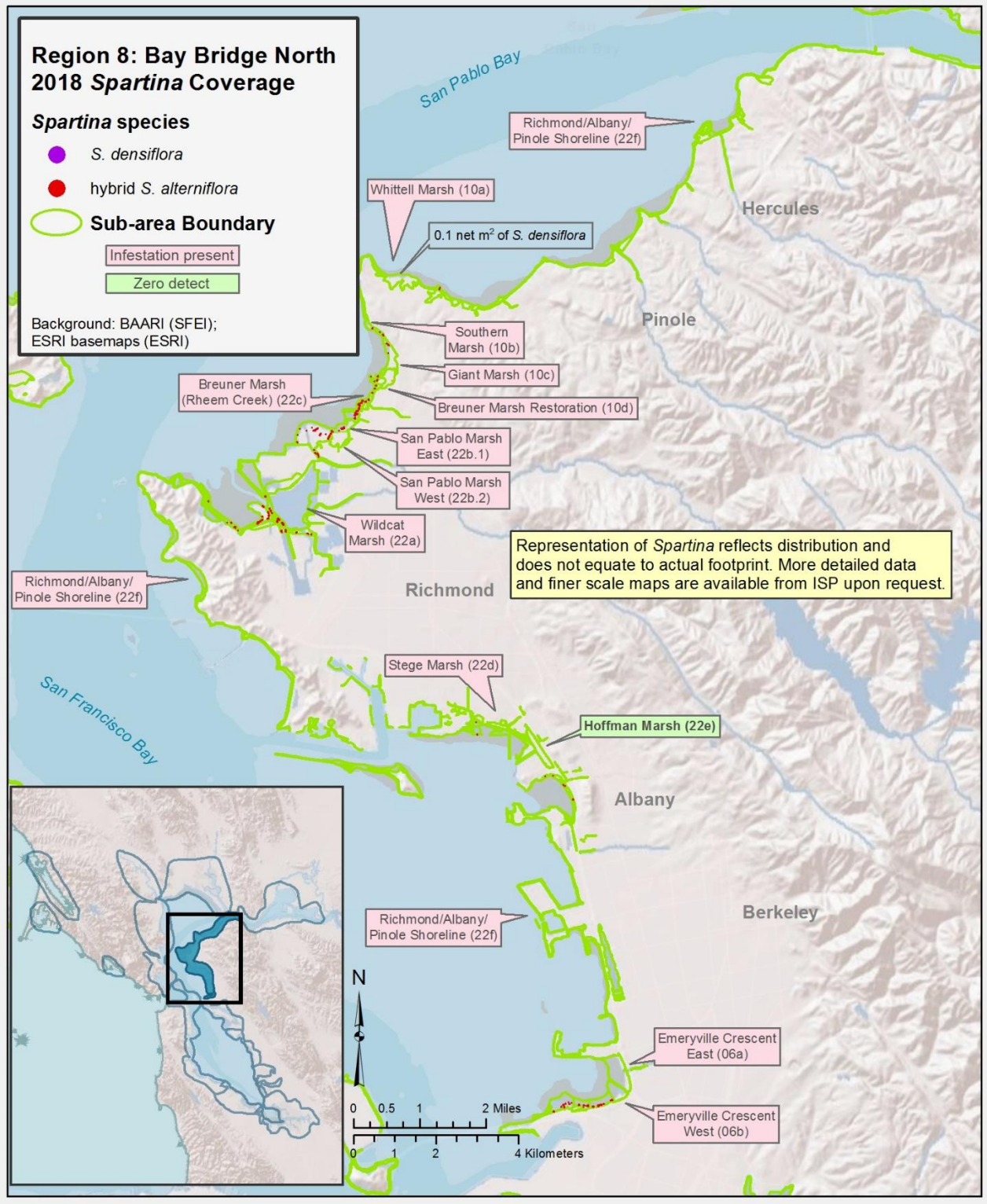

Figure 16. Distribution of invasive *Spartina* in 2018 across the 13 sub-areas of Reporting Region 8: Bay Bridge North. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 13. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 8: Bay Bridge North.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			angilica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treatment Area	Peak Year	Since Peak	Since 2017
REGION 8: BAY BRIDGE NORTH												
06a: Emeryville Crescent East	9/18	Backpack	0			7 m²	0	7 m²	228 m²	2005	>99%	56%
06b: Emeryville Crescent West	9/5	Backpack	0			13 m²	0	13 m²	446 m²	2004	>99%	77%
10a: Whittell Marsh	10/5; 1/24/19	Backpack	0			0.4 m²	0.1 m²	0.5 m²	29 m²	2005	>99%	Increase (0.4 m²)
10b: Southern Marsh	8/17; 10/16 (R2)	Backpack, Airboat	0			3 m²	0	3 m²	125 m²	2010	>99%	61%
10c: Giant Marsh	8/17; 10/16 (R2)	Backpack, Airboat	0			1 m²	0	1 m²	122 m²	2005	>99%	97%
10d: Breuner Marsh Restoration	8/17	Backpack	0			0.006 m²	0	0.006 m²	0.2 m²	2016	>99%	98%
22a: Wildcat Marsh	9/14	Backpack, Airboat	0			244 m²	0	244 m²	0.8 acres	2010	82%	Increase (203 m²)
22b.1: San Pablo Marsh East	9/13; 9/19	Backpack, Airboat	0			55 m²	0	55 m²	714 m²	2009	>99%	Increase (6 m²)
22b.2: San Pablo Marsh West	9/13-9/14	Backpack, Airboat	0			19 m²	0	19 m²	567 m²	2006	>99%	42%
22c: Breuner Marsh (Rheem Creek)	8/17; 10/16 (R2)	Backpack, Airboat	0			64 m²	0	64 m²	983 m²	2009	97%	33%
22d: Stege Marsh	9/19	Backpack	0			0.6 m²	0	0.6 m²	43 m²	2009	>99%	69%
22e: Hoffman Marsh	4 years with no invasive Spartina (2014-2017)		0			0	0	0	0	2004	100%	n/a
22f: Richmond / Albany / Pinole Shoreline	9/20	Backpack	0			4 m²	0	4 m²	140 m²	2004	>99%	75%
REGION 8 TOTAL			**0**			**411 m²**	**0.1 m²**	**411 m²**	**1.6 acres**	**2009**	**98%**	**16% increase (58 m²)**

2.2.9. Region 9: Suisun

The Suisun Region (Region 9) is bounded on the west by the Carquinez Strait and extends east approximately to Antioch, where the salinity level transitions to freshwater within the San Joaquin-Sacramento Delta. The Suisun Region consists of four sub-areas including Southampton Marsh (11) and three recently added sub-areas further east in Suisun Bay: Point Buckler (27a), MOTCO Islands (27b), and Honker Bay (27c). An infestation by hybrid *S. alterniflora* was discovered on Point Buckler in 2016, resulting in the expansion of this Region to the east to incorporate most of Suisun Bay. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 16** and **Table 14**. Treatment dates and methods are included in **Table 14**.

Southampton Marsh was surveyed thoroughly on foot in 2017 and 2018 for hybrid *S. alterniflora* and *S. patens*. Point Buckler, MOTCO Islands, and Honker Bay were primarily inventoried by Whaler with foot support where possible. The extensive side channels and back sloughs of MOTCO Islands and Honker Bay have never been fully inventoried due to difficulty of access and the sheer amount of ground to cover; each year some new areas are explored and assessed. The long rocky shoreline of the Carquinez Strait provides minimal opportunity for *Spartina* establishment. This area was not completely surveyed in 2016 so that resources could be focused on portions of the Estuary with more invasion pressure.

Southampton Marsh (11), a part of the Benicia State Recreation Area, is the only location in the Estuary where *S. patens* has been documented, and it has persisted there since at least the early 1960s according to records at the California Academy of Sciences. In 2018, ISP staff mapped a total of 10 m^2 of non-native cordgrass in this marsh, 8 m^2 of *S. patens* and 2 m^2 of hybrid *S. alterniflora* (**Figure 16, Table 14**).

Inventory of *S. patens* in 2018 showed a reduction of 74% from the 2017 net area of 31.5m^2 and 90% reduction from the 2015 net area of 84.5m^2 when work began. Control of *S. patens* is complicated here by its co-occurrence with the endangered *Chloropyron molle* ssp. *molle* (salty soft bird's beak) and the presence of the protected California black rail (*Laterallus jamaicensis coturniculus*). Salty soft bird's beak is a hemiparasitic plant that obtains nutrients in part from the roots of *S. patens;* areas where the two plants co-occur are called *interaction zones*. There are seven interaction zones in the Southampton Marsh sub-area, of which five have been treated annually since 2015 and two have had treatment suspended for one or more years due to protection measures for the black rail. At four of the five interaction zones with annual treatment *S. patens* has been reduced to trace (<1%) levels; at the fifth, *S. patens* has been reduced 2% cover across the plot. The two interaction zones where treatment was interrupted contain 57% of the remaining net *S. patens* in Southampton Marsh.

In 2018, the mapped hybrid *S. alterniflora* in the eastern sub-areas of Region 9, Point Buckler (27a), MOTCO Islands (27b), and Honker Bay (27c), increased by 5 m^2 net cover over 2017. In this case, the increased *S. alterniflora* was largely the result of a having conducted a more extensive inventory over a greater area. This portion of the estuary was added to ISP's Monitoring Plan in 2016, and then increased in size and survey effort in 2017 (see **Section 3.4** for further discussion). In 2018, inventory effort was further increased to access more of the back sloughs and hidden shorelines. As a result, previously undetected clones were found in areas that had never been inventoried before, most of which were on the shorelines of Honker Bay. An adaptive inventory strategy will be developed for this portion of the Estuary to expand the areas inventoried over time. The infestation that had been found and subsequently treated in 2016 and 2017 all responded strongly to treatment and showed dramatic declines.

Very few organizations conduct rail surveys in this region and data are sparse. Avocet Research Associates detected one Ridgway's rail at Southampton Marsh in 2017, the first time a Ridgway's rail had been detected in the sub-area since 2011 and the only record of Ridgway's rail detections at ISP sub-areas in Suisun Region. In general, the Suisun Region with its extensive brackish and freshwater marshes, has a very low density of California Ridgway's rails. The nominal infestation by and treatment of invasive cordgrass is not anticipated to have any impact on local rail populations.

The ISP Restoration Program has not implemented habitat enhancements within this region. California Department of Parks & Recreation manages a successful *Lepidium latifolium* treatment program at Southampton Marsh aimed at protecting and restoring the native channel bank vegetation (e.g., *Grindelia stricta*).

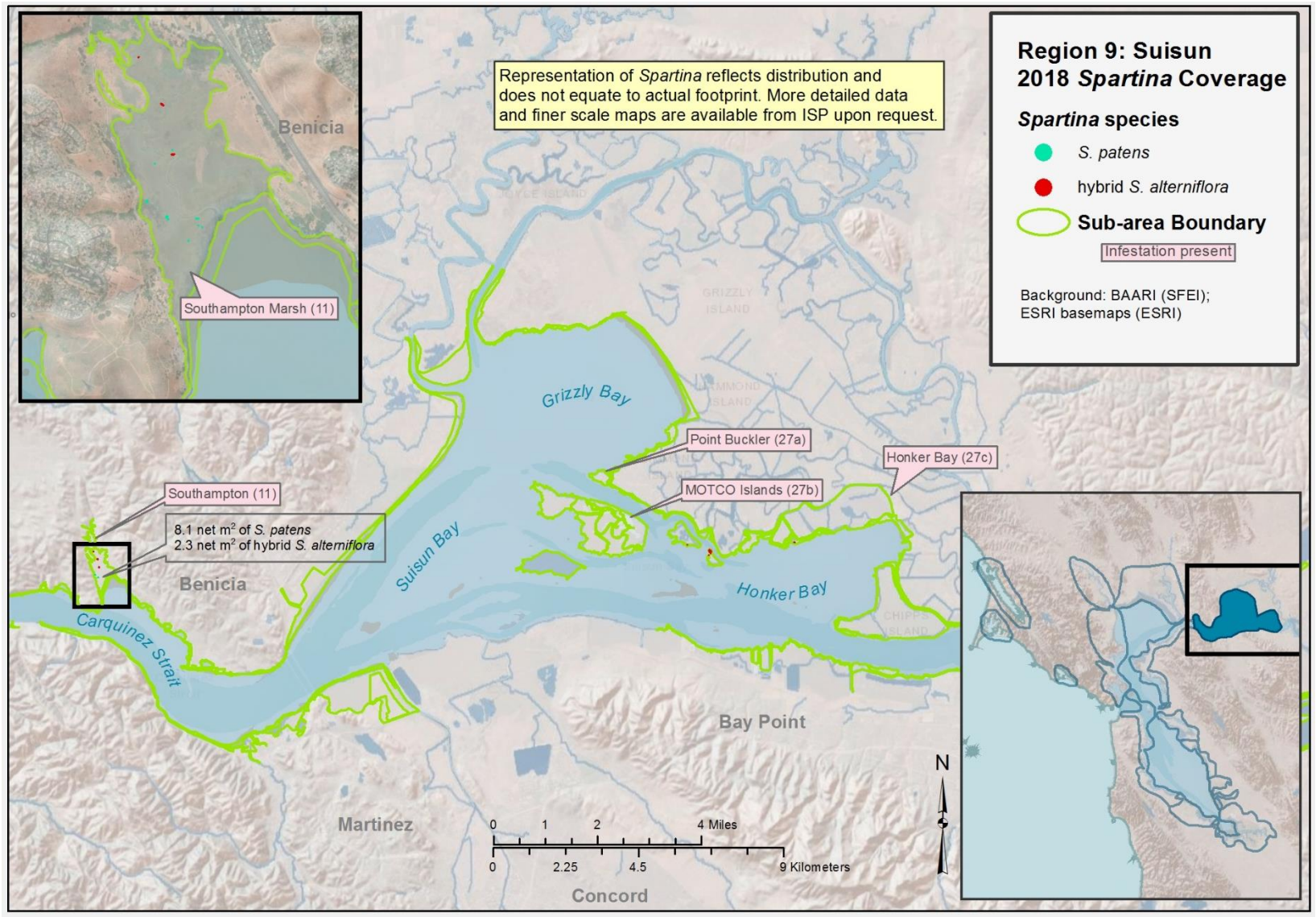

Figure 17. Distribution of invasive *Spartina* in 2018 in the four sub-areas of Reporting Region 9: Suisun. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 14. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 9: Suisun.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treat-ment Area	Peak Year	Since Peak	Since 2017
REGION 9: SUISUN												
11: Southampton Marsh	4/8; 9/28	Backpack	8 m²			2 m²	0	10 m²	184 m²	2005	>99%	70%
27a: Point Buckler	7/17	Backpack	0			0.06 m²	0	0.06 m²	2 m²	2016	>99%	90%
27b: MOTCO Islands	7/17; 10/11	Backpack	0			11 m²	0	11 m²	336 m²	2017	96%	96%
27c: Honker Bay	7/17	Backpack	0			19 m²	0	19 m²	109 m²	2018	n/a	Increase (10 m²)
REGION 9 TOTAL			**8 m²**			**32 m²**	**0**	**40 m²**	**632 m²**	**2005**	**98%**	**15% increase (5 m²)**

2.2.10. Region 10: Vallejo

The Vallejo Region (Region 10) is comprised of four sub-areas and covers the northern portion of San Pablo Bay, bounded by the mouth of the Petaluma River to the west and the City of Vallejo to the east, and extending eight miles inland to the north. Due to the region's large size and limited invasion pressure over much of its extent, it is not surveyed in entirety each year, and methods vary depending on resources. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 17** and **Table 15**. Treatment dates and methods are included in **Table 15**.

Portions of the shoreline at San Pablo Bay National Wildlife Refuge (SPBNWR), Mare Island (26b), and Sonoma Creek (26c) were surveyed by foot. Sonoma Baylands (26d), including Tolay Creek and Sears Point Restoration, was thoroughly inventoried by airboat, thanks to contributions of equipment and staff from California Department of Food and Agriculture. Mare Island was also inventoried on foot for both *S. densiflora* and hybrid *S. alterniflora*. The expansive White Slough/Napa River sub-area (26a) is under very low invasion pressure by non-native *Spartina* and has not been inventoried since 2015 when it was thoroughly inventoried by airboat with the assistance of SPBNWR staff.

The total amount of non-native *Spartina* mapped in Region 10 was 9 m^2, all of which was hybrid S. alterniflora (**Figure 17, Table 13**). 2018 was the first year that neither *S. densiflora* nor hybrid *S. densiflora* was found in this Region; in 2017 a single patch of regrowth of hybrid *S. densiflora* was found and treated. The infestation in this Region is at <1% of its peak in 2009 and is located along the Mare Island shoreline. Until 2013, the hybrid S*. alterniflora* infestation on the Mare Island shoreline was significant and effective treatment required assistance of an airboat. The dramatic reduction in the last five years allows inventory and treatment to be completed much more quickly, and often with the assistance of an ATV instead of an airboat.

In January 2015, Cullinan Ranch was restored to tidal action. In 2018, the site was assessed for infestation and the need for inventory by walking the portion of the levees most easily accessed. *Spartina foliosa* establishment was documented, and this new restoration marsh will be thoroughly inventoried in 2019.

Annual rail surveys by PBCS and San Pablo Bay NWR reflect an increasing trend in rail detections, as younger restoration marshes mature and develop (Wood 2017, 2018). In 2018, more than 30 rails were detected in Sonoma Baylands Restoration (Wood 2018) and more than 40 rails were detected in Lower Tubbs Island (SPBNWR 2018), both part of the 26d sub-area. No rails have been detected in the portions of Mare Island and along Sonoma Creek where detection and treatment of small invasive *Spartina* infestations have occurred.

There is extensive *S. foliosa* throughout Region 10, and it has quickly colonized and become established in various restoration projects. The ISP Restoration Program recently planted *S. foliosa* on more than 40 constructed islands located within the Sears Point restoration project. These islands were planted to help reduce erosion observed by project partners, SFSU (Margot Buchbinder), San Francisco Bay NERR, SPBNWR, and Sonoma Land Trust. The ISP Restoration Program has harvested *S. foliosa* from several of the fringe marsh areas along the Napa River for amplification in propagation beds at The Watershed Nursery. Propagated *S. foliosa* from this Region has been planted in three other Regions: Region 5: Union City, Region 6: Hayward, and Region 7: San Leandro Bay.

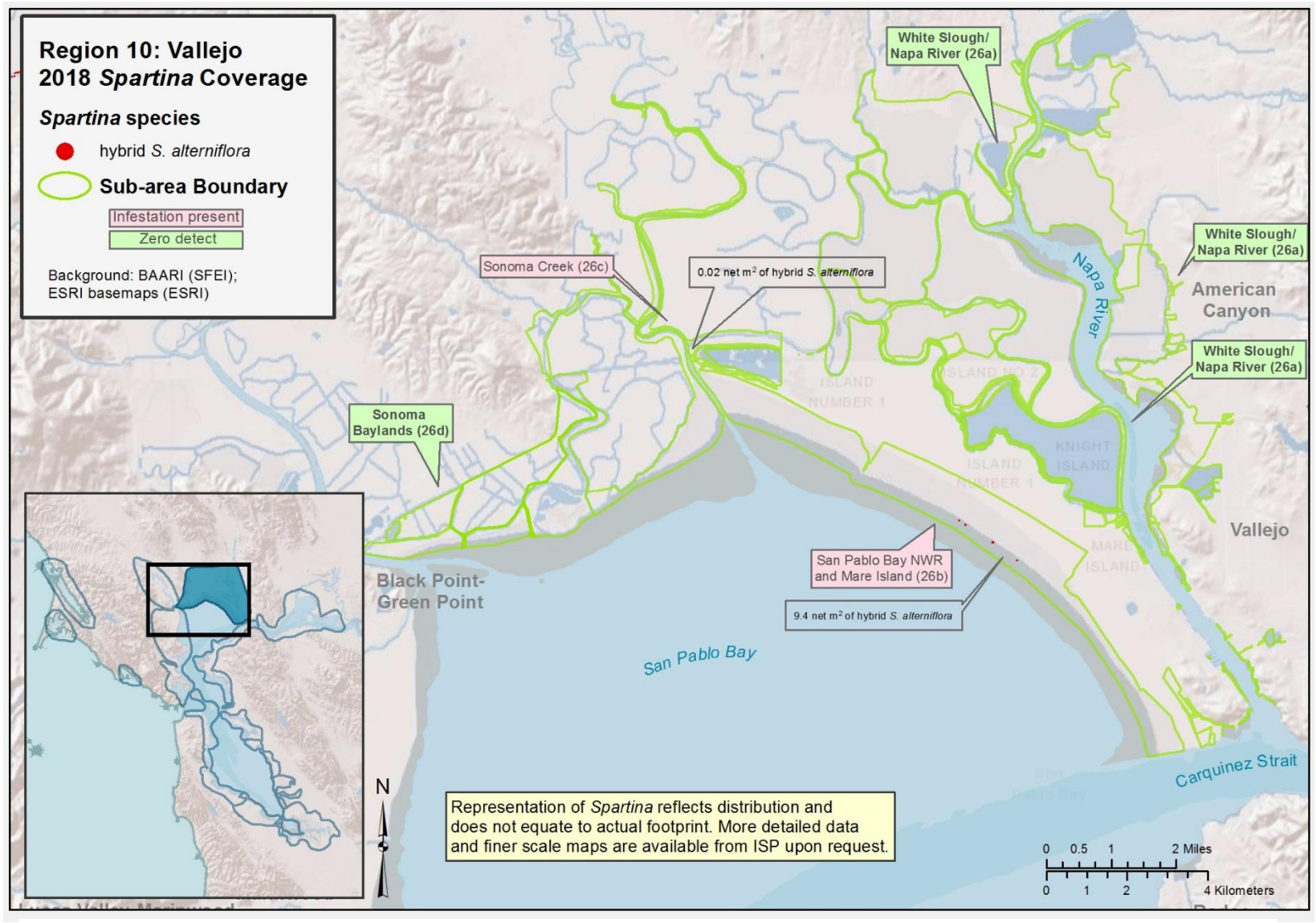

Figure 17. Distribution of invasive *Spartina* in 2018 across the four sub-areas of Reporting Region 10: Vallejo. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green

.

Table 15. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 10: Vallejo.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treat-ment Area	Peak Year	Net Area Decline	
											Since Peak	Since 2017
REGION 10: VALLEJO												
26a: White Slough / Napa River	5 years with no invasive Spartina (2011-2015)		0			0	0	0	0	2008	100%	n/a
26b: San Pablo Bay NWR and Mare Island	10/3	Dug, Backpack	0			9 m²	0	9 m²	130 m²	2009	>99%	13%
26c: Sonoma Creek	7/15	Backpack	0			0.02 m²	0	0.02 m²	4 m²	2010	>99%	66%
26d: Sonoma Baylands	8 years with no invasive Spartina (2011-2018)		0			0	0	0	0	2008	100%	n/a
REGION 10 TOTAL			**0**			**9 m²**	**0**	**9 m²**	**135 m²**	**2009**	**>99%**	**13%**

2.2.11. Region 11: Petaluma

The Petaluma Region (Region 11) is composed of four sub-areas and includes the wetlands lining the tidal portions of the Petaluma River and its tributaries in Marin and Sonoma Counties, from downtown Petaluma to the river's mouth in northwestern San Pablo Bay. The historic infestation of hybrid *S. alterniflora* in this region peaked in 2007 at 0.15 acre, has been fairly localized to the upper reaches of the Petaluma River. It is suspected that hybrid *S. alterniflora* was introduced here by propagules transported via uncleaned dredge or construction equipment. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 18** and **Table 16**. Treatment dates and methods are included in **Table 16.**

All four of this region's sub-areas were inventoried partially in both 2017 and 2018. These sub-areas are often surveyed with the assistance of an airboat, but that was not available for either year, so access was provided by Whaler. All areas of known or historic infestation were thoroughly surveyed; interior channels where no hybrid *S. alterniflora* has ever been detected were not surveyed.

The 2018 inventory of this region yielded 26 m^2 of hybrid *S. alterniflora* and no other non-native cordgrass species (**Figure 18, Table 14**). This represents a 72% reduction from 2017 and a greater than 97% reduction from peak levels in 2007. Most of the infestation (>60%) was within 24a (Upper Petaluma River-Upstream of Grey's Field), which experienced an 82% reduction since 2017. No invasive *Spartina* of any species has been found in Lower Petaluma River-Downstream of San Antonio Creek (24d), which is one reason the upstream introduction is presumed to be assisted by human activity.

The infestation in the Petaluma Region exists along the narrow shoreline of upstream Petaluma River; while most of the rails in the region are detected further downstream, within Lower Petaluma River-Downstream of San Antonio Creek (24d). Surveys for California Ridgway's rails within Region 11 are conducted by PBCS, which has had inconsistent funding over the years making trend predictions in the region difficult without advanced analysis. Based on survey results, rail populations in the region generally appear stable (Wood 2017, 2018).

No ISP habitat enhancements have been implemented in Region 11 because the northern reaches of the Petaluma River have abundant *S. foliosa* and *G. stricta* throughout the extensive tidal marsh habitat. ISP's Restoration Program has collected *S. foliosa* from Port Sonoma Marina for amplification in nursery propagation beds. Native cordgrass from this region has then been collected, propagated, and planted into the four Reporting Regions where the ISP has reintroduced *S. foliosa*: Region 2: San Francisco Peninsula, Region 5: Union City, Region 6: Hayward, and Region 7: San Leandro Bay.

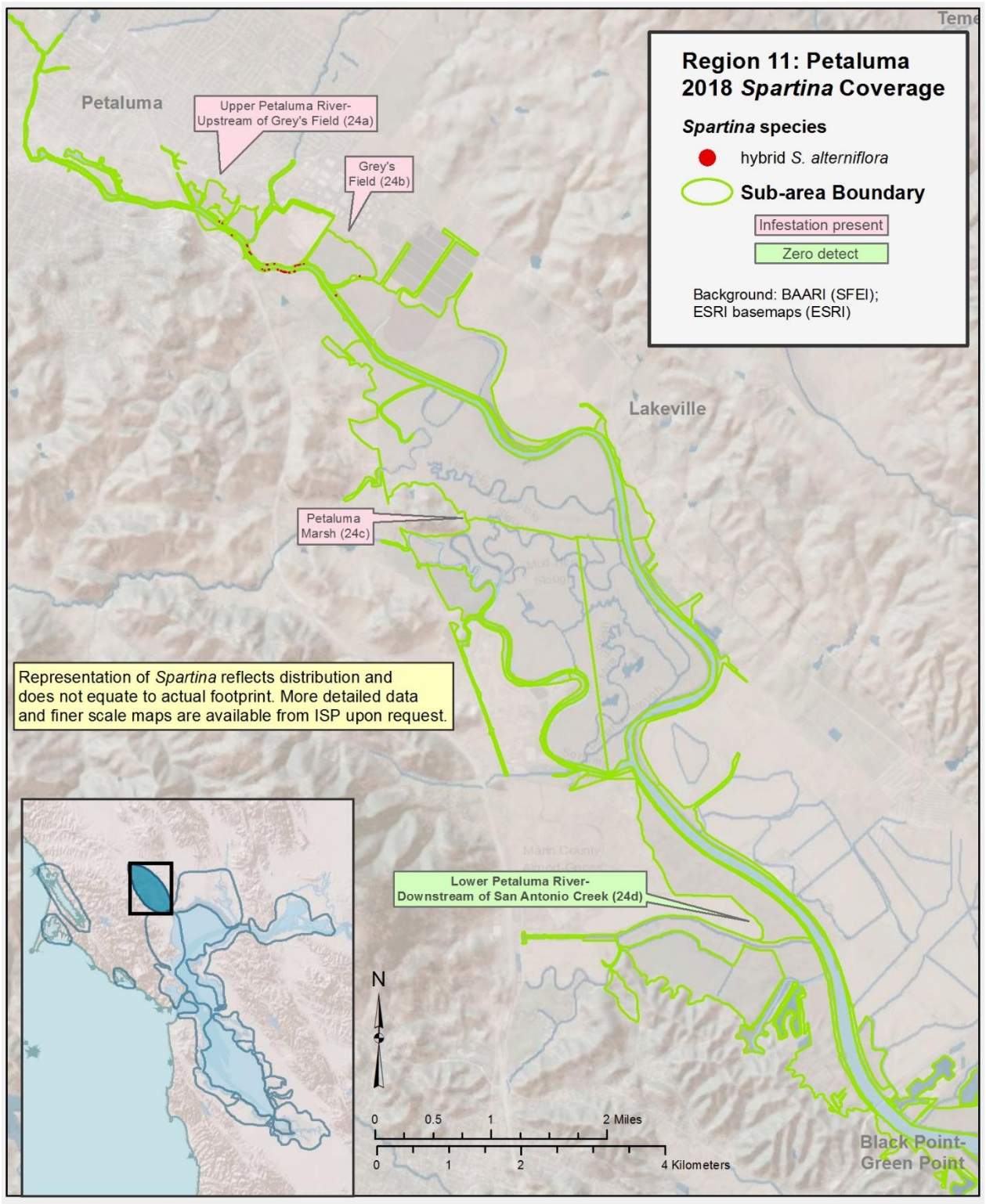

Figure 18. Distribution of invasive *Spartina* in 2018 across the four sub-areas of Reporting Region 11: Petaluma. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 16. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 11: Petaluma.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			anglica	*patens*	*densiflora x foliosa*	*alterniflora x foliosa*	*densiflora*	2018 Net Area	2018 Treatment Area	Peak Year	Since Peak	Since 2017
REGION 11: PETALUMA												
24a: Upper Petaluma River - Upstream of Grey's Field	9/26	Backpack, Airboat		0		11 m²	0	11 m²	264 m²	2007	98%	82%
24b: Grey's Field	9/26	Backpack, Airboat		0		2 m²	0	2 m²	11 m²	2009	80%	Increase (1 m²)
24c: Petaluma Marsh	9/26	Backpack, Airboat		0		5 m²	0	5 m²	59 m²	2010	82%	Increase (4 m²)
24d: Lower Petaluma River - Downstream of San Antonio Creek	No invasive Spartina ever detected			0		0	0	0	0	n/a	n/a	n/a
REGION 11 TOTAL				**0**		**18 m²**	**0**	**18 m²**	**333 m²**	**2007**	**97%**	**72%**

2.2.12. Region 12: Outer Coast

The Outer Coast Region (Region 12) includes the geographically isolated watersheds on the western side of Marin County. This region is composed of remote coastal estuaries and bays, most within Point Reyes National Seashore, several of which have been colonized by hybrid *S. alterniflora*. The 2018 distribution and abundance of invasive *Spartina* within each sub-area is presented in **Figure 19** and **Table 17**. Treatment dates and methods are included in **Table 17.**

All five sub-areas were at least partially inventory in 2018; Limantour Estero (25b) and Drakes Estero (25c) were not inventoried in 2017. Historic zones of infestation were all inventoried on foot in 2018. Because of very low invasion pressure and difficult access, thorough boat survey has not been conducted at Limantour Estero(25b) or Drakes Estero (25c) for four years. Tom's Point/Tomales (25a) was partially surveyed for *S. densiflora* only.

Invasive *Spartina* currently occurs in the Outer Coast Region in two instances: *S. densiflora* in one small marsh, Tom's Point (part of 25a), and hybrid *S. alterniflora* in Bolinas Lagoon, North (25d) (**Figure 19, Table 15**). *Spartina densiflora* persisted at Tom's Point in 2018 with two plants totaling 0.03 m^2 of cover; no *S. densiflora* plants have been found at Hog Island Oyster Company since 2015. No mature plants were found; ISP conducts two rounds of surveys at both marshes each year to ensure that all detections are removed before they can set seed. With virtually no re-invasion potential since these sites are far removed from other infestations, it is simply a matter of time until the *S. densiflora* seed bank is exhausted and local eradication achieved.

The infestation in Bolinas Lagoon North has been all but eliminated, with only 0.02 m^2 of regrowth in the historic footprint detected in 2018. This reflects a 91% reduction from 2017 and greater than 99% reduction from peak level in 2012. Two large hybrid *S. alterniflora* clones were discovered in 2011 out on the mudflats of Bolinas Lagoon, where tarping would not be an effective treatment method due to high wind and wave action and unconsolidated substrate on which to secure the tarps. After several years of environmental review and public meetings, the County of Sonoma began treatment in 2014; by 2016 the two clones had been reduced to scattered small patches and regrowth. Continued treatment has brought this area to the brink of local eradication.

All other occurrences of hybrid *S. alterniflora* have been removed from the region, with no invasive *Spartina* being found in Drakes Estero since 2012, Limantour Estero since 2011, and Bolinas Lagoon, South since 2012 (all achieving local eradication status after three years of zero detection).

Ridgway's rails do not occur in the region, as their observed geographic range is limited to the tidal marshes of the San Francisco Estuary, with the exception of occasional fall and winter observations along the Outer Coast. As such, no annual Ridgway's rail surveys have been conducted in the Outer Coast Region. No ISP habitat enhancements have been implemented here to date.

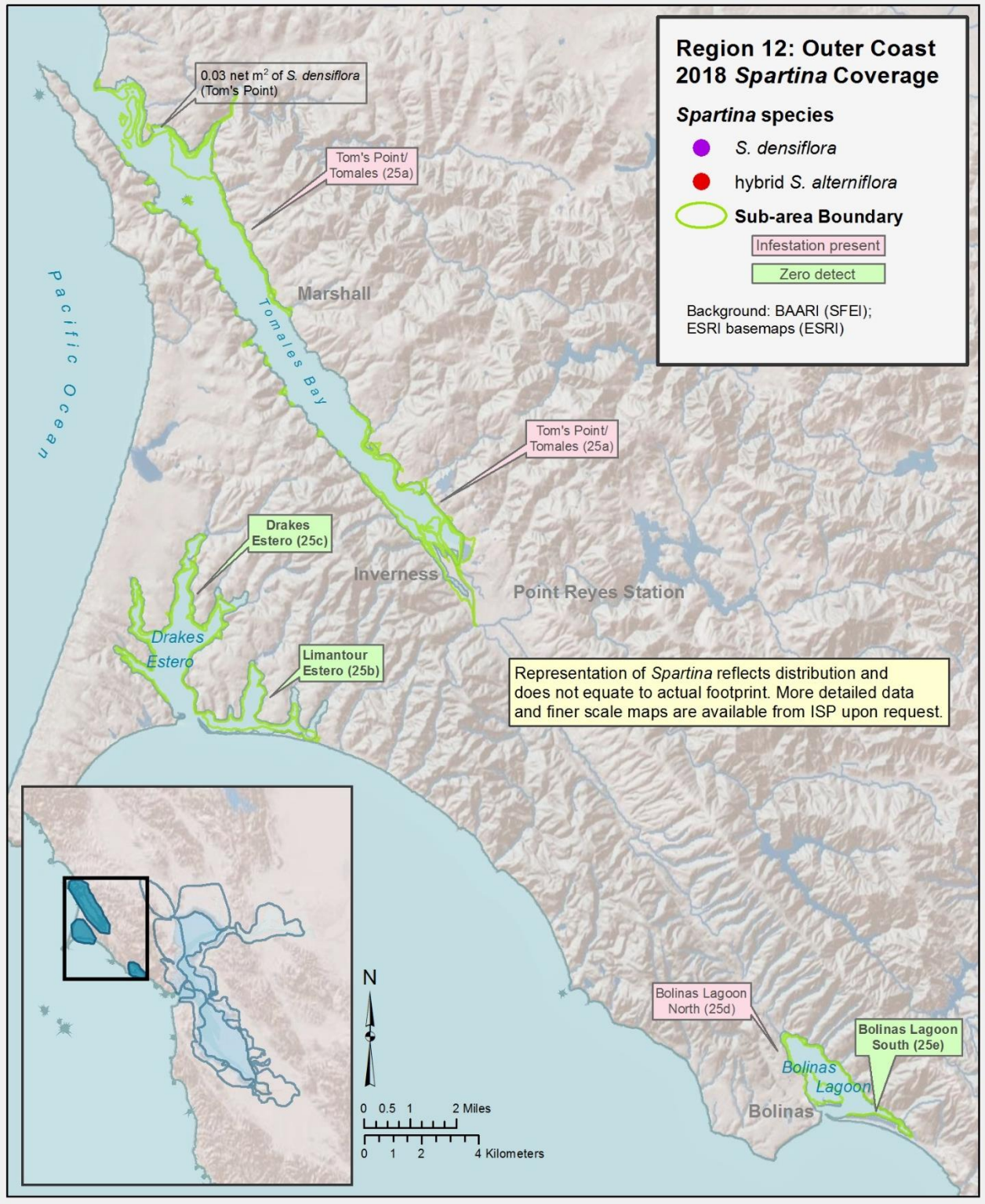

Figure 19. Distribution of invasive *Spartina* in 2018 across the five sub-areas of Reporting Region 12: Outer Coast. Sub-areas with current infestation are labeled in pink, while those with no detection of invasive *Spartina* are labeled in green.

Table 17. Summary of 2018 invasive *Spartina* area by sub-area within Reporting Region 12: Outer Coast.

Split Sub-Area	2018 Treatment Dates	2018 Treatment Method	2018 Net *Spartina* Coverage By Species					All Invasive *Spartina* Cover				
											Net Area Decline	
			anglica	*patens*	*densiflora* x *foliosa*	*alterniflora* x *foliosa*	*densiflora*	2018 Net Area	2018 Treat-ment Area	Peak Year	Since Peak	Since 2017
REGION 12: OUTER COAST												
25a: Tom's Point, Tomales	1/28/19	Dug	0			0	0.03 m²	0.03 m²	0.2 m²	2010	>99%	95%
25b: Limantour Estero	7 years with no invasive Spartina (2012-2018)		0			0	0	0	0	2010	100%	n/a
25c: Drakes Estero	6 years with no invasive Spartina (2013-2018)		0			0	0	0	0	2007	100%	n/a
25d: Bolinas Lagoon, North	10/9	Backpack	0			0.02 m²	0	0.02 m²	0.1 m²	2012	>99%	91%
25e: Bolinas Lagoon, South	6 years with no invasive Spartina (2013-2018)		0			0	0	0	0	2004	100%	n/a
REGION 12 TOTAL			**0**			**0.02 m²**	**0.03 m²**	**0.05 m²**	**0.4 m²**	**2007**	**>99%**	**94%**

3. Special Topics

3.1. From Multi-Year Drought to Record Rainfall: Impacts to the ISP

In the 2015-2016 ISP Monitoring and Treatment Report, we discussed the severe multi-year drought that affected the San Francisco Estuary from fall 2011- fall 2015 in terms of impacts that appear to have slowed progress towards invasive *Spartina* eradication. It was not until the Estuary returned to a relatively normal amount of rainfall over the winter of 2015-2016, and through observations over the subsequent 2016 field season, that we gained a better understanding of the drought and its possible impacts to the work of the ISP. Just as these dynamics were being reconciled, a record rainfall occurred during the winter and early spring of 2016-2017, bringing a resurgence of hybrid *S. alterniflora* at numerous sites. The ISP observed and adapted to the effects of this dramatic weather fluctuation during the 2017 and 2018 seasons, to continue progress toward eradication goals.

Maintaining an eradication trajectory across the range of scales from local to regional to project/Estuary-wide requires full detection of the target species followed by effective treatment. Once the stressor of drought was lifted by normal (2016) and then record (2017) rainfall, it became evident that the drought had affected the growth of some hybrid (and native) *Spartina*. It is well known that the abundance of native alkali bulrush (*Bolboschoenus maritimus*) in the saline tidal marshes of the Estuary fluctuates over time from near absence in a given marsh during dry years to extensive stands along channels and in the high marsh following wet years. Established hybrid *S. alterniflora* clones may have experienced a similar dormancy during years of very low freshwater input. With twice-daily tidal inundation over the majority of *Spartina* habitat preventing desiccation, *Spartina* rhizomes that survived treatment may have remained dormant until being resuscitated by the record rainfall in 2017.

Dormancy may also have manifested as stunted hybrid *S. alterniflora* plants with smaller traits (e.g. height, leaf width, leaf length, inflorescence length, etc.) that reduced plant detection by biologists; since, in many marshes, most morphologies of hybrid *S. alterniflora* are expected to be larger in various ways, biologists may have thought the compromised plants were *S. foliosa* during inventory and they were not mapped or treated. At numerous marshes in 2017, ISP biologists mapped hybrid *S. alterniflora* plants of substantial size that had not been detected since 2015 (or even 2014 in some cases). Undetected/untreated hybrids scattered throughout the native *S. foliosa* matrix appear to have festered over the course of the drought years, likely dispersing seeds which then contributed to the big recruitment event observed after the record rainfall of 2017.

Early senescence may have been the most challenging issue attributable to the drought over the past few years. Once the hybrid *S. alterniflora* begins to senesce, detection starts to be impacted since it is harder to differentiate between native and non-native cordgrass once leaves begin to curl. But the main issue caused by earlier senescence of the plants is the reduced uptake and translocation of the imazapyr ahead of the expected window of opportunity to treat, with efficacy dropping down to zero once the plants are brown. Systemic herbicides such as imazapyr require actively growing plants in order for their mode of action to be effective.

The primary impact of early senescence on the treatment program is the shortening of the window of opportunity for an effective imazapyr application, a big issue considering the ISP is already severely restricted by narrow tidal, biological, and regulatory windows. The early senescence was also observed to be highly variable within and across marshes, so it was difficult to predict which sub-areas or portions of

them would begin to die back first, knowledge that could have allowed for better prioritization of treatment at certain sub-areas ahead of others. Instead of reducing or eliminating those early-senescing plants through treatment, it is likely that vegetative expansion increased the footprint of their rhizomes, the density of the clones, and produced viable seed that could expand the infestation at that site or disperse on the tides to another location.

The overall area of hybrid *S. alterniflora* detections increased at numerous sites with moderate to heavy infestations in 2017, especially where it was growing within extensive *S. foliosa*. This was often expressed as an increase in treatment cover rather than net cover; the hybrid *S. alterniflora* spread into the established *S. foliosa* and impacted more ground but did not necessarily increase in density within historic mapped features. This may have resulted from hybrid seed that had spread into the surrounding marsh and recruited after the freshwater flushing from the rains. As a result, additional treatment days were needed to accommodate increases at some of the moderate to large infestations. With these increases in hybrid *S. alterniflora*, some sub-areas could not be treated before senescence, and most Round 2 treatment events were cancelled for 2017 because of the increased workload. Despite these shortfalls, ISP partners were able to complete much of the extra work in 2017 with two relatively small ($5,000) additional budget infusions from Coastal Conservancy and DENWR to complete the season, although it was challenging for field staff and the vegetation management contractors. As a result, much of the observed hybrid "bounce" was treated, aside from the issues discussed above.

Frustrated by increases of hybrid *S. alterniflora* within the *S. foliosa* matrix at some of the Estuary's highest quality marshes, in 2017 the *Spartina* Assessment Planning Team (SAPT) decided to test a new approach at some of the most persistent infestations. Where appropriate and consistent with guidance from senior staff, ISP biologists connected adjacent historical hybrid features that have emerged and persisted over the years, thereby mapping and calling for treatment of the entire areas within those newly mapped polygons. This methodology was developed to minimize opportunities for cryptic hybrid *S. alterniflora* to remain hidden in native cordgrass (or other native vegetation) between mapped treated patches, where it could escape detection and proliferate before being readily identified and treated.

This approach was first applied in 2017, following the heavy rains of the previous winter. The heavy rains may have substantially benefitted the effort by supporting early establishment and rapid growth of hybrid *S. alterniflora* seedlings (and possibly dormant rhizome), such that the plants within the *S. foliosa* matrix were more readily apparent during inventory and in perfect condition for effective treatment with herbicide – treating healthy, actively growing plants yields much higher efficacy. When the 2018 monitoring and treatment season arrived, the ISP found that these protocol shifts in 2017 had been very successful and, combined with the ability to treat the actively growing plants from the hybrid "bounce", resulted in big reductions in the infestations at most sites as compared to 2017. It is important to note that these high-quality habitat marshes have abundant native *S. foliosa* that continued to provide the ecosystem functions and values (including to Ridgway's rail), since only a very small percentage of the overall cordgrass at these sites was treated.

A possible benefit of the drought is that some dense stands of non-target brackish vegetation failed to thrive in the absence of freshwater flushing. This allowed for detection of some nascent unknown hybrid *S. alterniflora* infestations in the upper reaches of some of the channels that feed down into the more

expansive marshes on the bay. The reduction in non-target vegetation provided improved visibility, allowing for more thorough detection in areas where hybrid *S. alterniflora* had historically been found in dense stands of tules, such as the upper stretch of tidal influence in the Alameda Flood Control Channel (AFCC).

Although hybrid *S. alterniflora* is the primary target of the ISP (representing greater than 99% of the invasive cordgrass in the Estuary), it is worth mentioning that the other two non-native rhizomatous cordgrass species, *S. anglica* and *S. patens*, experienced a similar bounce from the record rainfall. These were at a much smaller scale since each only infests 1-2 sub-areas and both are approaching full eradication. *Spartina densiflora*, which doesn't spread by rhizomes in the Estuary, appears to have differed from the others in that it did very well during the drought, possibly due to its tolerance of relatively drier and higher marsh conditions. This species probably also benefitted from a reduction in competition from native tidal marsh plants during the drought because it is actively growing in early spring when the widespread natives such as perennial pickleweed are just emerging from winter dormancy.

3.2. South Bay Salt Pond Restoration Project

The South Bay Salt Pond Restoration Project (SBSPRP), managed by the Conservancy in partnership with USFWS and California Department of Fish and Wildlife (CDFW), is the largest tidal marsh restoration effort on the West Coast. The goal of the project is to restore and enhance wetlands in South San Francisco Bay, while providing for flood management, public shoreline access, and recreation. As the foundation for the effort, in 2003 State and Federal government investments acquired 15,100 acres of commercial salt ponds from Cargill and initiated planning for large-scale restoration. This ambitious project has a timeline of approximately 50 years to restore the decommissioned salt ponds to salt marsh and a variety of other tidal habitats. As these systems mature, they promise to provide much-needed support to a variety of species that have been seriously impacted by the loss of 85-90% of the historic wetlands around the Estuary since the turn of the 20th Century.

Experience with tidal marsh restorations in the South Bay since the late 1980s showed conclusively that, soon after tidal connection was reestablished at sites that have appropriate elevations, they were populated and rapidly dominated by hybrid *S. alterniflora*. However, during that period (Phase I) of large-scale restoration activities, the infestation has been reduced by greater than 95% and is largely focused around the areas of restricted treatment sites within central East Bay (**Section 3.3**). Phase II of the SBSPRP began construction in 2019 and it is possible that the first breaches may occur in 2020. The locations of planned breaches are more localized in the far South Bay and away from the restricted treatment sites, which reduces their potential for rapid colonization by hybrid *S. alterniflora*.

While the initial substrate elevation of restoration sites varies greatly due to subsidence or the import of fill, they all initially lack significant vegetation, although some may have sparse remnants of pickleweed on mounds or around the perimeter. With the absence of competition and biotic resistance, hybrid *S. alterniflora* can quickly colonize and expand vegetatively through the soft mud via rhizomes. Once hybrid *S. alterniflora* is well established, it can significantly alter the hydrology and further development of the plant community, pushing the site off a native tidal marsh development trajectory.

Since 2011, more than 1,900 acres of diked salt ponds in the South Bay have been breached and restored to twice-daily tidal exchange, expanding the potential habitat for hybrid S. alterniflora and necessitating some level of monitoring by the ISP (as well as the potential for follow-up treatment) (**Figure 20**).

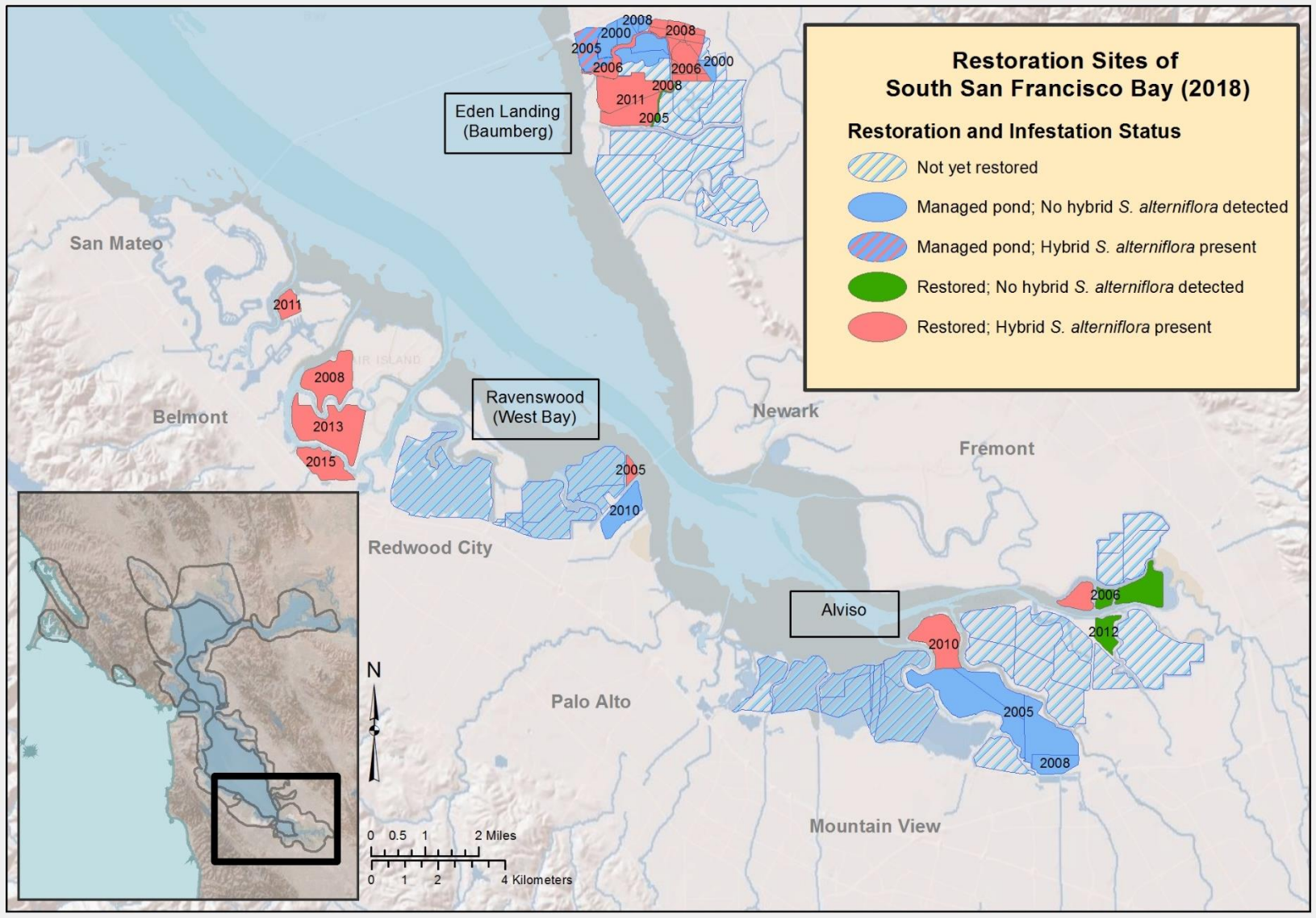

Figure 20. Map of the South Bay Salt Ponds and neighboring recent restoration projects in South San Francisco Bay. Sites are differentiated based on whether they have been restored to tidal action and if so, whether they have been infested with hybrid *S. alterniflora* or not as of 2018. Sites are labeled with the year in which they were restored to tidal action.

Experience with these challenging SBSPRP sites, many of which are large and remote, led to the development of a new strategy for conducting inventory that the ISP began implementing in 2015. Few of these sites can be accessed on foot, and those that can are far too large to be adequately inventoried simply from the levee. Accessing the sites by outboard motorboat requires water too deep to permit full detection of colonizing young *Spartina* or regrowth from treated plants, which can be short and would be submerged at higher tide. These factors necessitate the use of specialized equipment, mostly airboats, to accomplish the necessary surveys; since 2015 the ISP expanded its use of airboats to transport surveyors onto the mud flats and low marsh plains during the proper tide for full inventory. Airboats have been used extensively by the ISP for treatment since 2008-2009, but budget constraints have precluded their use purely for inventory surveys except on a limited basis. DENWR and SPBNWR have donated the use of their airboats with USFWS pilots for Refuge sites to help minimize airboat costs for inventory surveys, which not only improves efficiency but also safety. The Conservancy has also dedicated funds within the budgets of two ISP grant recipients, the San Mateo County Mosquito & Vector Control District (SMCMVCD) and the California Wildlife Foundation (CWF), specifically for airboat assistance with inventory.

No new SBSPRP sites have been breached to tidal exchange since 2012, when Pond 17 (15a.7) near the confluence of Coyote Creek and Alviso Slough in the far South Bay was reconnected to the Bay. As of 2018 no infestation has been detected here.

More recently, and although not a part of the SBSPRP, a 220-acre pond within Bair Island Ecological Reserve was restored to tidal action in December 2015. Known as Inner Bair Restoration (02l), this subarea has been a part of ISP inventory, but only the outer perimeter, which has always been tidal. The newly opened interior is now surveyed on an annual basis, and the first patch of hybrid *S. alterniflora* (0.003 m^2) was detected here in 2018.

3.3. Restricted Treatment Sites

The Conservancy and ISP staff worked with USFWS biologists at Don Edwards National Wildlife Refuge in 2017-2018 to prepare an update to the 2012 ISP Biological Assessment (BA) prepared by H.T. Harvey that was used to inform interagency Section 7 consultation. The ISP received a new five-year Biological Opinion (BO) on October 12, 2018 that covers a suite of invasive plant management and restoration activities from 2018-2022. The BA included a phased plan for resuming full treatment or seed suppression at a subset of sub-areas that haven't been permitted for this work since 2010, and the new BO subsequently authorized these activities. USFWS reevaluated the restrictions on treatment once Ridgway's rail detections at marshes consistently surveyed had increased by 80 rails for three consecutive years over an established 2010 baseline, and this benchmark was reached during the 2018 pre-breeding call count surveys. **Figure 21** shows the distribution of these sites where either full treatment or seed suppression is permitted to occur as of 2018, as well as the sub-areas that continue with the prior level of restrictions (no treatment of the hybrid *S. alterniflora*). The 26.4 acres of hybrid *S. alterniflora* in the sub-areas that remain treatment-restricted account for 70% of the total remaining invasive *Spartina* in the Bay as of their most recent coarse mapping in 2017. These sub-areas were not inventoried in 2018 due to budget limitations.

The phased plans serve to address the first steps in resuming treatment of hybrid *S. alterniflora* within four marsh complexes where treatment had been restricted since 2011. Each of these complexes supports substantial populations of Ridgway's rail (*Rallus obsoletus obsoletus*) and have specific considerations for a phased approach to resuming treatment over time. These initial phases of treatment activities proposed were selected to minimize the negative impacts to rails while the marsh is restored to a -

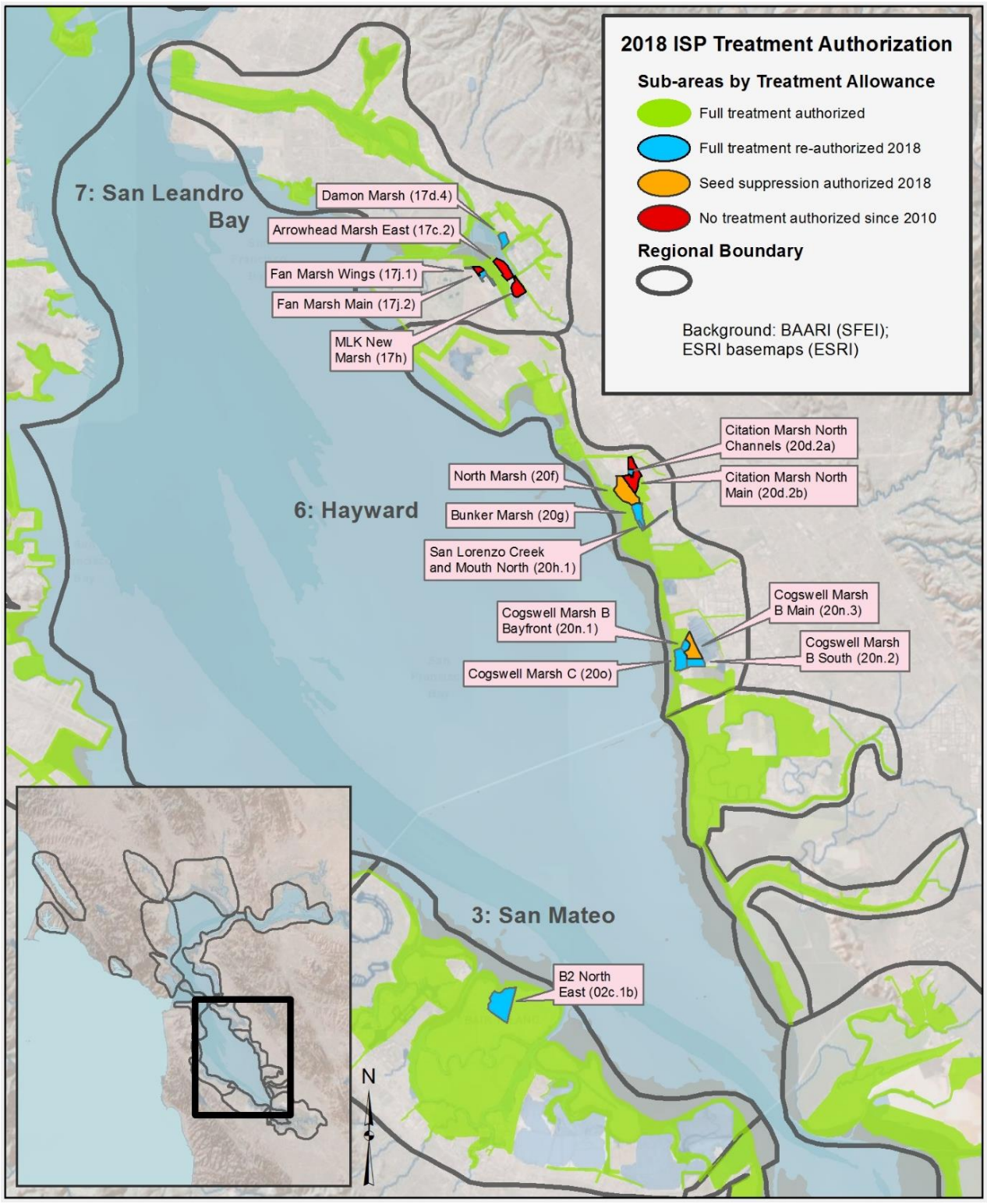

Figure 21. Distribution map of the ISP sub-areas across three reporting regions that have had treatment restrictions in place for some period of time since 2011.

more natural condition. Site-selection criteria considered the number of Ridgway's rail detections in a sub-area (in general, beginning with those that have the fewest rails), degree of hybrid *S. alterniflora* infestation (prioritizing sites with a more scattered distribution of non-native cordgrass as opposed to meadows providing extensive refugia), the presence of native vertical structure that will provide habitat after the hybrid *Spartina* is removed, and whether treatment will provide opportunities for future enhancements to the habitat. The phased plan necessitated the addition of four new sub-areas [Fan Marsh Wings (17j.1), Citation Marsh North channels (20d.2a), Cogswell Marsh B Bayfront (20n.1), and Cogswell Marsh B South (20n.2)] resulting from additional splits to the previously restricted sites to facilitate phased treatment. These sub-areas are permitted for full treatment in the current BO, along with the following previously restricted sites: Bair B2 North East (02c.1b), Damon Marsh (17d.4), Bunker Marsh (20g), San Lorenzo Creek & Mouth North (20h.1), and Cogswell Marsh C (20o). There are currently 217 sub-areas related to the Treatment Program (up from 213) including the five Outer Coast sub-areas (Site 25). There are now four sub-areas that continue to have no treatment permitted: Arrowhead Marsh East (17c.2), MLK New Marsh (17h), Fan Marsh Main (17j.2), and Citation Marsh North Main (20d.2b).

Resuming treatment at the previously restricted sub-areas will require an increased investment for inventory in future years. To allow inventory efforts to be focused in other marshes that would inform treatment for 2017 and 2018, the 11 restricted sub-areas were surveyed with a coarser, less costly, method that provided the general distribution and abundance of non-native cordgrass without the level of detail required to relocate individual plants for treatment purposes. These marshes were all surveyed in 2017 by "grid", which entails dividing each marsh into 25m x 25m grids and assessing cover classes for each. Inventory data from 2017 was carried over to 2018 for the 11 previously restricted sub-areas, but they will again be mapped by grid in 2019 to begin to track progress as either full treatment or seed suppression resumes at all but four of the sub-areas.

Resuming treatment of these large hybrid *S. alterniflora* meadows will also add expense in terms of labor, equipment, and chemicals. The absence of native *S. foliosa* at all but one of these sites means that eradication can progress on a faster trajectory than at more complex marshes with abundant native *S. foliosa* and, and ISP will subsequently begin restoration plantings and enhancements when appropriate. Two sub-areas (Cogswell Marsh B Main [20n.3] and North Marsh [20f]) were treated with a sub-lethal concentration of herbicide applied by helicopter to halt production and dispersal of hybrid *S. alterniflora* seed, and reduce vegetative expansion of existing clones, while maintaining aboveground biomass to provide endangered California Ridgway's rails with nesting substrate and cover from predators.

On Monday October 15, 2018 after receiving the signed BO, ISP partners conducted three days of work at Cogswell Marsh C (20o) and Cogswell Marsh B South (20n.2) using an amphibious tracked vehicle to access the extensive infestations in the interior of the site, with a truck providing treatment support within 100 meters from the levees for the perimeter infestation. Aerial treatment at Bair Island's B2 North East (02c.1b) was conducted on October 16, 2018 using the full 7.5% concentration applied at 10 gallons per acre after six years of using the dilute (2.5%) seed suppression concentration to hold the line. With delayed receipt of the BO in 2018, and with significant budget constraints that year, treatment was resumed at only three more of the now-permitted sites, Damon Marsh (17d.4) by airboat and truck, and the two smallest previously restricted sites Fan Marsh Wings (17j.1) by truck and San Lorenzo Creek & Mouth North (20h.1) by backpack sprayer.

Figure 22 shows ground-based herbicide application on a rebounded meadow of hybrid *S. alterniflora* Cogswell Marsh B South (20n.2), where treatment had previously been restricted for seven years**. Figure 23** shows an example of a hybrid *S. alterniflora* patch that invaded the ISP's *Grindelia stricta* plantings along a tidal channel edge in Cogswell Marsh C (20o). The blue color indicates that the patch has been spot-treated with herbicide.

Figure 22. Treating a meadow of hybrid *S. alterniflora* at Cogswell Marsh B South that had rebounded during the seven years of restrictions (ISP 2018).

Figure 23. Spot treatment of channel hybrid *S. alterniflora* in Cogswell Marsh C protects the surviving *Grindelia stricta* previously installed by the ISP and will open future planting opportunities to restore vertical structure for Ridgway's rail and other wildlife to use on extreme high tides. (ISP 2008)

3.3. New Infestations and Sub-Areas Added in 2017-2018

ISP defines a "new infestation" as a newly discovered instance of invasive *Spartina* greater than one kilometer from any historic location. A new "sub-area" within a previously existing site may also be created; in most cases, this would be associated with an area that was breached and returned to tidal action that subsequently became infested with non-native *Spartina*. A new "site" needs to be added if a new infestation is detected completely outside of previously codified treatment or inventory areas.

While numerous new sub-areas have been added over the years, they were within existing sites and within one kilometer of historic infestations and did not qualify as a new site. In 2016, the ISP confirmed a new hybrid *S. alterniflora* clone in the Suisun Region (Region 9, see section 2.2.9)[3], which resulted in creation of a new treatment site, Site 27, named Point Buckler after the island where it was found. In May and June 2017, the ISP surveyed extensively throughout the Suisun region to determine if there were other infestations in the area, and to identify the full scope of the problem. Surveys were conducted by foot, truck, and boat. The Grizzly Bay shoreline was surveyed by driving along shoreline roads, with biologists investigating all accessible areas for signs of hybrid *S. alterniflora*, and potential boat access points, which are very limited. Suisun Bay, Grizzly Bay, Honker Bay, and the Sherman Island area were surveyed by Boston Whaler over the course of several days. The preliminary inventory and scouting effort resulted in increasing the ISP's survey area by 16%, from 60,000 acres to nearly 70,000 acres.

No hybrid *S. alterniflora* was detected on the Grizzly Bay shoreline. However, populations of hybrid *S. alterniflora* were found on the neighboring islands to the south, owned by the Military Ocean Terminal Concord (MOTCO), especially around the perimeter of Snag Island (**Figure 24**). It was estimated, based on the size of these populations, that they had been present for at least 2-4 years, longer than the patch initially found at Point Buckler. With so many un-infested miles of shoreline between these newly discovered Suisun infestations, and the nearest hybrid *S. alterniflora* to the west at Southampton Marsh, it is expected that the introduction may have been through human actions (such as seeds or propagules on equipment) rather than naturally by the tides. There is virtually no native *Spartina foliosa* in this area of the Estuary except for small, scattered patches on the western edges of the MOTCO Islands and Simmons Island. Prior to the discovery of the new infestation, the ISP did not survey this far east due to the absence of any infestations detected along miles of shoreline between Southampton Marsh and Suisun, and the general lack of *Spartina* of any kind in this brackish area of the Estuary.

These new detections necessitated splitting Site 27 into three sub-areas and renaming the region Suisun Bay to indicate the expanded area it represents. The following sub-areas were created in 2017: Point Buckler (27a), MOTCO Islands (27b), and Honker Bay (27c) (see **Figure 16** for a map of the region). MOTCO Islands contained 97% of the overall Site 27 infestation in 2017 with a total net area of 269 m^2 (2114 m^2 treatment area) (**Table 14**). Honker Bay represented 3% with a total net area of 9 m^2 (117 m^2 treatment area), with Point Buckler less than 1%. By 2017, net cover at Point Buckler had already been reduced by 99% to 0.6 m^2, and treatment cover by 82% to 41 m^2.

By the end of 2018, the eastern extent of the infestation was comprised of a few small detections on the eastern shore of Honker Bay at the northern end of Chipps Island, with the next-nearest detection 2.5 km to the west. No hybrid *S. alterniflora* has been detected in the Browns Island or Sherman Island area to the east, or along the Pittsburg mainland shoreline.

[3] Previously reported in the 2015-2016 ISP Monitoring and Treatment Report, Section 3.

Figure 24. The original hybrid *S. alterniflora* infestation discovered at Snag Island in 2017 was composed of a dense fringe of especially tall cordgrass that represented 91% of the peak net cover for the three sub-areas of Site 27.

There is very little native *S. foliosa* fringe along the shoreline of Grizzly Bay east of I-680, which makes identification of hybrid *S. alterniflora* easier and removes the issue of further backcrossing to produce novel morphologies. Within the MOTCO Islands sub-area, *S. foliosa* is mostly relegated to the western shore of Ryer Island and Roe Island, and even there it has a minor presence with a scattered distribution. It manifests as a very short form along the wind and wave-swept western shores of these islands, in stark contrast to the tall hybrid *S. alterniflora* typically found in the area.

Two inventory and treatment seasons have passed since the broader detections in the Suisun Bay area. Scattered small patches have been detected and treated outside the immediate vicinity of the MOTCO Islands, but the surrounding area continues to appear free of hybrid *S. alterniflora*. Treatment has been very effective, and, as with detection, it is helped by there being very little native *S. foliosa* in the area to complicate treatment. After three seasons of treatment at Point Buckler, only a single stem of hybrid *S. alterniflora* was discovered and treated in 2018 (during a Round 2 trip to Suisun to complete MOTCO treatment). The biggest infestation around Snag Island was knocked back substantially in a single season with two treatments in 2017, leaving 11 m^2 net (336 m^2 treatment cover) detected and treated in 2018 (**Figure 25**). While the interior of several islands still needs to be further explored, there is a great deal of biotic resistance to invasion in those areas because of the presence of other dense brackish vegetation including *Phragmites*, *Typha*, *Bolboschoenus*, and *Schoenoplectus*. We are optimistic that the extent of the infestation has been generally defined and contained at this point. With reductions already at 96% net cover and 84% treatment cover after just a few years, this remote infestation is expectantly a relatively minor setback to ISP eradication efforts.

Figure 25. The footprint of the main hybrid *S. alterniflora* infestation on Snag Island during treatment in July 2018, reflecting a 96% reduction in net cover from the original infestation first discovered and treated in 2017 (Figure 24).

4. Considerations for 2019

Increased funding levels for 2019-2020 will allow the ISP to conduct both inventory and treatment at all historic infestation sites that don't have treatment restrictions. This includes resuming work at two large sub-areas within Bair Island Ecological Reserve, B2 North West (02.c1a) and B2 North South (02c.2), both of which received minimal inventory and treatment around the margins in 2018. In addition, treatment will resume at several previously restricted sites that were not treated in 2018 due to lack of contractor availability or because the Biological Opinion wasn't signed until after the target plants had senesced beyond the point of cost-effective treatment. This will result in a substantial increase in work for the Treatment Program and its contractors to add the large infestations in the previously restricted sites to an already full schedule.

Bunker Marsh (20g) within the Robert's Landing Complex will be fully treated by Marshmaster amphibious tracked vehicle and truck, to begin to reduce the 1.5 net acres of hybrid *S. alterniflora* that rebounded here since 2010. Full treatment will also resume at Cogswell Marsh B Bayfront (20n.1) to reduce the number of hybrid propagules re-infesting Cogswell A (20m), which has been under continuous treatment and is approaching zero detect. Cogswell A also contains established native *S. foliosa* (planted by ISP), and hundreds of meters of *Grindelia stricta* line the channel banks and provide habitat for Ridgway's rail. The meadows of hybrid *S. alterniflora* in Cogswell Marsh B Main (20n.3) will receive a seed suppression application by helicopter to further reduce propagule pressure in the area while maintaining the aboveground biomass for rails, as part of the phased treatment approach for Cogswell Marsh complex.

Resuming treatment in 2019 at the previously restricted sub-areas will begin to get those marshes back on an eradication trajectory and help to reduce the treatment burden at neighboring mudflats and marshes. Many sub-areas adjacent to the restricted sites were approaching eradication prior to 2011 and required a minimal investment for annual inventory and treatment at that time. In recent years these adjacent sub-areas have been swamped by hybrid propagules from the restricted sites, resulting in thousands of new plants each year establishing on the shoreline, mudflats, and distant marshes. Mapping and treating the annual infestation swell at these adjacent sub-areas, though critical, had the effect of drawing scarce resources away from work to protect other areas of the Estuary. The OEI in-house treatment program, initiated in 2016, proved effective in 2017-2018 at reducing treatment costs in many situations, including managing the annual flush of new seedlings at sub-areas near restricted sites. The capability of the in-house program will be expanded with addition of a truck-mounted spray rig and 300 feet of hose, which will extend this tool into sites that previously depended on the equipment of outside contractors.

During budget challenges of the past couple years, the ISP was not able to conduct as many second-round inventory and treatment events, which are critical for driving sites to Zero Detection (ZD) and achieving local eradication. In 2017, treating expanded populations caused by the increased rain left insufficient time and budget for the Round 2 treatment, and in 2018, reduced program funding resulted in cutting numerous aspects of the project, including Round 2 treatments. Sub-areas selected for two treatment rounds typically receive a first inventory survey early in the season to assess the historical infestation, detect any obvious new hybrid *S. alterniflora*, and take DNA samples for identifying more cryptic hybrid forms. The second survey then can detect hybrid *S. alterniflora* that developed later and can finally be differentiated from the surrounding native. These Round 2 detections can enable the ISP to

treat the new plants before they develop established roots and potentially produce hybrid seed, as opposed to waiting until the following year to implement any management actions. It will be a priority in 2019-2020 to revisit the persistent infestations that are approaching zero but have a very low level of infestation each year despite a lack of invasion pressure from neighboring sites. Identifying and eliminating the cryptic hybrid *S. alterniflora* within native *S. foliosa* at these sub-areas will help to accelerate the eradication timeline in much of the San Francisco Estuary.

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ISP Target Species Descriptions

There are one native and four non-native species of cordgrass in the San Francisco Estuary. The native species, Pacific cordgrass (*Spartina foliosa*), is avoided during treatment and is conserved by controlling the invasive species that can displace or genetically assimilate it. Key aspects of the cordgrass species found in the Estuary are contrasted below. All species and hybrids are perennial, salt-tolerant grasses that spread both sexually and asexually. The roles these species play in their native habitats give ecologists an indication of their potential to alter the salt marsh ecosystem of San Francisco Bay.

NATIVE: PACIFIC CORDGRASS (*SPARTINA FOLIOSA*)

California's only native cordgrass, *S. foliosa*, grows in a narrow range of the tidal spectrum due to its relatively short stature and intolerance for drought. *Spartina foliosa* is a vital component of the salt marsh plant community, occurring at the lowest intertidal elevation of any native macrophyte. This lower tidal marsh zone occurs at the upper elevation of the mudflat and along channel banks and benches. Native cordgrass is also found scattered throughout the next zone in the elevational gradient, the middle tidal marsh zone, or pickleweed (*Salicornia virginica*) marsh plain. *Spartina foliosa's* slender leafy shoots seldom exceed five feet in height including seed heads, with most shoots ranging from approximately one to three feet tall. Cordgrass height correlates with its tolerance of submersion, and as such *S. foliosa* can occupy only a limited range in the lower and middle tidal marsh zones (Cain and Harvey 1983). Its leaves and stems wither in fall and are shed in winter, as the clones die back to the mud substrate.

Spartina foliosa is particularly valued as habitat for the endangered California Ridgway's rail (*Rallus obsoletus obsoletus*), which spends most of its time foraging for food within, or close to, the protective canopy of cordgrass. California Ridgway's rails can move within S*. foliosa* stands, and they spend most of their time under cover of the cordgrass foliar canopy, usually selecting prey items such as benthic and aquatic invertebrates inhabiting the cordgrass stands and their edges. The benthic invertebrate community found in the substrate at the base of *S. foliosa* is also an important food source to a variety of other consumers including both resident and migratory shorebirds.

While it was widely recognized that hybrid *S. alterniflora* (discussed next) could potentially threaten the existence of native *S. foliosa*, control of the hybrids began sufficiently early that *S. foliosa* still anchors thousands of acres of tidal marsh throughout the Estuary. Most of the North Bay was relatively unimpacted by hybrid *S. alterniflora*, and more than 99% of the cordgrass in the remnant marshes throughout the Estuary is still intact *S. foliosa*. However, *S. foliosa* was assimilated into the hybrid swarm, and even locally extirpated, in some of the largest infestations around South San Francisco Bay, including the Alameda Flood Control Channel (Site 1) and Eden Landing (Site 13). These sites are the focus of an extensive reintroduction effort by the Conservancy that began in 2010, to establish stands of *S. foliosa* that will begin to disperse seeds throughout these sites, leveraging the investment in direct planting.

ATLANTIC SMOOTH CORDGRASS (*SPARTINA ALTERNIFLORA*) AND ITS HYBRIDS

Atlantic smooth cordgrass is unique among the world's cordgrass species in terms of its growth potential and ecological breadth. *Spartina alterniflora* is genetically very similar to *S. foliosa*, but the two species have significant differences. In size, growth rate, pollen and seed production, culm (stem) density and ecological tolerances, *S. alterniflora* is more robust than *S. foliosa* (Smart and Barko 1978; Boyer, Callaway et al. 2000). The San Francisco Estuary population of *S. alterniflora* was introduced from seed collected in Maryland in the early-1970s to aid in a dredge spoils stabilization and marsh restoration experiment (Faber 2000). Genetic similarity to *S. foliosa* allowed multiple hybridization and eventual backcrossing events that produced the "hybrid swarm" that has posed the most widespread and intrusive threat to the Estuary (Daehler and Strong 1997). Pollen production, higher fertility, greater tolerance for both inundation and drought, and increased timeframe for flowering make these hybrids a prominent threat to native cordgrass through outcompetition, pollen swamping, and hybrid assimilation (Rhymer and Simberloff 1996; Ayres, Garcia-Rossi et al. 1999; Anttila, King et al. 2000; Levin, Neira et al. 2006).

Hybrid *S. alterniflora* was well established and widely distributed in the Central and South Bay at the start of the ISP Control Program, but has been reduced by 95% bay-wide, down to 38 net acres[1] since its peak of 805 net acres in 2005.

When stands of *S. foliosa* are displaced by hybrid *S. alterniflora*, not only does the biomass of the benthic invertebrates decline by more than 70%, the benthic community also shifts from surface feeders to belowground feeders that are inaccessible to foraging birds (Levin et. al. 2006).

[1] The ISP uses the terms "net area" and "treatment area" to define the extent of non-native *Spartina*. *Net area* refers to the size of the infestation if the space between stems were subtracted from the overall footprint of the plant or clump of plants. Net area is the metric typically used in botanical surveys. *Treatment area* describes the area that will be directly affected by treatment. Treatment area is a separate measurement used for planning, and it is general 2 to 3 times greater than the net area of given instance of invasive *Spartina*.

CHILEAN CORDGRASS (*SPARTINA DENSIFLORA*) AND ITS HYBRID WITH PACIFIC CORDGRASS (*S. FOLIOSA*)

Chilean cordgrass (also called dense-flowered cordgrass) is a distinctive cordgrass species native to South America that grows as a bunchgrass in the middle marsh plain, eventually forming tussocks and meadows (Spicher and Josselyn 1985; Kittelson and Boyd 1997). *Spartina densiflora* was introduced to California in Humboldt Bay by dry ship ballast containing propagules from South American ports that traded lumber (Spicher and Josselyn 1985). Thought for most of the 20th century to be a form of Pacific cordgrass, *S. densiflora* was deliberately transplanted to a salt marsh restoration project at Creekside Park (4g) along Corte Madera Creek in Marin County in the 1970s. Within the salt marshes fringing Corte Madera Creek, it became a locally-dominant component of the middle and high salt marsh vegetation, displacing even robust pickleweed.

While the bulk of the *S. densiflora* invasion has been contained within Marin around the Corte Madera Creek watershed, other populations have been detected and largely eliminated in Redwood City (19s), Point Pinole Regional Shoreline (Site 10), Burlingame (19k & 19l), Tom's Point (25a) in Tomales Bay, and the shoreline of San Pablo Bay National Wildlife Refuge (26b). Most of the novel population establishments appear to have been the result of active planting by anonymous parties. When established in close proximity to *S. foliosa*, *S. densiflora* has produced infertile hybrids with the native cordgrass that spread solely via vegetative growth (Ayres, Zaremba et al. 2008).

By 2016, the population of *S. densiflora* had been reduced to 24 m^2 Estuary-wide, and 12.5 m^2 of the hybrid between *S. foliosa* and *S. densiflora* remained; both are reductions of more than 95% since the peak years for each. These successful reductions have been achieved through dedicated implementation of an adaptive Integrated Vegetation Management (IVM) strategy that includes multiple treatment methods. Because of the unique biology of this form of *Spartina*, any single-tool approach would have been ineffective. The efficacy of herbicide treatment (using imazapyr) varies widely between large plants and small plants, as well as between pioneering individuals and established stands. The seed bank viability of *S. densiflora* is estimated at 3 to 5 years (as compared to 1 to 1.5 years for *S. alterniflora*), which increases the time required for full eradication, even after an infestation is effectively reduced to just a few individuals. With these additional challenges, it is fortunate that *S. densiflora* appears to be somewhat limited in its ability to disperse around the San Francisco Bay ecosystem, and that the infestation has never approached the scale of hybrid *S. alterniflora*, which both consistently responds well to imazapyr treatment and has shorter seed viability.

ENGLISH CORDGRASS (*SPARTINA ANGLICA*)

English cordgrass is an aggressive invader of mudflats and salt marshes in Britain, New Zealand, Australia, and the Pacific Northwest, and thrives in cool temperate climates. It originated in Britain as a fertile hybrid derived from introduced Atlantic smooth cordgrass and common cordgrass (*S. maritima*). It was introduced to the San Francisco Estuary at Creekside Park (4g) along Corte Madera Creek in Marin

County, along with Chilean cordgrass (*S. densiflora*), in 1976. Unlike Atlantic smooth cordgrass and Chilean cordgrass, this species failed to disperse from its point of introduction to expand the infestation beyond Creekside Park. It may be at or near its southern climatic limit on the Pacific Coast in the Estuary.

Spartina anglica is nearly eradicated from San Francisco Bay, and it is not known to occur in any other location in California. The ISP mapped just 8.3 m^2 of *S. anglica* in 2016. There are several factors that contributed to this infestation lingering longer than might be expected given its relatively small size and presence at only a single ISP site. *Spartina anglica* flowers and sets seed in early summer, slightly later than *S. densiflora* but far ahead of hybrid *S. alterniflora*. This phenology did not allow for treatment ahead of seed dispersal prior to 2008, when ISP was first permitted to enter the sites before California clapper rail breeding season ends on September 1. In addition, there were several other years where either delayed permits (2011 and 2012 Biological Opinions) or political concerns (delays with Marin County finalizing its revised IPM Policy in 2009) caused the implementing ISP partner, Friends of Corte Madera Creek Watershed, to miss the optimal treatment window for that year. Finally, the remaining *S. anglica* at Creekside Park is often found growing as a short understory to the native *S. foliosa* that lines the main channel, which limited the full detection of the target plants, and the desire to preserve as much of the native cordgrass as possible further complicated the matter.

SALT-MEADOW CORDGRASS (*SPARTINA PATENS*)

In its native range on the Atlantic coast, salt-meadow cordgrass is naturally restricted to the well-drained high salt marsh and relatively moist sandy depressions at or above tidal influence. However, in the San Francisco Estuary, it has thrived along channel banks and on the pickleweed plain. *Spartina patens* arrived in the Estuary by the early 1960s in Southampton Marsh (Site 11; Benicia State Recreation Area), as evidenced by a sample present in the California Academy of Science's collection from circa 1962. At the initiation of treatment by ISP and the California Department of Parks and Recreation (State Parks), 0.65 net acre of salt-meadow cordgrass was present in large, discrete patches at Southampton Marsh. In 2014, the net cover was only 75 m^2, and treatment was reinitiated after three years of hiatus due to complications related to the presence of three special status species. In 2016 a total of 35 m^2 of net cover was mapped by ISP biologists.

Spartina patens has spread into an area of Southampton Marsh that supports a population of an endangered annual hemi-parasitic plant, soft bird's-beak (*Chloropyron molle* ssp. *molle,* formerly *Cordylanthus mollis ssp. mollis*). The treatment approach initially approved and used in this area of the marsh was to treat the *S. patens* stands with herbicide in the late fall, after the soft bird's beak had produced seed and senesced, so that the treatment would not negatively affect the soft

bird's beak population. However, *S. patens* itself flowers in May at that location, and by the time herbicide was applied in October, the *S. patens* plants had also already produced seed and begun senescing. When a plant senesces it is no longer able to uptake and translocate the herbicide, processes that are necessary to kill the plant. It soon was clear that no additional headway was being made toward eradication of *S. patens*.

In 2011, the ISP worked with rare plant researcher Brenda Grewell (USDA-ARS) and State Parks to develop a new eradication plan to address the shortcomings of the earlier plan. The new plan permits limited, temporary impacts to *C. molle* ssp. *molle e* so that the *S. patens* can be treated effectively, and may include collecting and banking seed from the hemi-parasite to sow once *S. patens* has been eradicated and native host plants reestablished.

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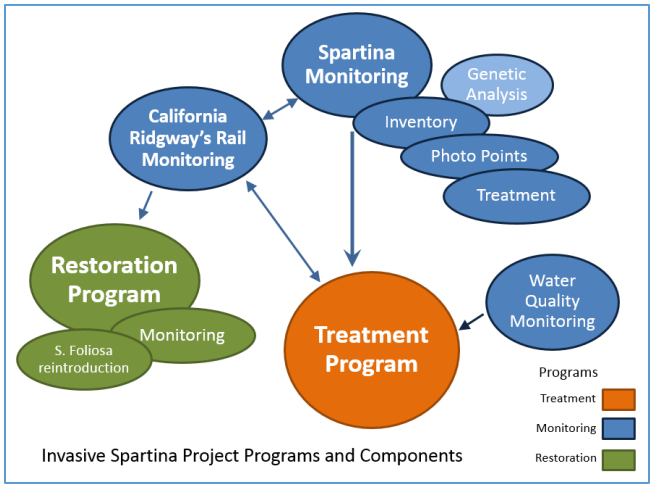
Invasive *Spartina* Project Programs

The ISP is comprised of three broad programs– treatment, monitoring, and restoration, which coordinate closely to achieve the ISP goals. Monitoring is comprised of several programs including *Spartina* inventory monitoring, treatment monitoring, California Ridgway's (formerly "clapper") rail monitoring, and water quality monitoring. Important tools within the monitoring programs are genetic sampling and analysis of *Spartina,* and photo point monitoring. The many programs work together to assure and document an effective regional treatment effort, while protecting water quality, wildlife, and the ecosystem structure. The status of each of the program areas is provided below.



Invasive Spartina Project Programs and Components

TREATMENT PROGRAM

The Treatment Program coordinates a multitude of contractors, agencies, landowners, and staff to plan and conduct annual treatment of the various non-native *Spartina* species found throughout the Estuary. Pilot efforts to test herbicide methods and coordination mechanisms began in 2004, when the total known footprint of non-native *Spartina* was at that time 758 acres. In 2005, the ISP partners began coordinated, Estuary-wide treatment. Treatment initially focused on large infestations and areas where partners were most ready to begin work, and expanded to include the total of sites in 2006 and 2007. Aerial broadcast treatment by helicopter at several of the large hybrid *Spartina* monocultures of the central and south bay soon effectively reversed the spread of hybrid *Spartina* and established control over the infestations. Once continuous meadows of hybrid *Spartina* at sites like Alameda Flood Control Channel (Site 1), Eden Landing Ecological Reserve (Site 13) in Union City, and Seal Slough (19p) in San Mateo, were reduced to a patchy distribution of plants across each site, the herbicide methods were shifted away from broadcast spray to use of amphibious tracked vehicles on the mudflats and marsh plain, and hauling hose from trucks staged on surrounding levees to accessible marshes. Smaller infestations were treated by applicators with backpack sprayers walking through the marsh, as well as by manual removal of isolated seedlings. *Spartina densiflora*, a species that grows in a bunchgrass form and doesn't spread significantly by rhizome, was effectively controlled by a strategic combination of herbicide application and digging (see Chilean Cordgrass description in Appendix 1).

After several years of regionally coordinated control work, the character of the infestations had changed. Very large meadows of non-native *Spartina* were rare, replaced by sparse infestations spread over larger areas that were more difficult to locate and access. New outlier populations were being discovered in more remote areas of the Estuary. By 2008, the ISP began to experiment with utilizing airboats on the open mud to allow treatment during low tide, thus maximizing herbicide dry time. The airboats were also used to deploy personnel with backpacks onto the marsh plain of islands and other sites

that were inaccessible by land. By 2009, this approach was employed for treatment throughout Don Edwards San Francisco Bay National Wildlife Refuge (DENWR), and by 2012 there were as many as four airboats on a given day working on hybrid *Spartina* treatment around the Estuary. While the use of airboats in this way is essential for accessing difficult areas at this stage, the vast majority of herbicide treatment is conducted by trained personnel walking through the marsh with backpack herbicide sprayers.

Similarly, there have been shifts in methodology for *S. densiflora* treatment. By 2012, all sites were using manual removal as the primary technique, with only two sites still requiring an early season application of herbicide to stop seed production until digging could be implemented after California Ridgway's rail breeding season. Mowing was also an important technique used early on in combination with other treatment methods at sites with meadows of *S. densiflora*, but the reductions achieved through the successful implementation of the adaptive IPM strategies allowed Friends of Corte Madera Creek to discontinue mowing in 2012. Control methods used in 2016 are listed by sub-area in each of the Reporting Region tables in the accompanying report.

MONITORING PROGRAM

Inventory Monitoring

The ISP began Estuary-wide inventory monitoring of invasive *Spartina* in 2000, with annual monitoring of all known infestation sites beginning in 2004. The original geographic scope of inventory monitoring was limited to the bayward side of most major highways (Hogle 2008). Since 2006, all potential invasive *Spartina* habitat identified within the San Francisco Estuary and tidal tributaries, Bolinas Lagoon, Point Reyes National Seashore, and Tomales Bay has been surveyed by ISP biologists or its partners. This includes annual surveys over 50,000 acres of tidal marsh and mudflat throughout the Estuary and Outer Coast areas. The inventory area is shown in Section 2.1 of the 2014 Monitoring and Treatment Report. While the area inventoried covers some large remnant marshes as well as many fringe marshes, it also includes miles of flood control channels and many small fragmented marshes, channels and drainage ditches in a matrix of highly urbanized land use.

Inventory monitoring is conducted for two purposes: to track change in the extent and net cover of the infestation over time for analyzing and reporting, and to locate and map patches of invasive *Spartina* to inform management and coordination of Treatment Program operations. The ISP typically completes inventory of sites prior to treatment (generally from May through October) to allow for the most efficient use of time and personnel during limited treatment windows. Minimizing time in the marsh during treatment also serves to minimize potential disturbance to marsh plants and animals. Data is collected using global positioning system (GPS) and managed using a Geographic Information System (GIS).

Since 2008, all monitoring has been conducted on the ground or by helicopter for select large and remote sites where large patches of infestation persist. Ground mapping is done mostly on foot, but also by kayak and motorized boats when surveying islands, extensive shorelines, and lengthy waterways. 2012 was the last year that ISP conducted monitoring by helicopter due to its inherent decrease in precision as compared to ground mapping. As of 2013, all sites previously monitored by helicopter have been reduced to a lower status of infestation level and warrant more detailed ground mapping.

A history of the evolution of the ISP Monitoring Program between 2000 and 2012 (Zaremba and Hogle, in progress) is also available on the ISP website (http://www.spartina.org/project.htm).

Genetic Sampling and Analysis

Genetic analysis is a necessary tool for all of the ISP programs. *Spartina* leaf samples are collected and genetically analyzed to distinguish plants with native vs. non-native ancestry. Staff collect leaf samples from *S. foliosa* and hybrid *S. alterniflora* to verify identification of select plants, guide treatment practices, and keep an eye on new or changing plant morphologies. A genetic sampling plan is developed internally each season to address questions posed by the Treatment and Restoration programs and assure efficient use of limited laboratory resources. Samples are shipped to a commercial laboratory for extraction, and then sent to the UCLA Human Genomics Laboratory, where they are analyzed using Simple Sequence Repeats (SSRs; aka "microsatellites") and scored. The laboratory used fifteen SSR loci during the 2018 monitoring season. The ISP analyzes the data from UCLA using the software package Structure (Pritchard Lab, Stanford University) to determine, for every sampled plant, the likelihood of it being descended from *S. alterniflora* ancestry. The ISP incorporates these results into the program's GIS layers for further analysis and for reference in the field during future treatment and inventory events. Over 6,500 plants have been collected and analyzed in this manner since 2010, allowing the identification and treatment of many otherwise morphologically indistinct hybrid *S. alterniflora* plants throughout the Estuary.

More information regarding the genetic sampling program is available in the Monitoring Program Quality Assurance Document (http://www.spartina.org/project_documents/QAD_2009_Update_All.pdf) and the ISP *Spartina* Monitoring Program Approach report referenced above.

Photo Point Monitoring

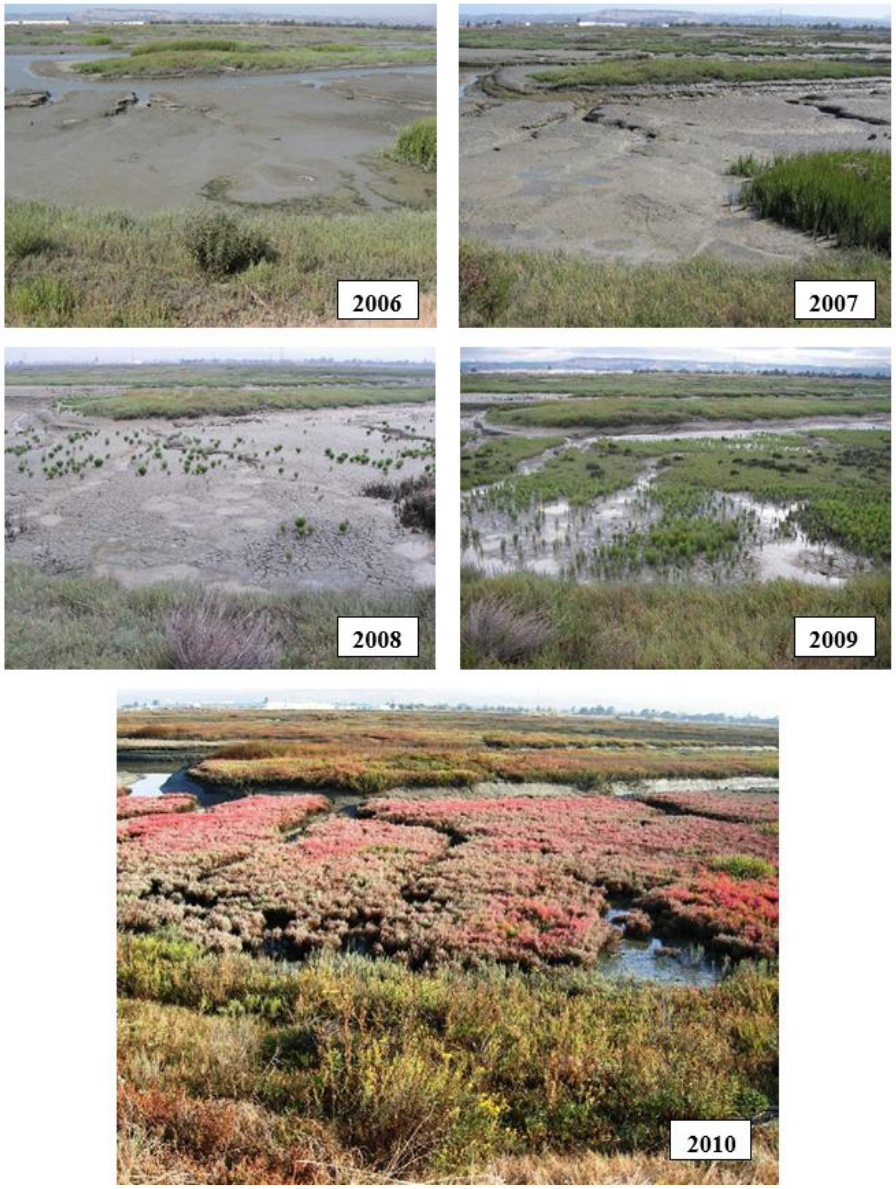
Another tool used by the Treatment and Monitoring Programs is photo point monitoring. The ISP established and has maintained 93 permanent locations within 51 sub-areas from which staff take consistent photos twice annually to qualitatively monitor marsh changes between seasons and years. Photo points are used to inform the extent of the next treatment effort and to visually document the changes in vegetation occurring at the sites. Visible changes often include rapid disappearance of large areas of non-native *Spartina* within one to three seasons of treatment, passive (and frequently rapid) establishment of native vegetation, and expansion or "rebounding" of hybrid *Spartina* populations when treatment is missed or restricted for one or more seasons.

The intra- and inter-annual visual comparisons of marsh composition are useful to the ISP for monitoring treatment efficacy and for presenting local trends to outside parties. These photos are especially useful to illustrate different marsh trajectories when comparing sites with continuous full treatment with those where treatment was absent or incomplete, as has happened since 2011 in 11 sub-areas a result of permit restrictions. An example of photo point data is provided on the **next page.** Also, all ISP Photo Point photos are available on the web, through Google Maps and Picasa Web Albums, at http://maps.google.com/maps/ms?ie=UTF8&hl=en&msa=0&msid=212795091225976478689.00049ce382daadf691d97&t=h&z=10.

Treatment Monitoring

The ISP began monitoring all treatment events in 2009. Treatment monitoring involves pairing ISP personnel with the agency or private contractor treatment crews to accomplish the following important objectives: (1) assure protection of California Ridgway's rails and other sensitive species during treatment activities; (2) enhance conservation of native *S. foliosa* that may be present by delimiting it in no-treatment areas for the crew; (3) substantially improve the ability for crews to locate and target plants for treatment by leading them to less obvious plants requiring treatment; and (4) document completed

treatment in real time at the patch level. As previously mapped *Spartina* locations are revisited, ISP staff update the map features using GPS data loggers to reflect the day's treatment action (e.g. "treated," "not treated," "sub-optimally treated" etc.). This data is uploaded daily to the ISP's ArcGIS geodatabase for use in the field the next day. Accompanying treatment crews also allows ISP staff to identify, mapping, and concurrently record treatment of patches of invasive *Spartina* that had not been detected during initial inventory monitoring. Treatment monitoring is perhaps the most important of the ISP's new programmatic initiatives, allowing ISP partners to gain ground on the remaining substantial infestations in the West Bay, and greatly accelerating the rate at which eradication may be achieved at all sites.



An example of photo point monitoring data showing habitat transition over several years.

Since the timing of inventory and treatment overlap from mid-July through November, the ISP hires additional seasonal staff to conduct treatment monitoring at suitable sites – that is, at sites where native *Spartina* is not present, where hybrid *Spartina* has been recently mapped by more experienced staff, or where native and hybrid morphologies are sufficiently distinct to allow the interns to make consistently correct determinations. More experienced biologists are thus reserved to inventory and monitor treatment at more complex sites.

California Ridgway's Rail Monitoring

Implementation of *Spartina* control measures requires annual breeding season surveys of the endangered California Ridgway's rail (*Rallus obsoletus obsoletus*) in marshes affected by the invasion and management of non-native *Spartina*. Annual breeding season surveys provide a standardized measure of Ridgway's rail presence and distribution in marshes throughout the Estuary. This information guides the

ISP in the planning, permitting, and implementation of treatment strategies and helps to minimize the impacts of *Spartina* control on rail populations. Results from California Ridgway's rail surveys help determine the time of year in which ISP monitoring staff and treatment contractors will enter a site so as to not disturb birds present during their breeding season, and are used by USFWS and others for making decisions regarding the ISP program.

Water Quality Monitoring

The application of herbicide for *Spartina* control is covered under the Statewide General National Pollutant Discharge Elimination System (NPDES) Permit for Application of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States (General Permit No. CAG990005; www.swrcb.ca.gov/water_issues/programs/npdes/docs/aquatic/permit.pdf). To obtain coverage under this permit, each grantee or other ISP partner that will be applying herbicide must submit a Notice of Intent (NOI) to comply with the terms of the General Permit and an annual fee to the Regional Water Quality Control Board (RWQCB). The permit requires preparation of an Aquatic Pesticide Application Plan (APAP) that includes a Water Quality Monitoring Plan (WQMP), which must be updated annually as needed. The ISP arranged with the State Water Resources Control Board and the San Francisco Bay RWQCB to allow the ISP to prepare and implement a programmatic APAP and WQMP on behalf of the ISP partners who submitted NOIs. The ISP prepared a programmatic APAP in 2006 and updated it in 2015, which is available on the ISP website at http://www.spartina.org/documents/2015_ISP_APAP_wAppendices.pdf.

As with many substances, there are no State or Federal numeric water quality objectives or limits established for imazapyr herbicide; therefore, concentrations are compared to tested toxicity and effects levels found in the literature. In 2013, concentrations of imazapyr herbicide measured immediately following treatment events were two to four orders of magnitude below those reported in the literature as a concern to humans or the animals that inhabit the tidal marsh ecosystem. Imazapyr is not persistent in the aquatic environment because it is rapidly degraded by sunlight; thus, as expected, the one-week post-treatment samples with any residual herbicide detected showed a mean reduction of 91.4% of the treatment event levels. Details regarding sampling and analysis methods and the monitoring results are provided in the 2017 Water Quality Monitoring Report (Kerr 2013).

The ISP commissioned a focused review of imazapyr herbicide in 2005, prior to adopting it into the Treatment Program. The review, *The use of Imazapyr Herbicide to Control Invasive Cordgrass (Spartina spp.) in the San Francisco Estuary: Water Quality, Biological Resources, and Human Health and Safety (Leson & Associates 2005)*, is on the ISP website at www.spartina.org/project_documents. The Conservancy's findings under CEQA may be found at www.spartina.org/2005Addendum.htm.

RESTORATION PROGRAM

The Restoration Program was initiated in 2011 to rapidly establish habitat features to benefit California Ridgway's rails in areas where recent removal of non-native *Spartina* has caused decreases in Ridgway's rail habitat. The plan for the program is contained in the California Clapper Rail Habitat Enhancement, Restoration and Monitoring Plan (Olofson Environmental, Inc. 2012). As part of the plan, the Conservancy and other regional ISP partners are employing several habitat enhancement methods including construction of high tide refuge islands, deployment of artificial floating nesting islands, and extensive revegetation, focusing on native tidal marsh plant species that provide foraging, breeding, and high tide refuge cover.

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Summary of Areas Surveyed for Invasive Spartina in 2017 and 2018

2017				2018			
2017 Sub-area	**2017 Sub-area Name**	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
REGION 1: MARIN							
03a	Blackie's Creek (above bridge)	Complete		03a	Blackie's Creek (above bridge)	Complete	
03b	Blackie's Creek Mouth	Complete		03b	Blackie's Creek Mouth	Complete	
04a	Corte Madera Ecological Reserve	Partial	Historical only	04a	Corte Madera Ecological Reserve	Partial	Historical only
04b	College of Marin Ecological Study Area	Complete		04b	College of Marin Ecological Study Area	None	
04c	Piper Park East	Complete		04c	Piper Park East	None	
04d	Piper Park West	Complete		04d	Piper Park West	None	
04e	Larkspur Ferry Landing Area	Complete		04e	Larkspur Ferry Landing Area	Complete	
04f	Riviera Circle	Complete		04f	Riviera Circle	Complete	
04g	Creekside Park	Complete		04g	Creekside Park	Complete	
04h	Upper Corte Madera Creek (Above Bon Air Rd)	Complete		04h	Upper Corte Madera Creek (Above Bon Air Rd)	Complete	
04i	Lower Corte Madera Creek (Bon Air Rd to HWY 101)	Complete		04i	Lower Corte Madera Creek (Bon Air Rd to HWY 101)	Complete	
04j.1	Corte Madera Creek Mouth - North Bank	Complete		04j.1	Corte Madera Creek Mouth - North Bank	Complete	
04j.2	Corte Madera Creek Mouth - South Bank	Complete		04j.2	Corte Madera Creek Mouth - South Bank	Complete	
04k	Boardwalk No. 1 (Arkites)	Complete		04k	Boardwalk No. 1 (Arkites)	Complete	
04l	Murphy Creek	Complete		04l	Murphy Creek	None	
09	Tiscornia Marsh / Pickleweed Park	Complete		09	Tiscornia Marsh / Pickleweed Park	Complete	
23a	Brickyard Cove	Partial	Historical only	23a	Brickyard Cove	Partial	Historical only
23b	Beach Drive	Complete		23b	Beach Drive	Complete	
23c	Loch Lomond Marina	Complete		23c	Loch Lomond Marina	Complete	
23d.1	San Rafael Canal Mouth East	Complete		23d.1	San Rafael Canal Mouth East	Complete	
23d.2	San Rafael Canal Mouth West	Complete		23d.2	San Rafael Canal Mouth West	Complete	
23e	Muzzi and Martas Marsh	Partial	Inner/upland side of Muzzi to be briefly inventoried	23e	Muzzi and Martas Marsh	Partial	**Upper Muzzi** Historics only during DS; **Lower Muzzi** Historics and shoreline only **Marta's** Complete
23f	Paradise Cay	Complete		23f	Paradise Cay	Partial	
23g	Greenwood Cove	Complete		23g	Greenwood Cove	None	
23h	Strawberry Point	Complete		23h	Strawberry Point	Complete	
23i	Strawberry Cove	Complete	early season and intense inventory	23i	Strawberry Cove	Complete	early season and intense inventory
23j	Bothin Marsh	Partial	Historical and northern marsh only	23j	Bothin Marsh	Partial	Historics only
23k	Sausalito	Partial	Historical only in 2017. Zero detect since 2015. Thorough survey 2016.	23k	Sausalito	Partial	Historic location only in 2018. Zero detect since 2015. Thorough survey 2016.
23l	Starkweather Park	Complete		23l	Starkweather Park	None	

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
23m	Novato	Partial	**Gallinas Creek** watershed throughly surveyed 2016 and not to be surveyed 2017 **Novato Shoreline-North** historics only **Novato Shoreline - South and McInnis** none	23m	Novato	Partial	**Gallinas Creek** not surveyed; rest of watershed thoroughly surveyed 2016 and not to be surveyed 2018 **Novato Shoreline-North** surveyed by CDFA airboat **Novato Shoreline - South and McInnis** surveyed by CDFA airboat
23n	Triangle Marsh and shoreline	Complete		23n	Triangle Marsh and shoreline	Complete	
23o	China Camp	Complete		23o	China Camp	Partial	Full inventory 2017
n/a	Hamilton Airforce Base	Complete	Inventoried on foot; no CDFA airboat available 2017	n/a	Hamilton Airforce Base	Complete	surveyed by CDFA airboat
n/a	Fort Baker	No Survey: Low Risk of Infestation > 3.5 km	Not since 2012	n/a	Fort Baker	None	Not since 2012
n/a	Tiburon	Complete	Not surveyed in since 2011. Survey by whaler	n/a	Tiburon	None	Surveyed 2017 by whaler
n/a	Bel Marin Keys	Complete		n/a	Bel Marin Keys	None	
n/a	East Marin Island	Complete	Survey by whaler	n/a	East Marin Island	None	Surveyed 2017 by whaler
n/a	Point San Pedro	Complete	Survey by whaler	n/a	Point San Pedro	None	Surveyed 2017 by whaler
n/a	Point San Quentin	No Survey: suboptimal habitat	Not surveyed in since 2011	n/a	Point San Quentin	None	Not surveyed in since 2011
REGION 2: SAN FRANCISCO PENINSULA							
12a	Pier 94	Complete		12a	Pier 94	Complete	
12b	Pier 98 / Heron's Head	Complete		12b	Pier 98 / Heron's Head	Complete	
12c	India Basin	Complete		12c	India Basin	Partial	
12d	Hunters Point Naval Reserve	Complete		12d	Hunters Point Naval Reserve	Partial	**Western embayment** (historical zone) scanned with binoculars from across cove
12e	Yosemite Channel	Complete		12e	Yosemite Channel	Complete	
12f	Candlestick Cove	Complete		12f	Candlestick Cove	Complete	+R2
12g	Crissy Field	Partial	Historic only	12g	Crissy Field	Partial	Historic only
12h	Yerba Buena Island	Partial	**Angel Island** survey by whaler **Yerba Buena Island** partial survey of historic infestation. No complete (no habitat) since 2011.	12h	Yerba Buena Island	Partial	**Angel Island** none **Yerba Buena Island** partial survey of historic infestation. No complete (no habitat) since 2011.
12i	Mission Creek	Complete		12i	Mission Creek	Complete	+R2
18a	Colma Creek	Complete		18a	Colma Creek	Complete	+R2
18b	Navigable Slough	Complete		18b	Navigable Slough	Complete	+R2
18c	Old Shipyard	Complete		18c	Old Shipyard	Complete	+R2
18d	Inner Harbor	Complete		18d	Inner Harbor	Complete	+R2
18e	Sam Trans Peninsula	Complete		18e	Sam Trans Peninsula	Complete	+R2
18f	Confluence Marsh	Complete		18f	Confluence Marsh	Complete	+R2
18g	San Bruno Marsh	Complete		18g	San Bruno Marsh	Complete	+R2
18h	San Bruno Creek	Complete		18h	San Bruno Creek	Complete	+R2
19a	Brisbane Lagoon	Complete		19a	Brisbane Lagoon	Complete	+R2

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
19b	Sierra Point	Complete		19b	Sierra Point	Complete	+R2
19c	Oyster Cove	Complete		19c	Oyster Cove	Complete	+R2
19d	Oyster Point Marina	Complete		19d	Oyster Point Marina	Complete	+R2
19e	Oyster Point Park	Complete		19e	Oyster Point Park	Complete	+R2
19f	Point San Bruno	Complete		19f	Point San Bruno	Complete	+R2
19g	Seaplane Harbor	Partial	Actual harbor only partially walked 2017	19g	Seaplane Harbor	Complete	
19h	SFO	Complete		19h	SFO	Complete	
19i	Mills Creek Mouth	Complete		19i	Mills Creek Mouth	Partial	2018 inventory of everything on the bayward side on US-101
19j	Easton Creek Mouth	Complete		19j	Easton Creek Mouth	Partial	2018 inventory of everything on the bayward side on US-101
19k	Sanchez Marsh	Complete		19k	Sanchez Marsh	Complete	
19l	Burlingame Lagoon	Complete		19l	Burlingame Lagoon	Complete	
19m	Fisherman's Park	Complete		19m	Fisherman's Park	None	
19n	Coyote Point Marina / Marsh	Complete		19n	Coyote Point Marina / Marsh	Complete	
19o	San Mateo Creek / Ryder Park	Complete		19o	San Mateo Creek / Ryder Park	Complete	
19p	Seal Slough Mouth - Central Marsh	Complete		19p	Seal Slough Mouth - Central Marsh	Complete	
19p	Seal Slough Mouth - Peripheral Marshes	Complete		19p	Seal Slough Mouth - Peripheral Marshes	Complete	
19r	Anza Lagoon	Complete		19r	Anza Lagoon	Complete	
REGION 3: SAN MATEO							
02a.1a	Belmont Slough Mouth	Complete		02a.1a	Belmont Slough Mouth	Complete	
02a.1b	Belmont Slough Mouth South	Complete		02a.1b	Belmont Slough Mouth South	Complete	
02a.2	Upper Belmont Slough and Redwood Shores	Complete	interior shorelines not thoroughly inventoried since 2012	02a.2	Upper Belmont Slough and Redwood Shores	Partial	interior shorelines not surveyed (thoroughly inventoried in 2017)
02a.3	Bird Island	Complete		02a.3	Bird Island	Complete	
02a.4	Redwood Shores Mitigation Bank	Complete		02a.4	Redwood Shores Mitigation Bank	Partial	**Shoreline** complete **Islands** scanned with binoculars
02b.1	Corkscrew Slough	Complete		02b.1	Corkscrew Slough	Complete	
02b.2	Steinberger Slough South, Redwood Creek Northwest	Complete		02b.2	Steinberger Slough South, Redwood Creek Northwest	Complete	
02c.1a	B2 North Quadrant West	Complete		02c.1a	B2 North Quadrant West	Partial	**Eastern islands** none **Interior tracking polys** none **Sponge and blue tracking poly to nort**h complete **NW and reveg zones** complete
02c.1b	B2 North Quadrant East	Grid	need grid survey for Seed Suppr. data	02c.1b	B2 North Quadrant East	None	
02c.2	B2 North Quadrant South	Complete		02c.2	B2 North Quadrant South	Partial	**Southern orange tracking poly** complete **NW grey and partial green tracking poly** complete **The rest** none
02d.1a	B2 South Quadrant West	Complete		02d.1a	B2 South Quadrant West	Complete	
02d.1b	B2 South Quadrant East	Complete		02d.1b	B2 South Quadrant East	Complete	
02d.2	B2 South Quadrant (2)	Complete		02d.2	B2 South Quadrant (2)	Complete	

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
02d.3	B2 South Quadrant (3)	Partial	primarily historical	02d.3	B2 South Quadrant (3)	Partial	
02e	West Point Slough NW	Complete		02e	West Point Slough NW	Complete	
02f	Greco Island North	Complete		02f	Greco Island North	Complete	
02g	West Point Slough SW and East	Complete		02g	West Point Slough SW and East	Complete	
02h	Greco Island South	Complete		02h	Greco Island South	Complete	
02i	Ravenswood Slough and Mouth	Complete		02i	Ravenswood Slough and Mouth	Complete	
02j.1	Ravenswood Open Space Preserve (N of Hwy 92)	Complete		02j.1	Ravenswood Open Space Preserve (N of Hwy 92)	Complete	
02k	Redwood Creek and Deepwater Slough	Complete		02k	Redwood Creek and Deepwater Slough	Partial	Northern 2/3 complete Southern 1/3 none
02l	Inner Bair	Complete		02l	Inner Bair	Complete	
02m	Pond B3	Complete		02m	Pond B3	Coarse	survey with AEI airboat during treatment
02o	Central Bair	Complete	survey with SMCMVCD airboat during treatment	02o	Central Bair	Coarse; Partial	surveyed with SMCMVCD airboat during treatment--incomplete
19q	Foster City	Complete		19q	Foster City	Complete	
19s	Maple Street Channel	Partial	partial due to encampments	19s	Maple Street Channel	None	Densi dig in June
REGION 4: DUMBARTON SOUTH							
02j.2	Ravenswood Open Space Preserve (S of Hwy 92)	Complete		02j.2	Ravenswood Open Space Preserve (S of Hwy 92)	Complete	
02n	SF2	Complete		02n	SF2	Partial	
05a.1	Mowry Marsh and Slough	Partial	**Mowry Marsh** only surveyed by early season fringe; no main marsh survey due to senescence **Mowry Slough** complete **Mowry-Calaveras Strip Marsh** complete	05a.1	Mowry Marsh and Slough	Complete	**Mowry Marsh** only surveyed by early season fringe; no main marsh survey due to senescence in 2017 **Mowry Slough** complete **Mowry-Calaveras Strip Marsh** complete
05a.2	Calaveras Marsh	Complete		05a.2	Calaveras Marsh	Complete	**Fringe** full **Interior** complete, though only visiting historics within upper half
05b	Dumbarton/Audubon	Complete		05b	Dumbarton/Audubon	Partial	Full fringe treatment **Dumbarton** full fringe, otherwise limited to historic zones **Audubon** limited to historic zones **Railroad/Barge** limited to historic zones **Plummer Creek** full
05c.1	Newark Slough West	Complete		05c.1	Newark Slough West	Complete	Inventory and treat on fly via airboat
05c.2	Newark Slough East	Complete		05c.2	Newark Slough East	Complete	
05d	LaRiviere Marsh	Complete		05d	LaRiviere Marsh	Partial	
05e	Mayhew's Landing	Complete		05e	Mayhew's Landing	Partial	
05f	Coyote Creek - Alameda County	Partial	To be partially surveyed within 1 km of 2016 infestation	05f	Coyote Creek - Alameda County	Partial	To be partially surveyed within 1 km of 2017 infestation
05g	Cargill Pond (W Hotel)	Complete		05g	Cargill Pond (W Hotel)	Complete	
05h	Plummer Creek Mitigation Marsh	Complete		05h	Plummer Creek Mitigation Marsh	Complete	
05i	Island Ponds	Complete		05i	Island Ponds	Partial	**A19** complete **A20** not inventorying in 2018 **A21** complete

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
08	Palo Alto Baylands	Complete		08	Palo Alto Baylands	Complete	**SE Hooks** complete **Embarcadero Islands** complete + early fringe **Palo Alto Harbor** complete + early fringe **Harriet Mundy** inventory w/treatment
15a.1	Charleston Slough to Mountainview Slough	Complete		15a.1	Charleston Slough to Mountainview Slough	Full	
15a.2	Stevens Ck to Guadalupe Sl	Complete		15a.2	Stevens Ck to Guadalupe Sl	Full	
15a.3	Guadalupe Slough	Complete		15a.3	Guadalupe Slough	Partial	
15a.4	Alviso Slough	Complete		15a.4	Alviso Slough	Coarse; Full	**Ogilvie** full coarse inventory early season **Coyote Mainland** full coarse inventory early season **Knapp Tract** full **Alviso** partial, historics
15a.5	Coyote Creek to Artesian Slough	Partial	To be partially surveyed within 1 km of 2016 infestation	15a.5	Coyote Creek to Artesian Slough	Partial	Surveyed within 1 km of 2017 infestation
15a.6	Knapp Tract	Complete		15a.6	Knapp Tract	Complete	
15a.7	Pond A17	Partial	Perimeter walked in 2017; interior never surveyed	15a.7	Pond A17	Complete	
15b	Faber / Laumeister Marsh	Complete		15b	Faber / Laumeister Marsh	Complete	
15c	Shoreline Regional Park	Complete		15c	Shoreline Regional Park	Complete	
16.1	Cooley Landing Central	Complete		16.1	Cooley Landing Central	Complete	
16.2	Cooley Landing West	Complete		16.2	Cooley Landing East	Complete	
n/a	Ponds A5, A7, A8, A8S	None	Perimeter walked 2016; no tidal action since 2015	n/a	Ponds A5, A7, A8, A8S	None	Perimeter walked 2016; no tidal action since 2015
REGION 5: UNION CITY							
01a	Channel Mouth	Complete		01a	Channel Mouth	Complete	+R2
01b	Lower Channel	Complete		01b	Lower Channel	Complete	+R2
01c	Upper Channel	Complete		01c	Upper Channel	Complete	+R2
01d	Upper Channel - Union City Blvd to I-880	Complete		01d	Upper Channel - Union City Blvd to I-880	Complete	
01e	Strip Marsh No. of Channel Mouth	Complete		01e	Strip Marsh No. of Channel Mouth	Complete	
01f	Pond 3 - AFCC	Complete		01f	Pond 3 - AFCC	Complete	
13a	Old Alameda Creek North Bank	Complete		13a	Old Alameda Creek North Bank	Complete	downstream of E9 breaches, done with E9
13b	Old Alameda Creek Island	Complete		13b	Old Alameda Creek Island	Complete	
13c	Old Alameda Creek South Bank	Complete		13c	Old Alameda Creek South Bank	Complete	
13d	Whale's Tail North Fluke	Complete		13d	Whale's Tail North Fluke	Complete	
13e	Whale's Tail South Fluke	Complete		13e	Whale's Tail South Fluke	Complete	
13f	Cargill Mitigation Marsh	Complete		13f	Cargill Mitigation Marsh	Complete	
13g	Upstream of 20 Tide Gates	Complete		13g	Upstream of 20 Tide Gates	None	
13h	Eden Landing - North Creek	Complete		13h	Eden Landing - North Creek	Complete	+R2
13i	Eden Landing - Pond 10	Partial	Historical only	13i	Eden Landing - Pond 10	Partial	
13j	Eden Landing - Mt Eden Creek	Complete		13j	Eden Landing - Mt Eden Creek	Complete	+R2
13k	Eden Landing Reserve South - North Creek Marsh	Complete		13k	Eden Landing Reserve South - North Creek Marsh	Complete	+R2

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
13l	Eden Landing Reserve North - Mt Eden Creek Marsh	Complete		13l	Eden Landing Reserve North - Mt Eden Creek Marsh	Complete	
13m	Eden Landing - Ponds E8A, E9, and E8X	Complete	survey by EBRPD airboat + jon boat	13m	Eden Landing - Ponds E8A, E9, and E8X	Complete	survey by EBRPD airboat + jon boat
21a	Ideal Marsh North	Complete		21a	Ideal Marsh North	Complete	
21b	Ideal Marsh South	Complete		21b	Ideal Marsh South	Complete	
REGION 6: HAYWARD							
07a	Oro Loma Marsh - East	Complete		07a	Oro Loma Marsh - East	Complete	
07b	Oro Loma Marsh - West	Complete		07b	Oro Loma Marsh - West	Complete	
20a	Oyster Bay Regional Shoreline	Complete		20a	Oyster Bay Regional Shoreline	Complete	
20b	Oakland Metropolitan Golf Links	Complete		20b	Oakland Metropolitan Golf Links	Complete	
20c	Dog Bone Marsh	Complete		20c	Dog Bone Marsh	Complete	
20d.1	Citation Marsh South	Complete		20d.1	Citation Marsh South	Coarse	
20d.2	Citation Marsh North	Grids		20d.2a	Citation Marsh North Channels	None	
				20d.2b	Citation Marsh North Main	None	
20e	East Marsh	Complete		20e	East Marsh	Complete	
20f	North Marsh	Grids		20f	North Marsh	None	
20g	Bunker Marsh	Grids		20g	Bunker Marsh	Partial	**Main Marsh** none **Channe**l complete **Southern lobe** complete
20h.1	San Lorenzo Creek and Mouth North	Complete	inventoried using point/ line/poly instead of grids due to small infestation	20h.1	San Lorenzo Creek and Mouth North	Complete	
20h.2	San Lorenzo Creek and Mouth South	Complete		20h.2	San Lorenzo Creek and Mouth South	Complete	
20i	Bockmann Channel	Complete		20i	Bockmann Channel	Complete	
20j	Sulphur Creek	Complete		20j	Sulphur Creek	Complete	
20k	Hayward Landing	Complete		20k	Hayward Landing	Complete	
20l	Johnson's Landing	Complete		20l	Johnson's Landing	Complete	
20m	Cogswell Marsh, Quadrant A	Complete		20m	Cogswell Marsh A	Complete	
20n	Cogswell Marsh, Quadrant B	Grids		20n.1	Cogswell Marsh B Bayfront	None	
				20n.2	Cogswell Marsh B South	None	
				20n.3	Cogswell Marsh B Main	None	
20o	Cogswell Marsh, Quadrant C	Grids		20o	Cogswell Marsh C	None	
20p	Hayward Shoreline Outliers	Complete		20p	Hayward Shoreline Outliers	Complete	
20q	San Leandro Shoreline Outliers	Complete		20q	San Leandro Shoreline Outliers	Complete	
20r	Oakland Airport Shoreline and Channels	Complete		20r	Oakland Airport Shoreline and Channels	Complete	
20s	H.A.R.D. Marsh	Complete		20s	H.A.R.D. Marsh	Complete	
20t	San Leandro Marina	Complete		20t	San Leandro Marina	Complete	OEI treatment during inventory
20u	Estudillo Creek Channel	Complete		20u	Estudillo Creek Channel	Complete	OEI treatment during inventory
20v	Hayward Landing Canal	Complete		20v	Hayward Landing Canal	Complete	
20w	Triangle Marsh	Complete		20w	Triangle Marsh	Complete	
REGION 7: SAN LEANDRO BAY							
17a	Alameda Island South (Elsie Roemer Bird Sanctuary, Crown Memorial State Beach, Crab Cove)	Complete		17a	Alameda Island South (Elsie Roemer Bird Sanctuary, Crown Memorial State Beach, Crab Cove)	Complete	**Elsie Roemer:** Full inventory for foliosa plantings + R2

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
17b	Bay Farm Island	Complete		17b	Bay Farm Island	Complete	OEI treatment during inventory
17c.1	Arrowhead Marsh West	Grids	Infestation wide spread enough to not warrant point/line/poly inventory	17c.1	Arrowhead Marsh West	Grids	Infestation wide spread enough to not warrant point/line/poly inventory
17c.2	Arrowhead Marsh East	Grids		17c.2	Arrowhead Marsh East	None	
17d.1	MLK Regional Shoreline - Fan Marsh Shoreline	Complete		17d.1	Fan Marsh Shoreline	Complete	
17d.2	Airport Channel - MLK Shoreline	Complete		17d.2	Airport Channel	Complete	
17d.3	East Creek - MLK Shoreline	Complete		17d.3	East Creek	Complete	
17d.4	MLK Regional Shoreline - Damon Marsh	Grids		17d.4	Damon Marsh	None	
17d.5	Damon Slough / Elmhurst Creek - MLK Shoreline	Complete		17d.5	Damon Slough / Elmhurst Creek	Complete	
17e.1	San Leandro Creek North	Complete		17e.1	San Leandro Creek North	Complete	
17e.2	San Leandro Creek South	Complete		17e.2	San Leandro Creek South	Complete	
17f	Oakland Inner Harbor	Complete		17f	Oakland Inner Harbor	Partial: Historics	
17g	Coast Guard Island	Complete		17g	Coast Guard Island	Partial: Historics	
17h	MLK New Marsh	Grids		17h	MLK New Marsh	None	
17i	Coliseum Channels	Complete		17i	Coliseum Channels	Complete	
17j	Fan Marsh	Grids		17j.1	Fan Marsh Wings	Complete	
				17j.2	Fan Marsh Main	None	
17k	Airport Channel	Complete		17k	Airport Channel	Complete	
17l	Doolittle Pond	Complete		17l	Doolittle Pond	Complete	
17m	Alameda Island (Aeolian Yacht Club and East Shore)	Complete		17m	Alameda Island (Aeolian Yacht Club and East Shore)	Complete	
REGION 8: BAY BRIDGE NORTH							
06a	Emeryville Crescent East	Complete		06a	Emeryville Crescent East	Complete	
06b	Emeryville Crescent West	Complete		06b	Emeryville Crescent West	Complete	
10a	Whittel Marsh	Complete		10a	Whittel Marsh	Complete	
10b	Southern Marsh	Complete		10b	Southern Marsh	Complete	+R2
10c	Giant Marsh	Complete		10c	Giant Marsh	Complete	+R2
10d	Breuner Marsh Restoration	Complete		10d	Breuner Marsh Restoration	Complete	
22a	Wildcat Marsh	Complete		22a	Wildcat Marsh	Partial	Complete inventory needed 2019 due to increased infestation
22b.1	San Pablo Marsh East	Complete		22b.1	San Pablo Marsh East	Complete	
22b.2	San Pablo Marsh West	Complete		22b.2	San Pablo Marsh West	Complete	
22c	Breuner Marsh (Rheem Creek)	Complete		22c	Breuner Marsh (Rheem Creek)	Complete	+R2 of northern 2/3
22d	Stege Marsh	Complete		22d	Stege Marsh	Complete	
22e	Hoffman Marsh	Complete		22e	Hoffman Marsh	None	

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
22f	Richmond / Albany / Pinole Shoreline	Partial	**Pinole Shoreline** None. Thoroughly surveyed 2016 **Brooks Island** partial survey during annual shorebird surveys **Rodeo Shoreline** None. Thoroughly surveyed 2016 **Stege Marsh Channels** No survey: Low Risk of Infestation >1 km **Point Richmond Marin**a Complete **Point Molate & Western Shoreline** Complete. Not surveyed since 2014. **Crockett Shoreline** None. Thoroughly surveyed 2016	22f	Richmond / Albany / Pinole Shoreline	Partial	**Pinole, Rodeo, Crocket Shorelines** None. Thoroughly surveyed 2016 **Brooks Island** partial survey during annual shorebird surveys **Albany Shoreline** historics only **San Pablo Yacht Harbor** historics only **Stege Marsh Channels** None **Point Richmond Marin**a Complete **Point Molate & Western Shoreline** None **Castro Cove** historics only
n/a	Berkeley Aquatic Park	No Survey	Suboptimal habitat	n/a	Berkeley Aquatic Park	None	
REGION 9: SUISUN							
11	Southampton Marsh	Complete		11	Southampton Marsh	Complete	
27a	Point Buckler	Complete	new 2016	27a	Point Buckler	Complete	
27b	MOTCO Islands	Partial	new 2017	27b	MOTCO Islands	Partial	Island interiors mnot accessed
27c	Honker Bay	Partial	new 2017	27c	Honker Bay	Partial	
n/a	Suisun Bay Marshes	Partial	Check potential recuitment areas of Grizzley Bay	n/a	Suisun Bay Marshes	None	
n/a	Benicia Shoreline	Partial	Surveyed 2016	n/a	Benicia Shoreline	None	Surveyed 2016
REGION 10: VALLEJO							
26a	White Slough / Napa River	None	**American Canyon** foliosa collection zone may require survey if any organization requires foliosa **Napa River** foliosa collection zone may require survey if any organization requires foliosa **Napa River Mouth** None. Surveyed 2016 **Vallejo** None. Surveyed 2016 **White Slough** Not surveyed since 2013 **Napa Sonoma Marshes** No survey: Low Risk of Infestation >3.5 km	26a	White Slough / Napa River	None	**American Canyon** foliosa collection zone may require survey if any organization requires foliosa **Napa River** foliosa collection zone may require survey if any organization requires foliosa **Napa River Mouth** None. Surveyed 2016 **Vallejo** None. Surveyed 2016 **White Slough** Not surveyed since 2013 **Napa Sonoma Marshes** No survey: Low Risk of Infestation >3.5 km
26b	San Pablo Bay NWR and Mare Island	Partial	**Mare Island** only central shoreline of historic infestation inventoried **San Pablo Bayfront** No Survey: Low Risk of Infestation > 1 km	26b	San Pablo Bay NWR and Mare Island	Complete	**Mare Island** complete on foot and w/CDFA airboat **San Pablo Bayfront** complete w/CDFA airboat
26c	Sonoma Creek	Partial	To be partially surveyed within 1 km of 2015 infestation; thorough airboat surveys in 2015	26c	Sonoma Creek	Partial	**Sonoma Creek** partially surveyed within 500m of 2017 infestation; thorough airboat surveys in 2015 **Creek Mouth Restoration** channel surveyed by USFWS airboat

2017 Sub-area	2017 Sub-area Name	Inventory Level Completed	Detail (where needed)	2018 Sub-area	2018 Sub-area Name	Inventory Level Completed	Detail (where needed)
26d	Sonoma Baylands	Partial	**Tolay Creek** levees walked **Sonoma Baylands Restoration** levees walked **Tubbs Island** levees walked **Sears Point Restoration** levees walked. Breached October 2015 and has rapid *Spartina* recruitment.	26d	Sonoma Baylands	Complete	**Tolay Creek** Complete w/CDFA airboat **Sonoma Baylands Restoration** Complete w/CDFA airboat **Tubbs Setback** Complete w/CDFA airboat **Sears Point Restoration** Complete w/CDFA airboat.
n/a	Cullinan Ranch	None	Breached January 2015: Assess for *Spartina* recruitment	n/a	Cullinan Ranch	Partial	Breached January 2015: Assessed for *Spartina* recruitment
REGION 11: PETALUMA							
24a	Upper Petaluma River - Upstream of Grey's Field	Partial	interior of pocket marshes and upstream of overpass not surveyed	24a	Upper Petaluma River - Upstream of Grey's Field	Complete	
24b	Grey's Field	Partial	interior not surveyed	24b	Grey's Field	Partial	Complete inventory needed 2019 due to increased infestation
24c	Petaluma Marsh	Partial	river edge only; interior not surveyed	24c	Petaluma Marsh	Partial	To be partially surveyed within 500m of 2015 infestation
24d	Lower Petaluma River - Downstream of San Antonio Creek	Partial	**Point Sonoma Marina** foliosa collection zone may require survey if any organization requires foliosa **Bahia Restoration, Petaluma River Black John Slough-North, Petaluma River Black John Slough-South, Petaluma River Carl's Marsh, Rush Creek** All No survey: Low Risk of Infestation >3.5 km	24d	Lower Petaluma River - Downstream of San Antonio Creek	Partial	**Point Sonoma Marina** complete with CDFA airboat; foliosa collection zone may require survey if any organization requires foliosa **Bahia Restoration, Petaluma River Black John Slough-North, Petaluma River Black John Slough-South, Petaluma River Carl's Marsh, Rush Creek** All No survey: Low Risk of Infestation >3.5 km
REGION 12: OUTER COAST							
25a	Tom's Point, Tomales	Partial	**Tom's Point** surveyed for *S. densiflora* only **Hog Island Oyster Farm** surveyed for *S. densiflora* only	25a	Tom's Point, Tomales	None	**Tom's Point** surveyed for *S. densiflora* only **Hog Island Oyster Farm** surveyed for *S. densiflora* only
25b	Limantour Estero	No Survey	Low Risk of Infestation > 3.5 km	25b	Limantour Estero	Partial	
25c	Drakes Estero	No Survey	Low Risk of Infestation > 3.5 km	25c	Drakes Estero	Partial	
25d	Bolinas Lagoon, North	Partial	Northern and Eastern shorelines to be throughly surveyed	25d	Bolinas Lagoon, North	Partial	Northern and Eastern shorelines to be thoroughly surveyed
25e	Bolinas Lagoon, South	Complete		25e	Bolinas Lagoon, South	Partial	
n/a	Bodega Bay	No Survey	Low Risk of Infestation > 3.5 km	n/a	Bodega Bay	None	
n/a	Dillon Beach	No Survey	Low Risk of Infestation > 3.5 km	n/a	Dillon Beach	None	