U.S. Fish and Wildlife Service
Humboldt Bay National Wildlife Refuge
Humboldt County, California

The Distribution of *Spartina densiflora* in the Humboldt Bay Region: Baseline Mapping

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INTRODUCTION

Spartina densiflora, an invasive salt marsh cordgrass native to the coasts of Argentina and Brazil (Bortolus 2006), was introduced to Humboldt Bay in the late 1800s and has since invaded over 90% of the bay's salt marshes (Pickart 2001). Restoration of *Spartina*-dominated salt marsh has been the focus of research and management at the Lanphere and Ma-le'l Units of Humboldt Bay National Wildlife Refuge (HBNWR) since 2004 (Pickart 2005, 2008). Based on the success of early research and experimental trials, the California State Coastal Conservancy and USFWS jointly funded a 35-ac (14 -ha) *Spartina* eradication/salt marsh restoration project on the Lanphere and Ma-le'l Dunes Units of the refuge. At the onset of this pilot project in 2006 all *Spartina* within the Lanphere Dunes, Ma-le'l Dunes, Salmon Creek, and Hookton Slough and White Slough Units was mapped using a two-cover-class system to serve as a baseline data set (Pickart 2008). As the project progressed successfully, the Conservancy awarded additional funds to the Service to carry out research designed to refine control methods as well as to map the regional infestation of *Spartina* in the Mad River and Eel River estuaries and Humboldt Bay. This regional mapping effort was begun in 2009. In 2010 the Refuge received $1 million in USFWS funding to complete the removal of *Spartina* within the entire Refuge boundary. The decision was made at this time to complete Refuge *Spartina* mapping as a first phase of regional mapping. This report addresses both of these mapping efforts while concentrating on documenting the regional project. The refuge mapping is detailed in Grazul and Rowland (2010). The baseline data in this report represent conditions prior to the initiation of the large-scale refuge eradication project, much of which has already been implemented as of the publication of this report. A separate inventory of eradication efforts in progress or completed was conducted to allow for an up to date assessment of the distribution of *Spartina*.

PROJECT AREA

The *Humboldt Bay regio*n is defined as the area captured by the Mad River to the north, and the Eel River delta to the south, including the river mouths, Humboldt Bay, and all associated sloughs, estuaries, and tidal channels. Most notably these include: Mad River Slough, McDaniel Slough, Jacoby Creek, Eureka Slough, Elk River, White Slough, Salmon Creek, Hookton Slough, and the Salt River. Also included in the regional area were islands and structures such as levees and tide gates, including the Eureka waterfront and Arcata wastewater treatment facility. (Fig. 1)

Within the region, a search area was defined by identifying known coastal marsh habitat including salt marsh and adjacent brackish marshes. Photo interpretation and site visits were used to identify other areas of interest outside known *Spartina* habitat including agricultural fields behind tide gates, upland marshes and relict salt marsh features.

METHODS

Mapping of *Spartina* took place in two phases. The first phase was within the Humboldt Bay National Wildlife Refuge. Refuge mapping was more detailed and included collection of ecological data (Grazul and Rowland, 2010). The regional mapping focused exclusively on cover

and distribution of *Spartina*. Regional mapping methods were developed so that the two data sets were easily integrated.

Whereas the first phase of the project was field-based to the highest degree possible, the larger regional effort relied heavily on photointerpretation. At this point in the project, the mappers had developed a high degree of skill in photointerpretation. Photo-interpretation was carried out using several sets of imagery, including NAIP 2005 and 2009 true-color imagery, and Humboldt Bay 2009 true-color imagery. The 2009 Humboldt Bay imagery proved to be most useful in detecting *Spartina* remotely. Heads-up digitizing was aided by ground truthing.

Mapping Features

Mapping utilized a combination of line and polygon features. Attributes recorded differed for each of these and were associated with features within a geodatabase.

Lines

Spartina plants distinct from the surrounding vegetation and found to be growing in linear occurrences (as is common along tidal creeks, roads and levees) were mapped as lines. Length and width of the lines were recorded allowing for the calculation of an area for the occurrence.

Polygons

Polygons were placed into three different classes based on percent cover of *Spartina*. The following cover classes were designed based on the ease of estimation as well as the labor needed for mechanical treatment:

0% <Cover Class 1 <25%
26% <Cover Class 2 <60%
61% ≤Cover Class 3 <100%

In addition to these cover classes, a separate layer was created to identify restoration efforts. These areas are placed within three categories: “Maintenance Level”, “In Progress”, and “Planned”. Maintenance Level areas are currently characterized by no more than 1% cover of *Spartina* as the result of new recruitment, and control efforts are ongoing to remove new juvenile plants and seedlings until such time as regional eradication is complete. Areas identified as In Progress, are currently undergoing some phase of treatment. Planned areas have been identified as targets for restoration by land managers, although these efforts may still require funding or additional organization. Data was collected in the form of paper and digital maps from restoration project managers in the region.

RESULTS

A total of 1,671.49 acres (117.00 ha) of salt marsh on the Humboldt Bay Region were infested with *Spartina* as represented by polygon or line features (Table 1, Fig. 2). Of this total, approximately 191 acres are currently undergoing restoration (treatment for *Spartina*), or have restoration efforts planned by a managing agency. In addition, more than 56 acres of salt marsh was identified as being restored to maintenance level in the Mad River Slough within the Lanphere and Ma-le’l dunes units of the Humboldt Bay National Wildlife Refuge (Table 2, Figs. 3-4). Larger scale maps depicting the distribution of Spartina in the four subareas (Mad River, North Humboldt Bay, South Humboldt Bay and Eel River) is shown in Fig. 5-8.

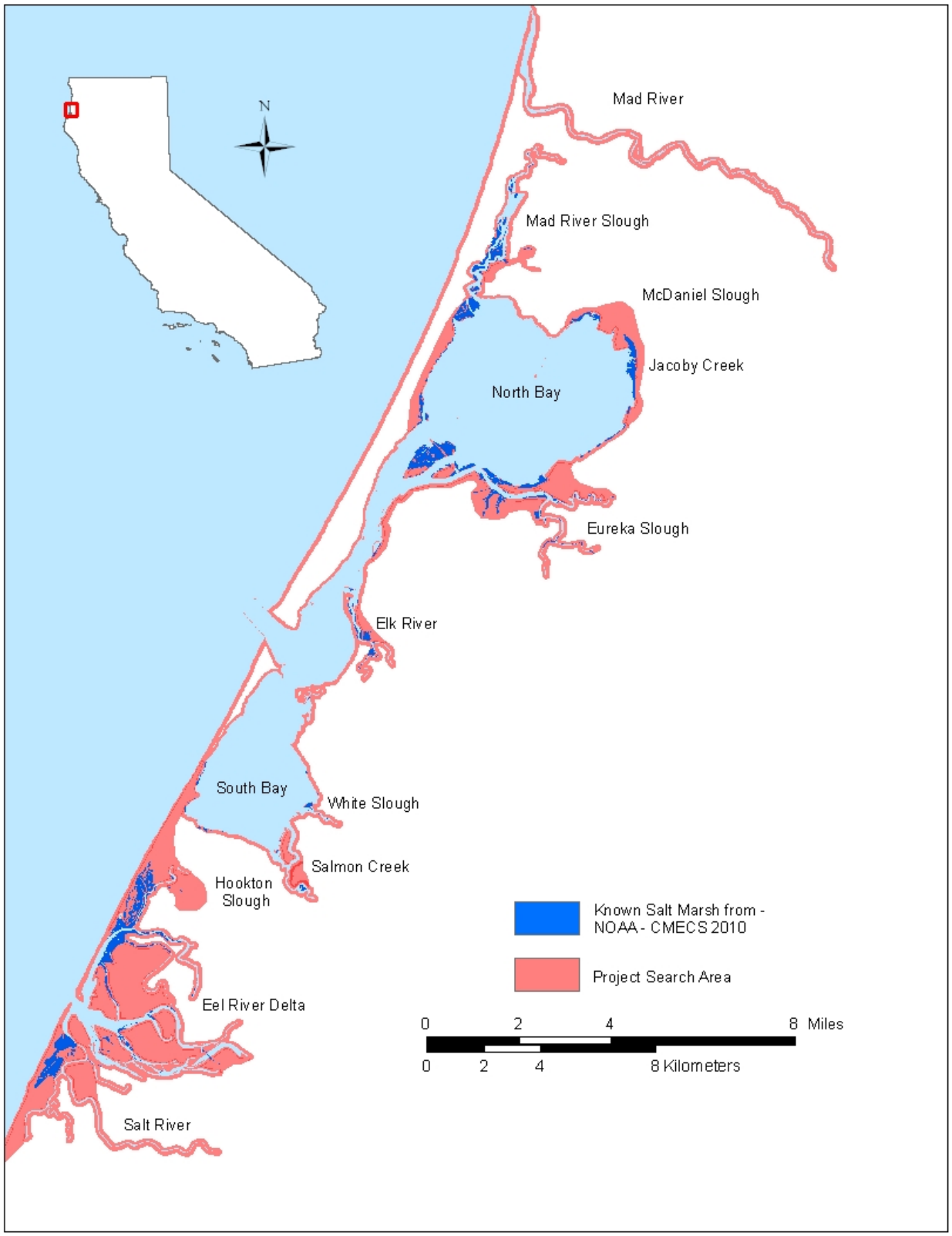

Figure 1. Major rivers, sloughs, bays, and estuaries in the Humboldt Bay Region. A search area was defined for the regional *Spartina* mapping effort using NOAA's Coastal and Marine Ecological Classification Standard for the area from 2010, Photo Interpretation (PI), and a series of field visits.

Table 1. Total acres infested by *Spartina densiflora* mapped as linear and polygon features distributed by cover class within the Humboldt Bay Region.

Project Area	Infested Acres	61-100%	26-60%	1-25%	Linear Features
Mad River	7.36	1.88	0	5.47	0.16
North Bay	867.5	314.94	243.37	308.18	14.43
South Bay	140.21	26.71	45.17	68.31	8.57
Eel River	656.42	278.96	171.78	205.66	2.61
Total Infested Acres	1,671.49	622.49	460.32	587.62	25.77

Table 2. Distribution of the 247 acres with completed, ongoing, or planned *Spartina densiflora* treatment efforts; together accounting for 14.7 % of the total regional infestation

Project Area	Restored to Maintenance Level	Restoration in Progress	Restoration Efforts Planned
Mad River	0	0	0
North Bay	56.32	58.9	82.61
South Bay	0	50.15	0
Eel River	0	0	0
Total Acres	56.32	108.24	82.61
Percent of Total Infestation	3.4%	6.4%	4.9%

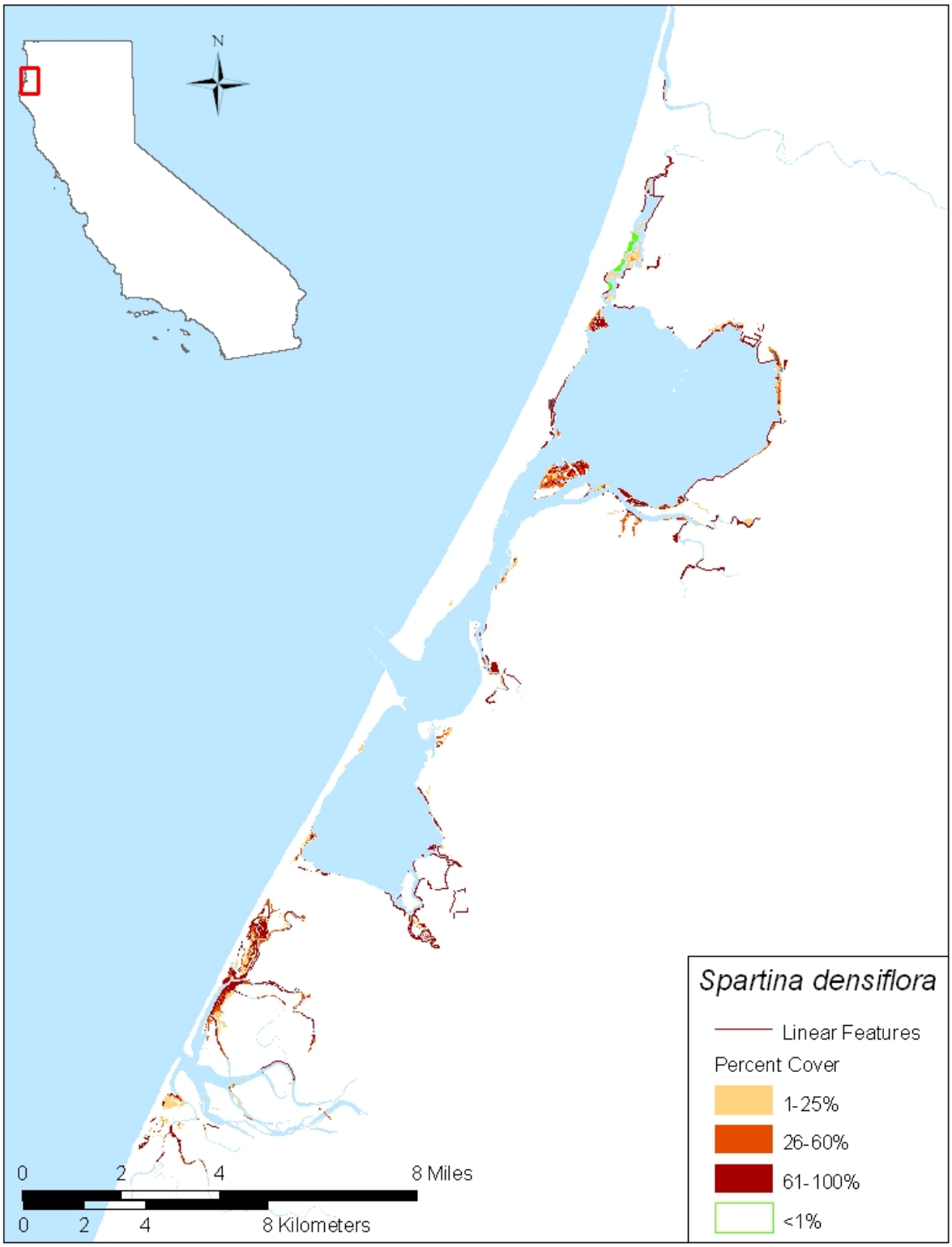

Figure 2. Distribution of *Spartina densiflora* by cover class within the Humboldt Bay Region.

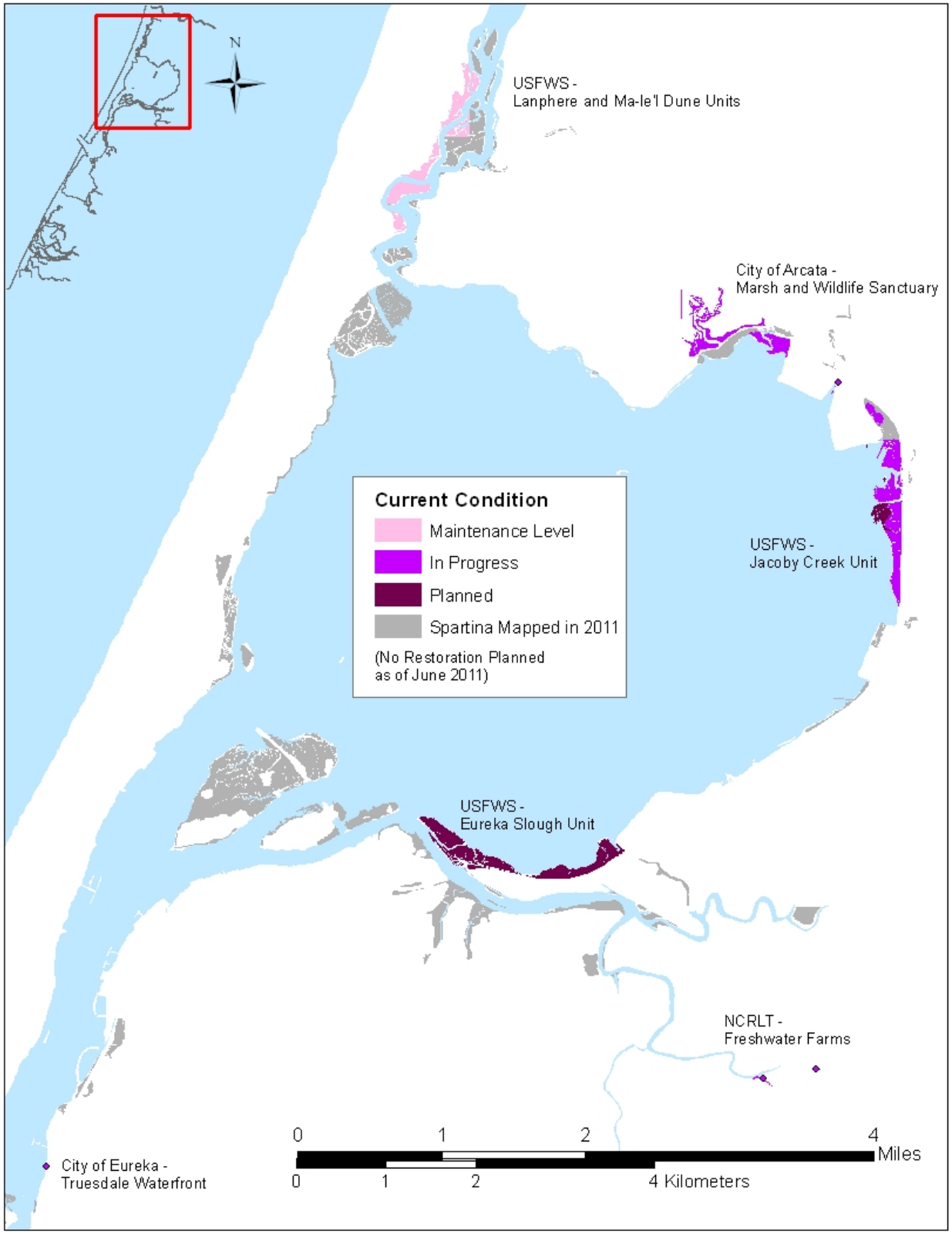

Figure 3. Coastal marsh lands infested with *Spartina densiflora* in the North Bay area of the Humboldt Region that have been restored to maintenance level, are in the process of restoration, or have restoration efforts planned.

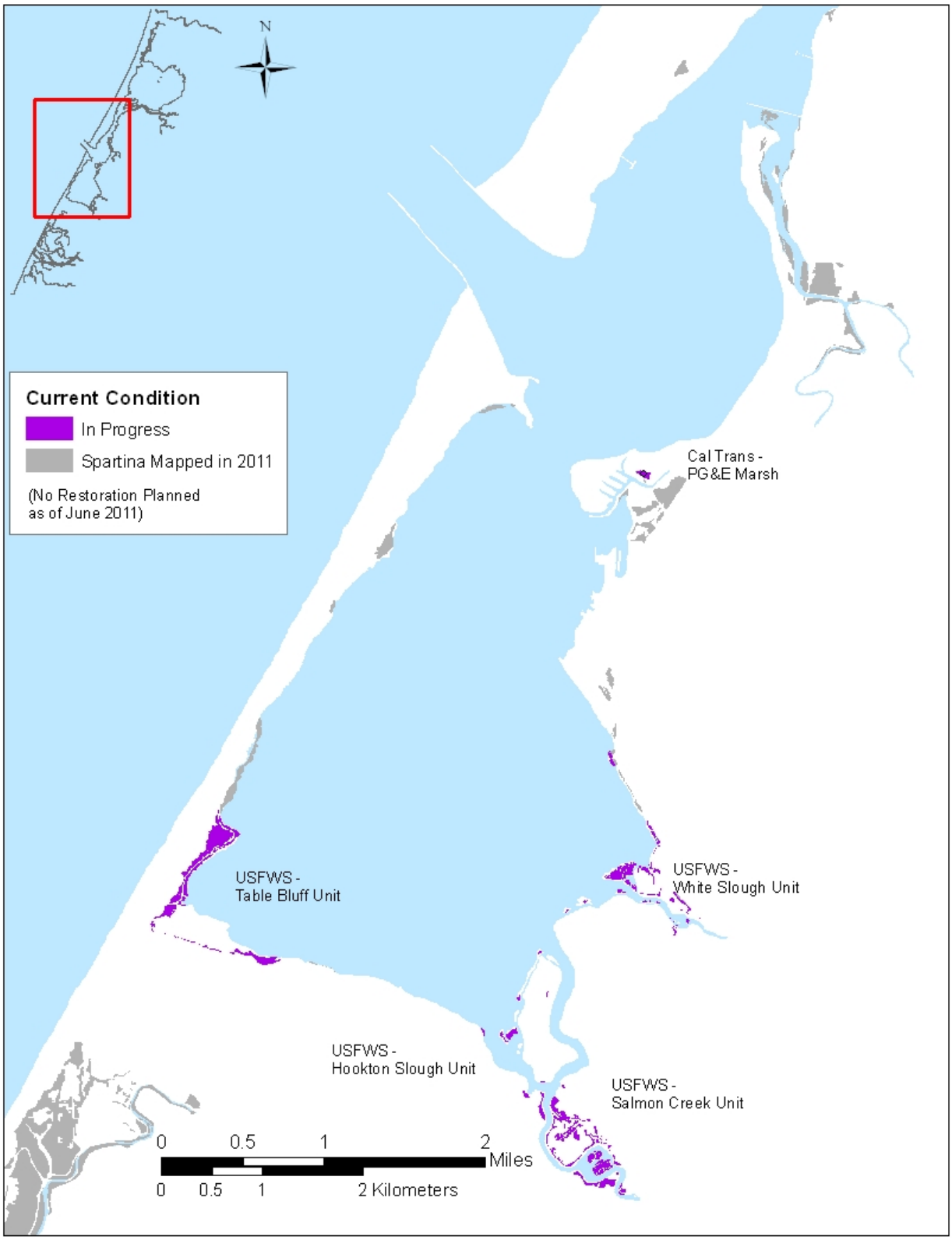

Figure 4. Coastal marsh lands infested with *Spartina densiflora* in the South Bay area of the Humboldt Region that are in the process of restoration, or have restoration efforts planned.

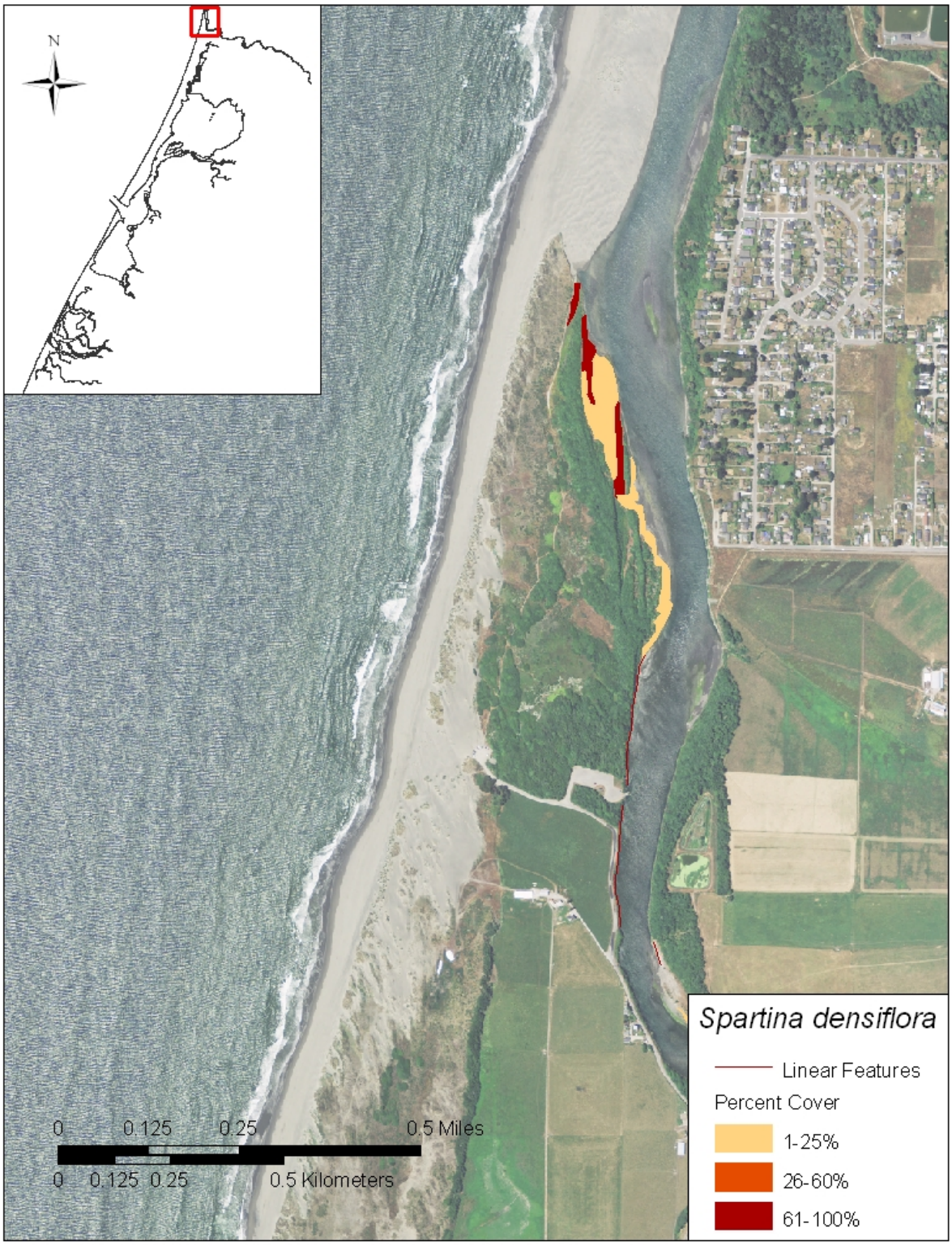

Figure 5. Distribution of *Spartina densiflora* by cover class within the Mad River area of the Humboldt Bay Region.

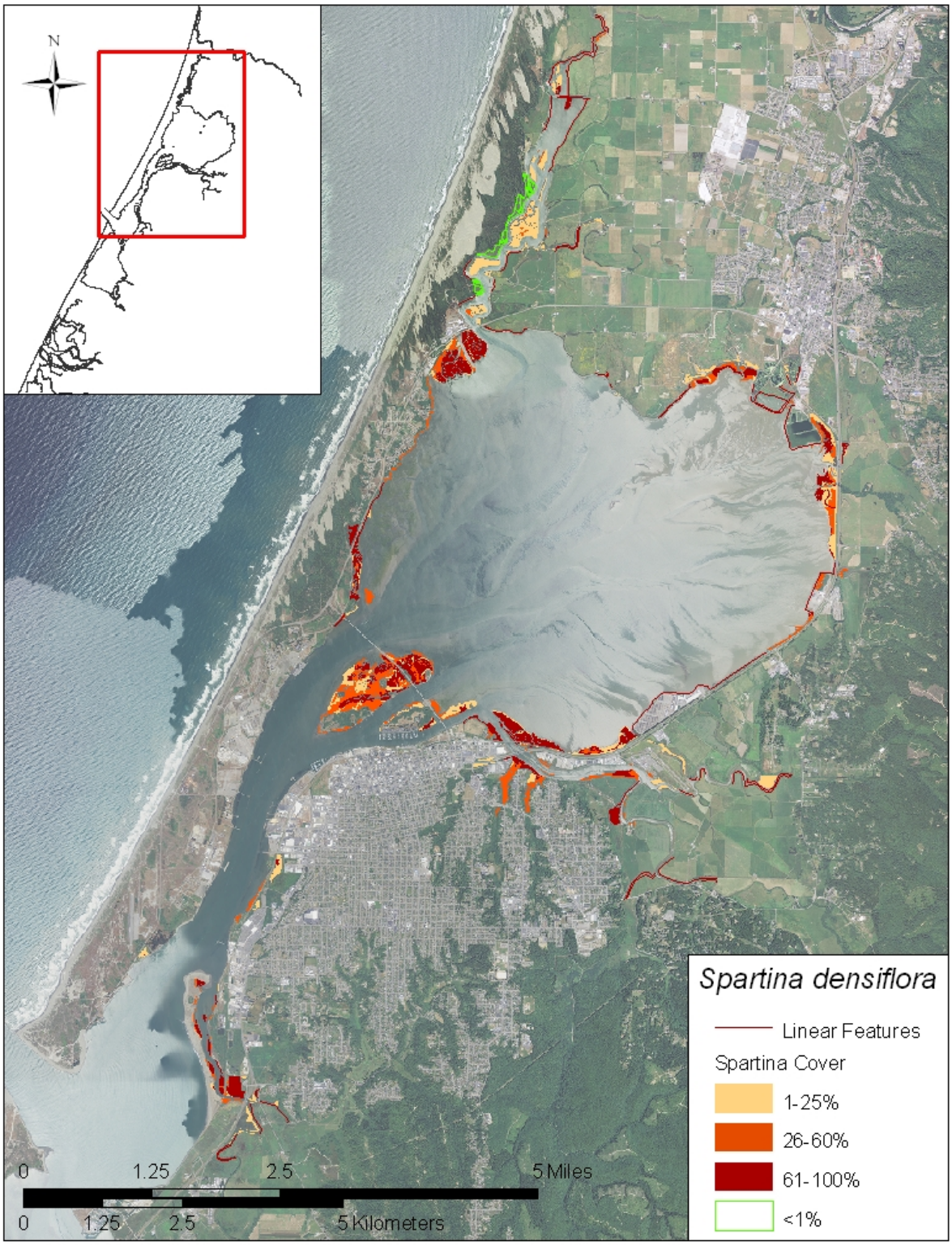

Figure 6. Distribution of *Spartina densiflora* by cover class within the North Bay area of the Humboldt Bay Region.

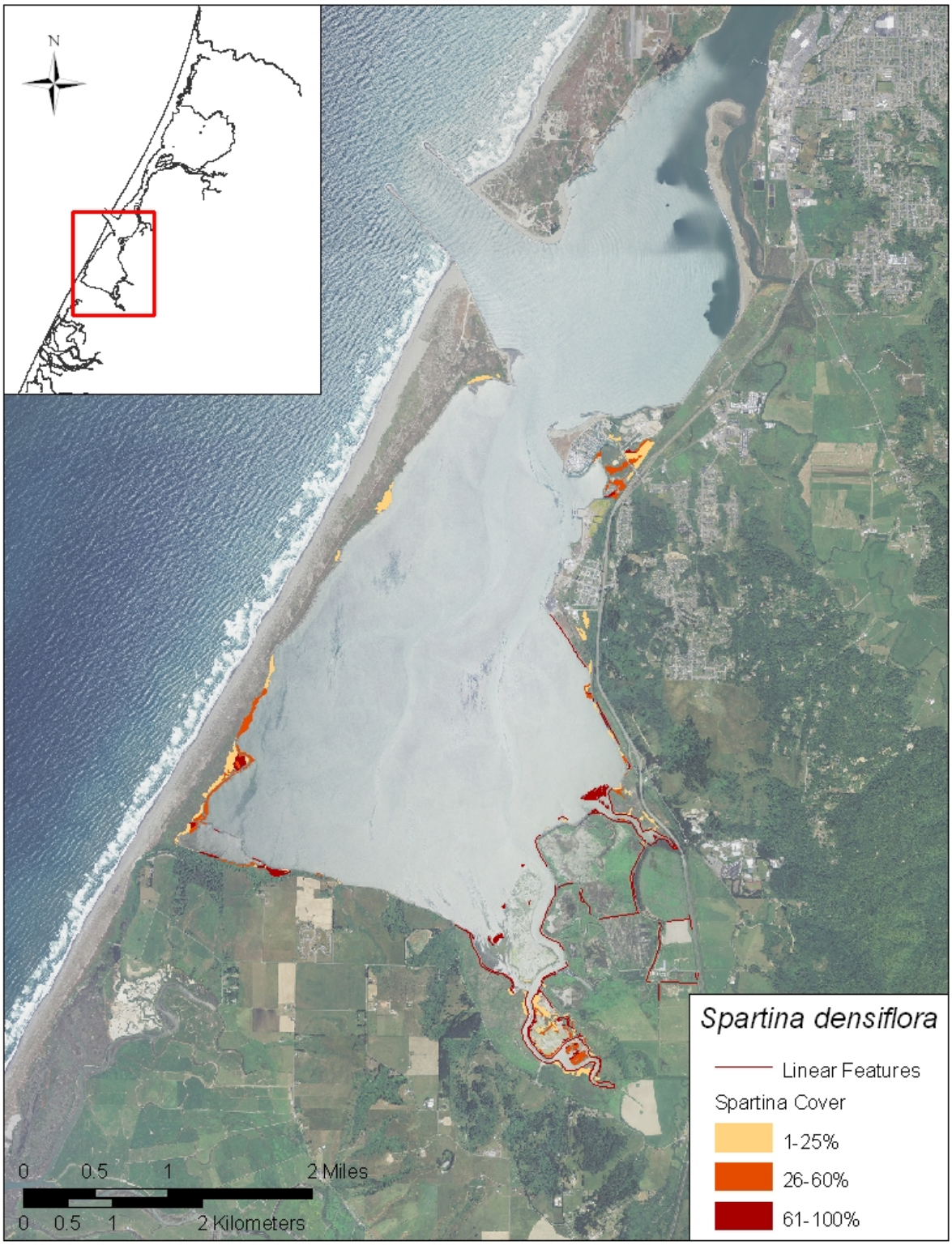

Figure 7. Distribution of *Spartina densiflora* by cover class within the South Bay area of the Humboldt Bay Region.

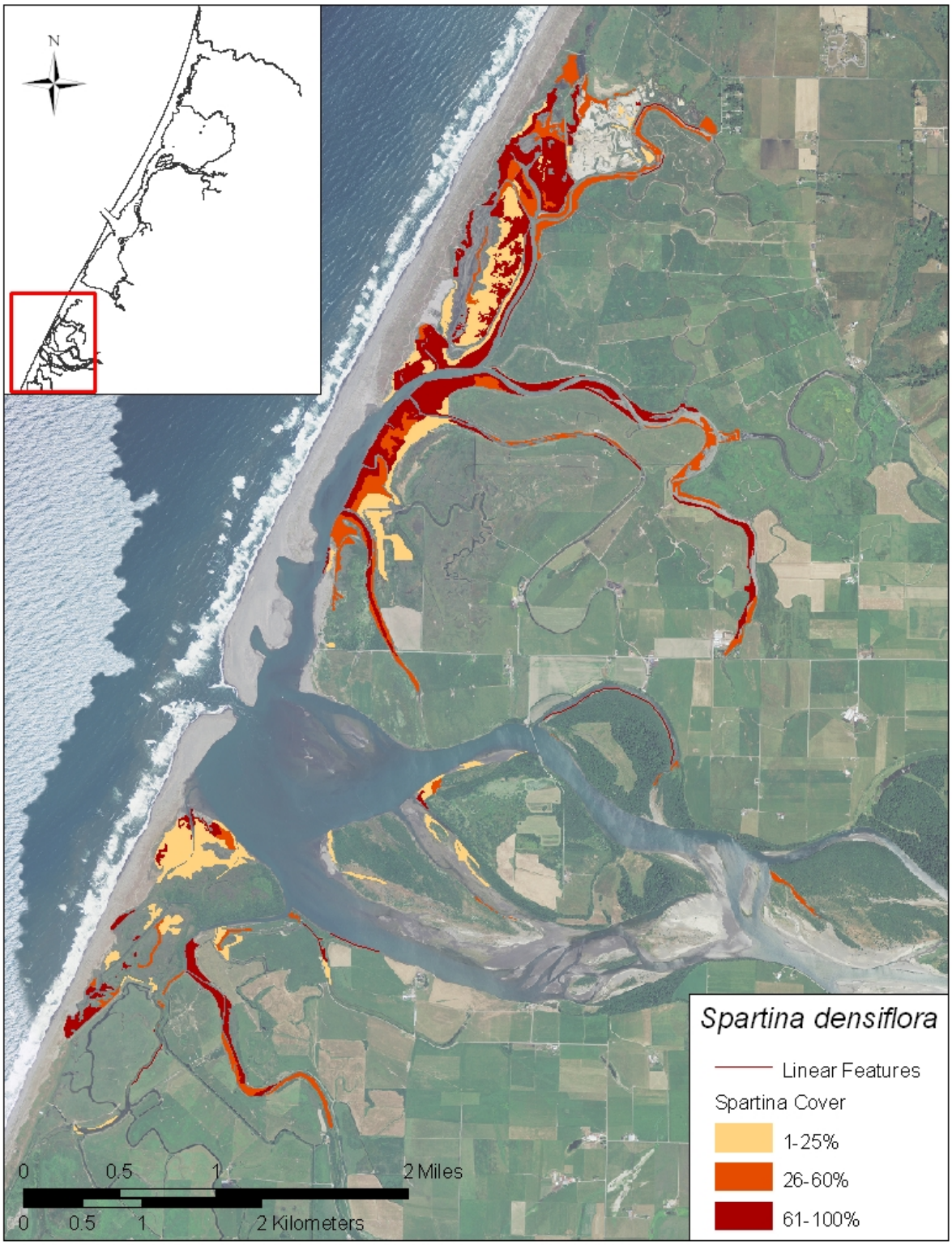

Figure 8. Distribution of *Spartina densiflora* by cover class within the Eel River area of the Humboldt Bay Region.

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