

SAN FRANCISCO WEED MANAGEMENT AREA

Weeds of San Francisco

Preliminary Mapping and Assessment Report for
WMA Strategic Planning

January 1, 2010

Table of Contents

Table of Contents	1
List of Figures	2
List of Appendices	2
Introduction.....	3
Purpose of project	4
Methods: Building the Weed Geodatabase.....	4
Data Sources	5
Joining Existing Information Together into a Central Geodatabase.....	7
Results: Distribution of weeds in the San Francisco County.....	10
Criteria Lists for Prioritizing Weed Species	10
California Department of Food and Agriculture (CDFA)	10
Figure 3: Locations of CDFA B Rated Weeds recorded in the SFWMA geodatabase.	13
California Invasive Plant Council (Cal-IPC)	14
SFWMA Initial Priority Rating System.....	17
SFWMA’s “San Francisco Six”	18
United States Department of Agriculture (USDA).....	20
Discussion – Prioritizing Weeds in the SFWMA	21
SFWMA Priority Weed List for Management.....	21
SFWMA “Watchlist Weeds”	24
Data Needs for Further Steps in Prioritization.....	25
Prioritizing Weed Species and/or Populations for High-Resolution Mapping.....	26
Outstanding Considerations for SFWMA Geodatabase	27
Data Gaps.....	27
Limitations	27

Conclusions..... 28

 Recommended Updates to SFWMA Strategic Plan 28

 Coordination with Regional Weed Mapping Efforts 29

 Future Additions to the SFWMA website 29

References..... 30

List of Figures

Figure 1: Schematic Diagram for SFWMA geodatabase 9

Figure 2: CDFA A Rated Weeds 12

Figure 3: CDFA B Rated Weeds 13

Figure 4: Cal-IPC Alert Rated Weeds 16

Figure 5: “San Francisco Six” Weeds..... 19

Figure 6: USDA Noxious Weeds..... 20

Figure 7: Schematic diagram of the SFWMA prioritization process 23

List of Appendices

Appendix A – Contact list for SFWMA

Appendix B – Matrix of all non-native species and all locations in database

Appendix C – Additional maps of weed distributions by various ratings

Appendix D – All non-native species not listed on any rating list.

Introduction

Invasive weeds are a serious threat to the natural resources of San Francisco County, an area located within a globally-significant biodiversity hotspot. In addition to creating fire danger, promoting soil erosion, threatening local food production, and impairing water quality, weeds are a major threat to the last remaining habitats for native and rare plants and wildlife. The San Francisco Weed Management Area (SFWMA) has been active since May 2003, and acts to promote and coordinate activities necessary to prevent the introduction, spread and establishment of invasive weeds in the city and county of San Francisco. As stated in the California Food and Agriculture Code, Section 7272(b),

"a 'weed management area' (WMA) is a local organization that brings together all interested landowners, land managers (private, city, county, state, and federal), special districts, and the public in a county or other geographical area for the purpose of coordinating and combining their actions and expertise to deal with their common weed control problems."

In 2005, the SFWMA outlined the framework within which weed management goals would be accomplished in a Strategic Plan (SFWMA 2005a). In addition to introducing the problem of invasive weeds to a broad audience, the Strategic Plan identified the following necessary program elements:

- Education, Awareness, and Outreach
- Prevention, Exclusion, and Early Detection
- Survey, Inventory, and Mapping
- Weed Management, Restoration, and Project Monitoring
- Administration and Funding Opportunities

To assist newer WMAs that lack basic weed distribution data and/or have not gone through strategic planning, the California Department of Food and Agriculture (CDFA) presented an opportunity for WMAs to apply for funding for regional mapping and strategic planning projects. The SFWMA submitted an application to CDFA in 2007 for project funds to assemble existing information about weeds in San Francisco from various land management jurisdictions in both tabular and geographic format (SFWMA 2007). In addition to establishing a county-wide weed database, the application proposed to facilitate communication across the WMA through development of a member contact list, as well to update the existing strategic plan. This request was granted, and in April 2009 an intern was hired to coordinate the efforts of this project. This Preliminary Mapping and Assessment Report is the culmination of the mapping and strategic planning project.

By providing a foundation of information for weed occurrences in San Francisco County, this Preliminary Mapping and Assessment Report addresses SFWMA program elements in

various ways. One principal area of focus for the SFWMA is to employ an integrated strategy for the exclusion, detection, suppression, and eradication of designated invasive weeds. In addition, the SFWMA aims to develop a multi-media education program targeted to local decision-makers, land owners and the general public about invasive weeds, including their identification, impact, and methods for management. This Preliminary Mapping and Assessment Report and accompanying geodatabase provides a foundation for achieving these goals by organizing weed occurrence data on a county-wide scale for use both in coordinated management of target populations as well as educating all interested parties of the extent of the problem.

Purpose of project

This project involves several components designed to coordinate the efforts of the SFWMA. First, this project serves to organize all available data on weed infestations so that SFWMA priorities can be set for both fine-scale mapping and monitoring of weeds, as well as regional coordination of eradication and containment projects. This project constitutes the first county-wide collection and storage of information on weed infestations for San Francisco County. As the SFWMA is a county-wide effort tied into a regional and state-wide weed management hierarchy, the data contained herein will provide a crucial link in the multi-scale approach to weed management. Second, this project will coordinate with the Bay Area Early Detection Network (BAEDN) and CalFlora to provide a platform for a data repository for future reporting and tracking of weed infestations at a county and regional scale. Beyond the local-regional scale, this information will be useful to CDFA and the California Invasive Plant Council (Cal-IPC), entities that coordinate weed monitoring and management efforts at the state-wide level. Third, this document communicates the results of the Preliminary Mapping and Assessment Project and summarizes the dataset in a way that can be useful for management prioritization, as well as in educating the public about the severity of invasive weeds in San Francisco. Prioritization of weeds for management is a major component of this project. Finally, to aid in communication between current and potential members of the SFWMA, a contact list of agencies and/or individuals is supplied in Appendix A.

Methods: Building the Weed Geodatabase

Beginning in April 2009, all active members of the SFWMA were contacted and asked to submit any and all information they had on weeds in San Francisco. In addition to SFWMA members, information was requested from other land managers in San Francisco as well as weed professionals from surrounding counties. All groups and other sources of information contributing to the SFWMA weed database are explained in further detail below.

Data Sources

San Francisco Recreation and Parks Natural Areas Program

The Natural Areas Program (NAP) coordinates community-based stewardship of 31 natural areas that represent approximately 4 percent of the total area of San Francisco. In February 2006, the NAP produced a final draft of a management plan (San Francisco Recreation and Parks Department 2006). Included in the management plan is a biological inventory of all native and non-native flora and fauna within the 31 natural areas. After speaking with NAP personnel, it was determined that the biological inventory was the most up-to-date and comprehensive collection of species in each of the natural areas. This inventory was utilized to extract a non-native plant species list for each natural area.

National Park Service – Golden Gate National Recreation Area

The Golden Gate National Recreation Area (GGNRA) unit of the National Park Service (NPS) consists of several parks along the northern and western edge of San Francisco managed as natural areas. The NPS maintains a database with all reported occurrences of non-native plants observed on park lands. Non-native plant species lists for 23 areas within the Presidio of San Francisco, Ocean Beach, Fort Funston, and Alcatraz Island were extracted from the database. Michael Chassé, Natural Resource Manager at the NPS, assisted with data retrieval and interpretation.

Golden Gate National Parks Conservancy

The Golden Gate National Parks Conservancy (GGNPC) coordinates volunteer site-stewardship programs at the Lands End natural area along the coastal trail in San Francisco. Caroline Christman and Alex Hooker, volunteer coordinators at the GGNPC, provided the SFWMA with a plant list of non-native species occurrences in the Lands End natural area.

California Native Plant Society - Yerba Buena Chapter

Jacob Sigg, the Conservation Chair for the Yerba Buena (San Francisco) Chapter of the California Native Plant Society (CNPS), was interviewed in person on April 16 and 23, 2009. The CNPS conducts site-stewardship activities in conjunction with the NAP in various natural areas throughout San Francisco, and Mr. Sigg was able to provide information on non-native plant species occurrences throughout natural areas in San Francisco.

San Francisco Public Utilities Commission

The San Francisco Public Utilities Commission (SFPUC) manages vegetation that threatens public safety, inhibits equipment maintenance, and/or creates a fire hazard on SFPUC lands. Jeannette Raye, a Pest Control Specialist with the SFPUC, was interviewed for information

and was able to provide information on the location of non-native plant species in various SFPUC lands in San Francisco.

Port of San Francisco and Golden Gate Audubon Society

The Port of San Francisco (Port) and the Golden Gate Audubon Society (GGAS) perform wetland enhancement and monitoring activities at Pier 94, adjacent to the Islais Creek outlet into San Francisco Bay. A list of non-native species observed at Pier 94 was obtained through in-person interviews with Port (Damon Burgett) and GGAS (Jennifer Robinson Maddox) personnel as well as from recent monitoring reports (Port of San Francisco 2008).

Literacy for Environmental Justice

Literacy for Environmental Justice (LEJ) performs site stewardship at Heron's Head Park. Personnel from LEJ were contacted and were able to supply the SFWMA with recent monitoring reports that contained information on both native and non-native plant species at Heron's Head Park (URS 2005). Additionally, information on non-native species in Heron's Head Park was obtained from lists of common species in a field guide for the park (Chambers 2006).

San Francisco Department of Public Works

The San Francisco Department of Public Works (SFDPW) performs roadside vegetation management on city streets, highway on- and off-ramps, and other transportation easements throughout San Francisco. A list of recent observations and locations of weed species from work performed over the summer of 2009 was obtained from Kevin Woolen, an Integrated Pest Management (IPM) Specialist at SFDPW.

Wood Biological Consulting

Wood Biological Consulting performed an inventory of all native and non-native flora of Yerba Buena Island (Wood Biological Consulting 2007). This flora was used to create a species list of all non-native plants for Yerba Buena Island.

Nature in the City

Peter Brastow, Founding Director of *Nature in the City* was interviewed in-person on April 9, 2009 for additional information on weed locations on Yerba Buena Island and other various natural areas in San Francisco.

San Mateo Weed Management Area

John Beall, Co-Chair of the San Mateo WMA, assisted with providing the location of occurrences of *Chondrilla juncea* (rush skeletonweed) near the San Francisco County / San Mateo County border.

The Presidio Trust

Christa Conforti, an Integrated Pest Management (IPM) Specialist with the Presidio Trust, provided information on weed occurrences in Starr King Park from a recent inventory list of weed species and their locations within the park.

CalFlora / BAEDN database

The CalFlora database provides free online information about native and non-native plant species and their reported locations in California (CalFlora 2009). The database was queried for all occurrences of non-native species in San Francisco that were not otherwise reported through other sources and these occurrences were added to the SFWMA database.

A list of all current SFWMA members, as well as all others contacted for this project is located in Appendix A.

Joining Existing Information Together into a Central Geodatabase

The procedure of melding together information on weed occurrences from the various sources of information into one common data structure was filled with myriad challenges. Because data was not systematically collected within the WMA unit, or for that matter within particular groups which contributed data to the WMA, manipulating data in various forms and structures into one common format proved to be a formidable task. Information collected from contributors ranged in detail and complexity from verbal accounts of weed occurrences by experienced botanists to Geographic Information Systems (GIS) data files created by natural resource managers. The large majority of the information entered into the database originated from existing electronic species lists for open space natural areas in San Francisco, however several contributing WMA members spent considerable time creating species lists specifically for purposes of this report.

A geodatabase, or spatial database, is a database designed to effectively manage large geographic datasets. Geodatabases are relational databases where information is contained in several tables or map layers, and are linked together by user-defined relationships. Map layers are commonly stored as shapefiles, which record the explicit spatial information for a record. Each shapefile or table in the geodatabase can have numerous attribute fields, where information about each map entity is stored as a value for every attribute. Attribute fields in multiple tables are linked together through a common key field, which must have the same value in both tables or layers for each record to be linked. Since map layers hold the spatial data that is tied to each individual record in another table, geodatabases can help reduce redundancy in data storage. Because this project involved assembling large quantities of inherently spatial data on weed occurrences, a geodatabase was decided upon as the appropriate data structure.

To organize the information in the SFWMA database most efficiently, a geodatabase was created in ArcGIS 9.3. This geodatabase consists of one shapefile and two tables – all associated in a relational database (Figure 1). The “Locations” shapefile in the geodatabase contains the spatial data for each location where a weed record exists, as well as additional information about the location. For point locations, the true Universal Transverse Mercator (UTM) (northing and easting) coordinates are stored. However, for records that were derived from a species list of a park, the UTM coordinates were recorded for the geographical center (centroid) of the natural area polygon, and thus are not true point representations of a species location. Additional attributes of each location also record the size of the natural area, land ownership, and the name of the location (Table 1). Each location is tied to potentially multiple records in the database through a “one-to-many” relationship and the “Location Code” key field (Figure 1).

The “Records” table in the geodatabase contains information about each observation of a species in the following attribute fields: species name, common name, observer, observers’ organization, date, source for SFWMA, date entered into geodatabase, location, details (if applicable), infested area, and any other additional comments (Table 1). Each record is tied to one species in the database through a “many-to-one” relationship and the “Species Code” key field (Figure 1). The “Species” table in the geodatabase contains detailed information about each non-native species in the following attribute fields: species name, common name, taxonomic family, weed ratings, and native status in California (Table 1).

Since the SFWMA will eventually upload weed data into the database for the BAEDN and CalFlora, the guidelines for minimum fields in records submitted to CalFlora were used as a template for the attribute fields in the tables and layers in this geodatabase. However, due to the issues discussed above regarding various sources and levels of detail with data submitted to the SFWMA, not all fields were populated for every record. Additionally, it is important to note that this geodatabase consists of the first collection of city/county wide non-native species occurrences for San Francisco; however it is not a complete survey of the entire city. Therefore, users must keep in mind that if a species has not been recorded at a certain area, it does not necessarily mean that it does not exist there, only that there is no formal record of it existing there at the time of this report.

Table 1: Fields for each component of the SFWMA relational geodatabase. Fields in each data layer were designed to be consistent with the fields contained in the BAEDN and CalFlora databases. See text for additional explanation.

Layer / Table	Attribute Fields	Key Field
Locations	location name, ownership, area (acreage and m ²), UTM coordinates (centroid for polygons)	Location Code
Species	species name (scientific and common), taxonomic family, latest weed rating (SFWMA, CDFA, Cal-IPC, Federal), native status in CA	Species Code
Records	species name (scientific and common), observer, observer organization, observed date, source for SFWMA, date entered into SFWMA database, location, detailed location, infested area, additional comments	Location Code, Species Code

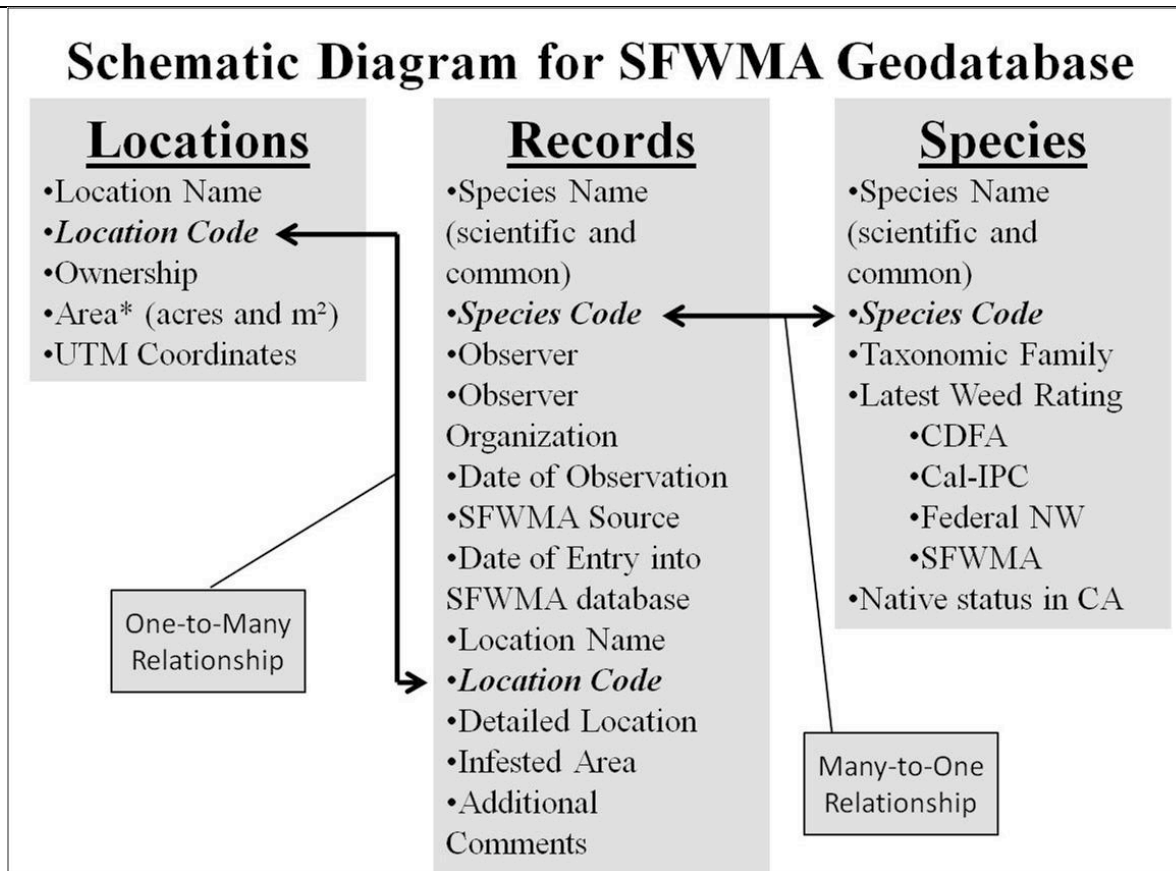


Figure 1: Schematic Diagram for SFWMA geodatabase. “Locations” is a shapefile, and “Records” and “Species” are tables. Key fields linking tables together are noted in *bold italics*. Each location can have multiple records, denoted by the “one-to-many” relationship. Multiple records can be tied to any particular species through a many-to-one relationship. * Area only applies to species occurrences in species lists.

Results: Distribution of weeds in the San Francisco County

Through data collection from the various WMA members and other sources on non-native species occurrence data, the main results of this project are the centralized collection of weed occurrence records to be used from this point on for tracking, monitoring, and managing the problematic non-native plant species in San Francisco County. In total 3,161 individual records of reported non-native species observations now exist in a centralized database (Appendix B).

Criteria Lists for Prioritizing Weed Species

To facilitate interpretation of the weed information contained within the SFWMA weed geodatabase, this section summarizes weed occurrences by various criteria. Several rating lists have been developed to rank the priority of weeds by species at federal, state, and local scales. These lists use various criteria based on the purpose for which they were intended. The rating lists used in California for weed management are created by the CDFA, the Cal-IPC, and the United States Department of Agriculture (USDA). Additionally, in concert with the creation of the original Strategic Plan, the SFWMA created a weed rating specific to San Francisco. The high number of species occurrences in the SFWMA database for most ratings highlights the importance of prioritization at a local level for SFWMA weeds. Each of these lists is explained below, along with a summary of the weed occurrences in the SFWMA database sorted by each list.

California Department of Food and Agriculture (CDFA)

The CDFA lists weeds that are found to be “troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species, and difficult to control or eradicate” (CDFA 2009). These species are assigned a rating of A, B, C, D, or Q, which reflect the statewide importance of the pest and the feasibility of successful eradication. These ratings are intended to support an “Action Oriented Rating System” to advise county agricultural commissioners about the CDFA policy regarding any particular species.

a. A-Rated

The CDFA defines an A-Rated weed to be “A pest of known economic or environmental detriment and is either not known to be established in California or it is present in a limited distribution that allows for the possibility of eradication or successful containment” (CDFA 2009). Any occurrence of an A-Rated species in California is subject to state-enforced action involving “eradication, quarantine regulation, containment, rejection, or other holding action”; in addition, A-Rated species are prohibited from entering the state (CDFA 2009). The SFWMA database contains 5 records of CDFA A-Rated weeds (3 different species) (Figure 2, Table 2).

b. B-Rated

Weed species that receive a CDFA B-Rated designation are defined as “A pest of known economic or environmental detriment and, if present in California, it is of limited distribution” (CDFA 2009). Eradication, containment, suppression, or other control activities for B-Rated weeds are at the discretion of the County Agricultural Commissioner. B-Rated species are allowed to enter the state only if the county of destination accepts the species (CDFA 2009). The SFWMA database contains 5 records of CDFA B-Rated weeds (4 different species) (Figure 3, Table 2).

c. C-Rated

The CDFA defines C-Rated species as “A pest of known economic or environmental detriment and, if present in California, it is usually widespread” (CDFA 2009). While there is no state enforced action for C-Rated weeds, they are subject to suppression regulations at the discretion of the County Agricultural Commissioner. The SFWMA database contains 111 records of CDFA C-Rated weeds (7 different species) (Appendix C, Table 2).

d. D-Rated

Species with a D-Rated designation are defined as “organism(s) known to be of little or no economic or environmental detriment, to have an extremely low likelihood of weediness, or not known to be a parasite or predator” (CDFA 2009). There is no state-level action enforced on D-Rated species. The SFWMA database does not contain any known occurrences of D-Rated weeds.

e. Q-Rated

Species of unknown impact are Q-rated, further defined as “An organism or disorder suspected to be of economic or environmental detriment, but whose status is uncertain because of incomplete identification or inadequate information” (CDFA 2009). The SFWMA database does not contain any known occurrences of Q-Rated weeds.

Table 2: The total number of occurrences and number of species present in the SFWMA database for each of the CDFA ratings.

CDFA Rating	Number of Species	Number of Records
A	3	6
B	4	5
C	7	111
D	-	-
Q	-	-

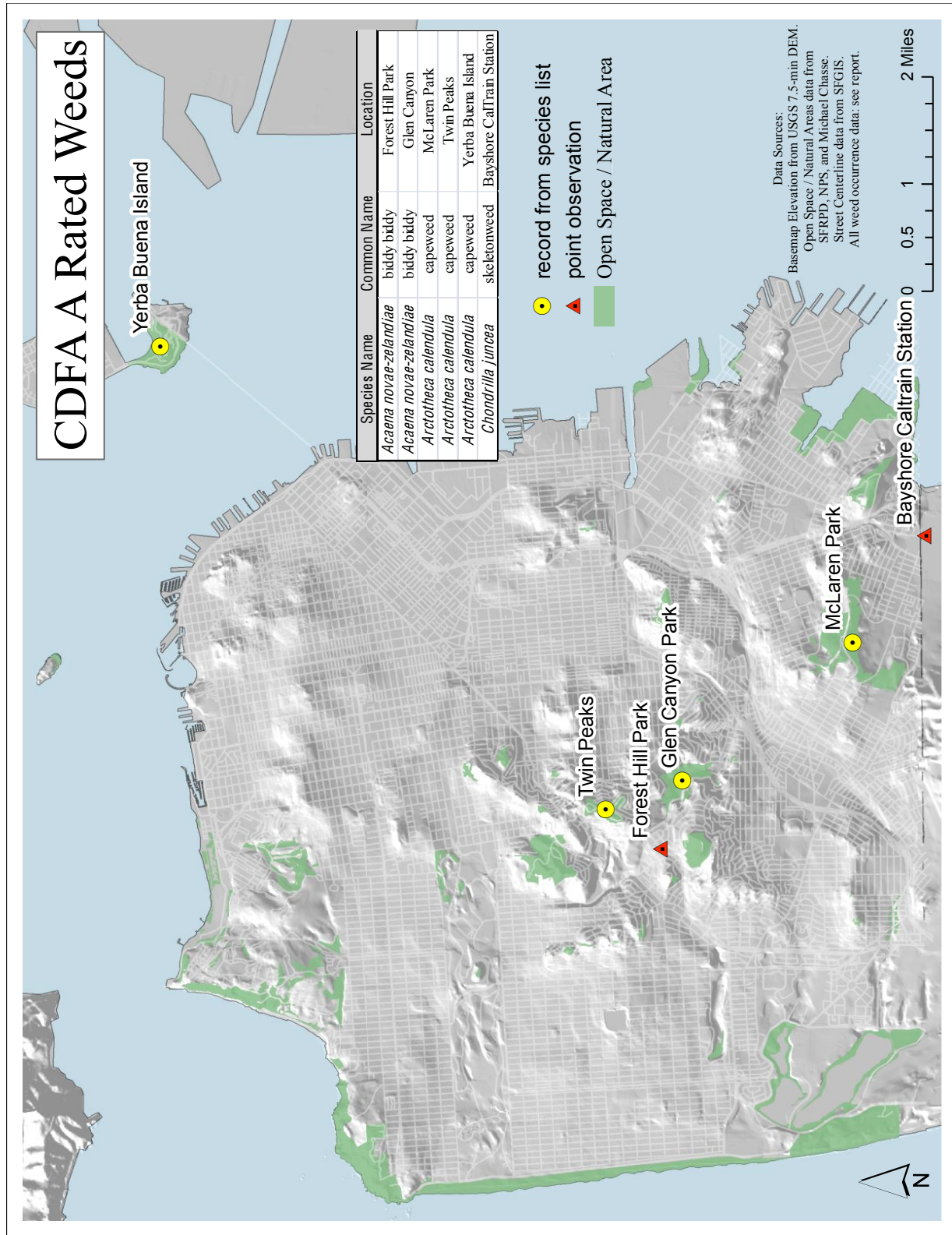


Figure 2: Locations of CDFA A Rated Weeds recorded in the SFWMA geodatabase.

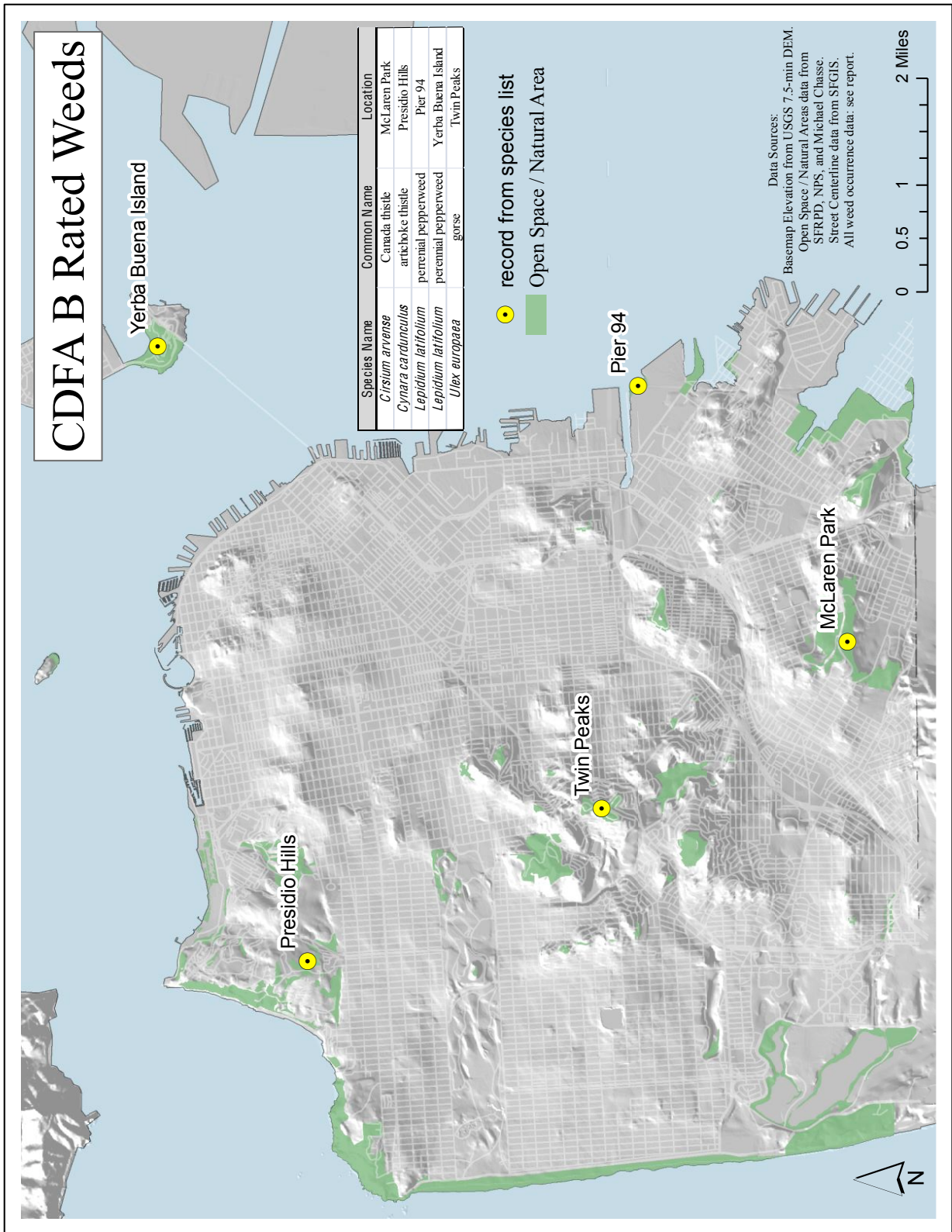


Figure 3: Locations of CDFA B Rated Weeds recorded in the SFWMA geodatabase.

California Invasive Plant Council (Cal-IPC)

The Cal-IPC rates weed species based solely on their ecological impact to native California wildlands. Cal-IPC ratings reflect ecological impact of a particular weed at a statewide level, and represent the collective knowledge of invasive plant experts in California. Based on their ecological impact, invasive potential, and distribution, weeds are assigned a “High”, “Moderate”, or “Limited” rating. Species which were considered, but not currently rated due to lack of information on potential impact, receive a “Not Listed” designation. Additionally, weeds that exhibit certain combinations of characteristics that are conducive to invading new ecosystems are given an “Alert” rating (Warner et al. 2003).

a. High – Rated Weeds

Cal-IPC rates a weed species as “High” if it has “severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically” (Cal-IPC 2003). Different from the highest rated CDFWA species (A-Rated), this highest rating for Cal-IPC includes many species that are widespread in the state, as the rating is based on ecological impact. The SFWMA database contains 322 records of Cal-IPC High - Rated weeds (18 different species in 70 locations) (Appendix C, Table 3).

b. Moderate – Rated Weeds

Species are assigned a “Moderate” rating by Cal-IPC if they have “substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread” (Cal-IPC 2003). The SFWMA database contains 759 records of Cal-IPC Moderate – Rated weeds (57 different species in 66 locations) (Appendix C, Table 3).

c. Limited – Rated Weeds

Species are designated as “Limited” – Rated weeds by Cal-IPC if they are “invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic” (Cal-IPC 2003). The SFWMA database contains 476 records of Cal-IPC Limited – Rated weeds (34 different species in 57 locations) (Appendix C, Table 3).

d. Not Listed – Rated Weeds

Species for which there is inadequate information, or are not currently known to have significant impacts worthy of assigning a specific rating are instead given a “Not Listed” – Rating by Cal-IPC (Cal-IPC 2003). The SFWMA database contains 285 records of “Not-Listed” weeds (32 different species in 52 locations) (Appendix C, Table 3).

e. Alert – Rated Weeds

In addition to the overall ratings, any species that is currently listed as a “High” of “Moderate” impact by Cal-IPC can also receive a designation as an “Alert” – Rated weed if it has a significant potential for invading new ecosystems (Cal-IPC 2003). The SFWMA database contains 16 records of “Alert” weeds (5 different species in 14 locations) (Figure 4, Table 3).

Table 3: The total number of occurrences and number of species present in the SFWMA database for each of the Cal-IPC ratings.

Cal-IPC Rating	Number of Species	Number of Records
High	18	322
Moderate	57	759
Limited	34	476
NL	32	285
Alert (H or M)	5	16

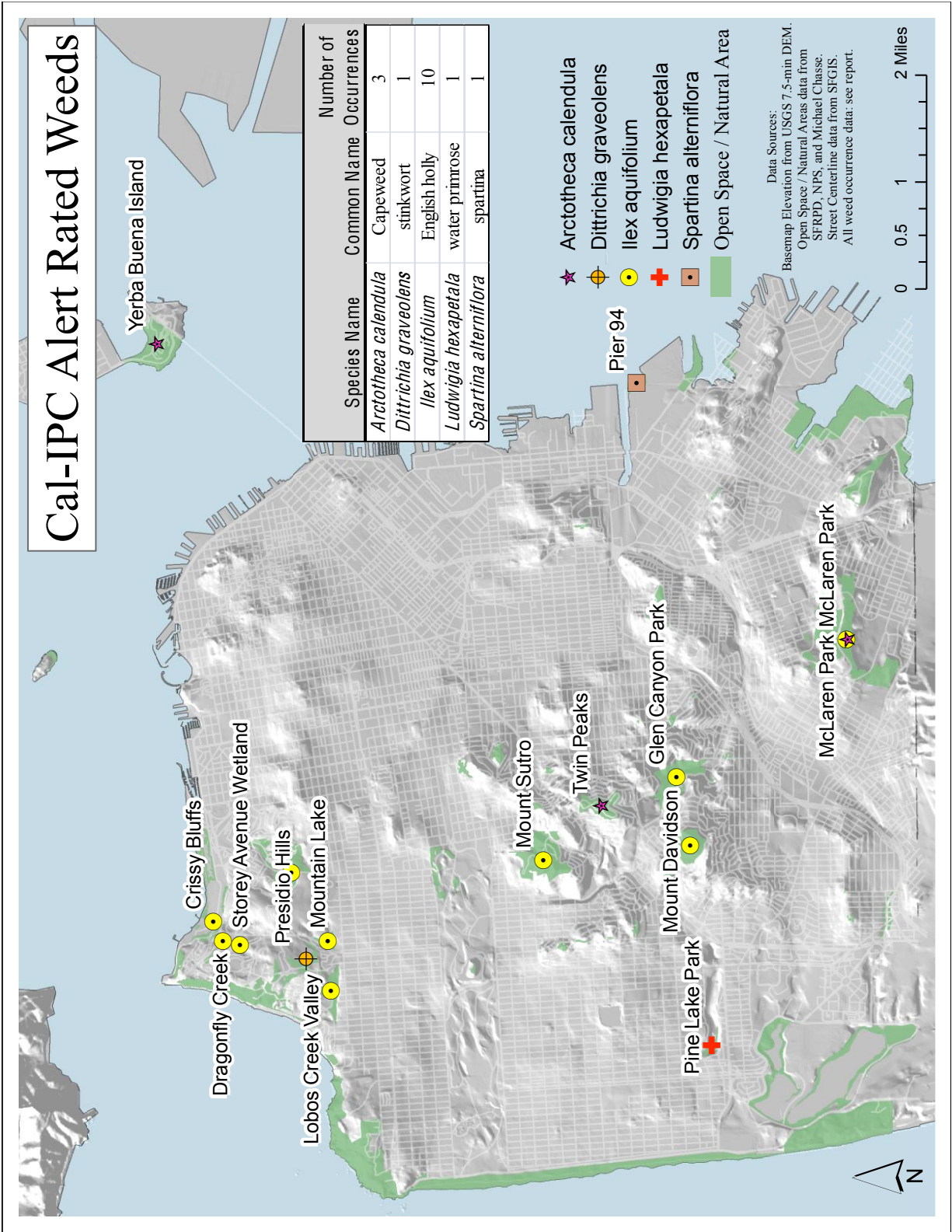


Figure 4: Locations of Cal-IPC Alert Rated weeds recorded in the SFWMA database.

SFWMA Initial Priority Rating System

In 2005, the SFWMA developed an initial rating system for species known to be problematic in San Francisco. These ratings are based on the biology (behavior), ecology (ecological damage in San Francisco habitats), and geography (distribution in San Francisco) of each species. Species were ranked 1, 2, or 3, representing severe, serious, and significant threats to native plant habitat, respectively.

a. 1 – Rated

Species were assigned a “1” rating by the SFWMA if they were determined to be a “Severe threat to sensitive habitats and/or rare plants, fast-growing and/or difficult to eradicate or contain” (SFWMA 2005b). These species were recommended for eradication or containment. The SFWMA database contains 449 records of “1” – Rated weeds (19 species in 74 locations) (Appendix C, Table 4).

b. 2 – Rated

The SFWMA assigned a “2” rating to species that were determined to be a “Serious threat to sensitive habitats, produces copious amounts of seed and/or fast-growing” (SFWMA 2005b). These species were recommended for frequent monitoring and weeding. The SFWMA database contains 567 records of “2” – Rated weeds (31 species in 68 locations) (Appendix C, Table 4).

c. 3 – Rated

Species determined to be a “Significant threat to sensitive habitats, slower-growing or less common” (SFWMA 2005b) were designated a “3” rating by the SFWMA. Regular monitoring and annual weeding was recommended for these species in sensitive habitats. The SFWMA database contains 634 records of “3” – Rated weeds (45 species in 55 locations) (Appendix C, Table 4).

Table 4: The total number of occurrences and number of species present in the SFWMA database for each of the SFWMA initial ratings.

SFWMA Rating	Number of Species	Number of Records
1	19	449
2	31	567
3	45	634

SFWMA's "San Francisco Six"

In 2008, the SFWMA produced an educational public outreach brochure featuring especially problematic weeds, designated the "San Francisco Six" (SFWMA 2008). Because the central purpose was to inform the general public about the issue of invasive plants in San Francisco, the weeds which were selected were known to be widespread and of high invasive potential in San Francisco County and easily recognizable for non-botanists. The actual species and the total number of reported occurrences for each of the "San Francisco Six" species are presented in Table 5 and shown in Figure 5.

Table 5: The six species in the "San Francisco Six" rating (SFWMA 2008). The total number of occurrences per species in the SFWMA database is noted.

Species Name	Common Name	Number of Records
<i>Delawarea odorata</i>	Cape ivy, German ivy	39
<i>Ehrharta erecta</i>	ehrharta	45
<i>Genista monspessulana</i>	French broom	41
<i>Oxalis pes-caprae</i>	yellow oxalis	38
<i>Raphanus sativus</i>	radish	46
<i>Rubus armeniacus (R. discolor)</i>	Himalayan blackberry	42

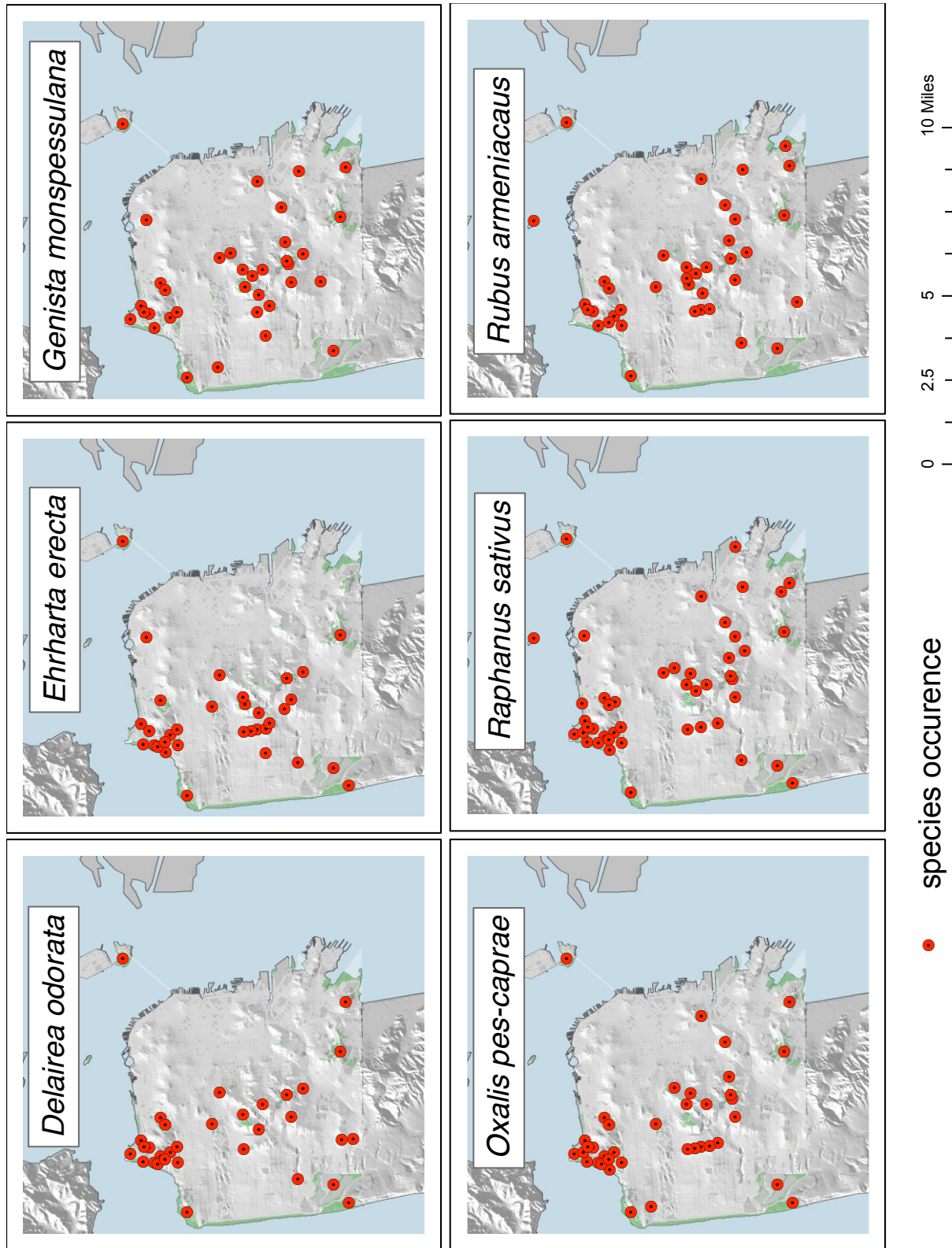


Figure 5: Locations of “San Francisco Six” weeds recorded in the SFWMA geodatabase.

United States Department of Agriculture (USDA)

The USDA Natural Resource Conservation Service (NRCS) rates weeds based on “characteristics of being aggressive and difficult to manage, parasitic, a carrier or host of deleterious insects or disease, and being non-native, new to, or not common to the United States or parts thereof” (USDA 2009). Weeds that meet these criteria are assigned a “NW” (noxious weed) or a “Q” (quarantine) designation. The SFWMA database contains 2 “NW” – Rated species in 11 different occurrences (Figure 6). No “Q” – Rated weeds were recorded in the SFWMA database.

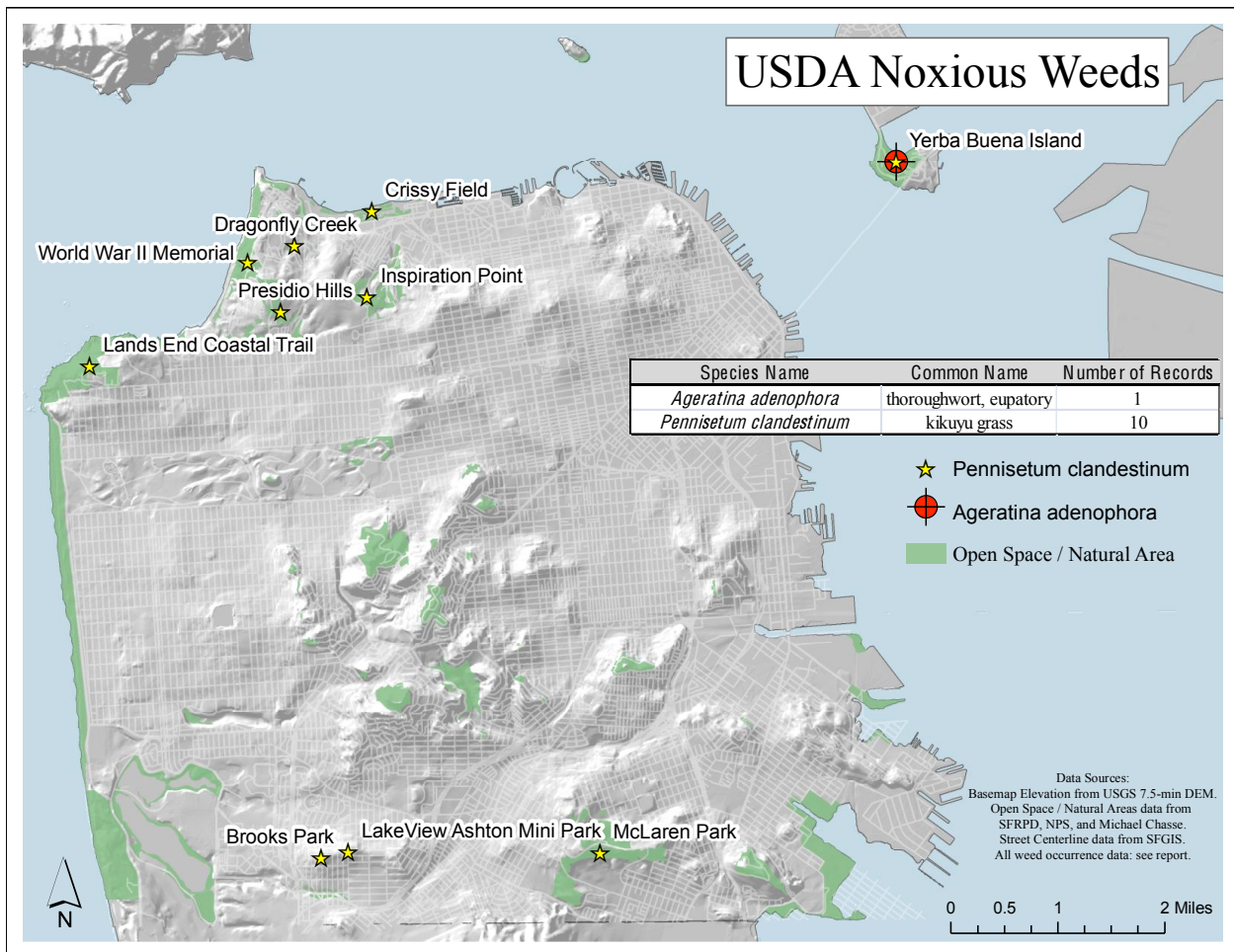


Figure 6: Locations of USDA Noxious Weeds recorded in the SFWMA database.

In addition to the non-native species noted in the various rating categories above, the SFWMA weed geodatabase contains an additional 863 reported occurrences of 191 species that are not on any weed rating list. Many of these species are relatively benign ornamentals, and others are species native to other habitats in California and the greater San Francisco Bay Area. However, there are some species on this list that could be considered undesirable and/or problematic weed species and therefore an inventory is justified. A list of these species and the number of reported occurrences for each species is included in Appendix D.

Discussion: Prioritizing Weeds in the SFWMA

With limited time and resources available to manage the 351 non-native weed species scattered over 3,000 reported occurrences in San Francisco County, establishing priorities for monitoring and treatment of weed infestations is a critical step in gaining ground in the effort to restore and protect natural areas. Although several rating and ranking systems already exist to sort through weeds by species (CDFA, Cal-IPC, SFWMA rating, USDA Noxious weeds), the list of weed occurrences in San Francisco County is so extensive that even the highest-rated categories of each of these systems contain counts of occurrences beyond the ability of current resources to address. This section outlines two important areas of prioritization for the SFWMA: the creation of a priority species list to be used in directing eradication projects; and recommendations for future mapping efforts to combine weed location information with data on the location of resources with high protection value.

SFWMA Priority Weed List for Management

After the collection of weed data and assemblage of the SFWMA geodatabase during the early summer of 2009, analysis of the database was conducted to utilize the weed data for strategic planning of WMA efforts. During SFWMA meetings in the late summer and fall of 2009, the records of non-native plant species in the SFWMA database were examined to determine species and populations that would be targeted for SFWMA eradication/control projects. After viewing the results of the data included in the database, active members of the SFWMA collectively decided that a prioritization system would be needed to simplify the list of 351 species and 3,161 occurrences into a shorter list of the most problematic weeds. Such a priority list could then be used to inform and direct specific SFWMA eradication and or suppression projects.

The first part of this process involved objectively ranking weeds by species using established ranking systems. Before the data could be manipulated, any non-native species listed in the SFWMA database that did not have any weed rating (CDFA, Cal-IPC, USDA, or SFWMA) was removed from the potential list of priority species. This resulted in a list of 156 weed species that were designated as a weed by any rating of any level in the aforementioned lists. Further, the Cal-IPC and SFWMA rating systems were selected as the systems to utilize in sorting the species. These two rating systems were employed as they are the two systems that

most consider ecological impact to native biodiversity on a local scale in their criteria. The CDFA and USDA weed ratings were not considered in ranking species for local priority because these rankings reflect the importance of a particular species at the state and national scales, respectively. Therefore, the records of species with high CDFA and USDA weed ratings will be reported to the respective agencies, but not used in further prioritization at the local level for the SFWMA.

After the SFWMA and Cal-IPC rating systems were selected for this analysis, a rating system was devised during SFWMA meetings (Figure 7).

- **Step 1:** All species were sorted by their SFWMA rating, with 1 being the highest priority; and species that were previously not given a SFWMA rating being the lowest priority.
- **Step 2:** Within each SFWMA rating level, species were sorted by the Cal-IPC rating with “High” being the highest priority and “NL” being the lowest priority.
- **Step 3:** The top 25 were designated high priority species for weed management projects.
- **Step 4:** To ensure that this quantitative ranking of priority species did not exclude weeds known to be problematic, the priority list was then examined by local weed management experts at the subsequent SFWMA meeting. A list of proposed changes was compiled, and SFWMA members discussed each species individually. After voting on each proposed change to the list, some species were added to the top 25 list, while some species were removed. This process resulted in a list of species with the highest priority for eradication and control efforts directed by the SFWMA (Table 7).

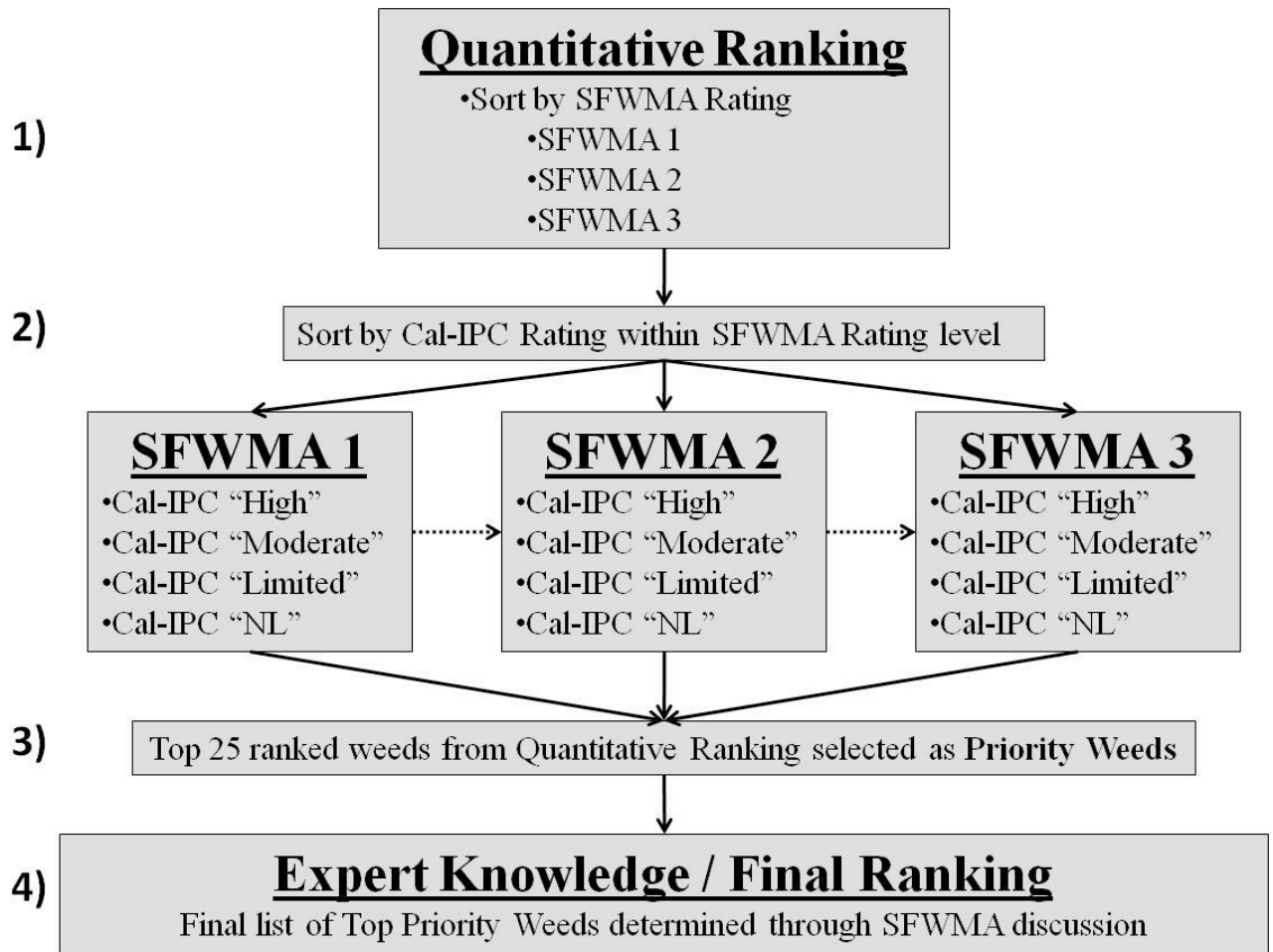


Figure 7: Schematic diagram of the SFWMA prioritization process. Steps are noted along the left-hand edge of the figure. 1) Species were first sorted by SFWMA rating, 2) then by Cal-IPC rating within each level of SFWMA rating. 3) The list was then cut-off at the top 25 species which were designated the Priority Weeds. 4) This list was then iteratively vetted by SFWMA members until a final list was determined. Solid lines represent the sequence of ranking procedures; dotted lines represent priority rank weight (arrows point from higher rank to lower rank).

Table 6: SFWMA Priority Weed List for Management in alphabetical order. “San Francisco Six” species are noted in bold. See Figure 5 for the distribution of records for these species.

Species Name	Common Name	Number of Occurrences
<i>Ammophila arenaria</i>	European beach grass	4
<i>Brassica rapa</i>	field mustard	13
<i>Carduus pycnocephalus</i>	Italian thistle	26
<i>Centaurea solstitialis</i>	yellow starthistle	14
<i>Centranthus ruber</i>	valerian	17
<i>Cortaderia jubata</i>	jubata grass	23
<i>Cortaderia selloana</i>	pampas grass	13
<i>Cytisus scoparius</i>	Scotch broom	11
<i>Delairea odorata</i>	Cape ivy, German ivy	39
<i>Ehrharta erecta</i>	ehrharta	45
<i>Eucalyptus globulus</i>	blue gum eucalyptus	47
<i>Festuca arundinacea</i>	alta fescue, tall fescue	12
<i>Foeniculum vulgare</i>	fennel	45
<i>Genista monspessulana</i>	French broom	41
<i>Hedera helix/canariensis</i>	English ivy, Algerian ivy	44
<i>Holcus lanatus</i>	velvet grass	25
<i>Hypochaeris radicata</i>	hairy dandelion, cats' ears	29
<i>Ludwigia hexapetala</i>	water primrose	1
<i>Oxalis pes-caprae</i>	yellow oxalis	38
<i>Plantago lanceolata</i>	English plantain	41
<i>Raphanus sativus</i>	radish	46
<i>Rubus armeniacus (syn. R. discolor)</i>	Himalayan blackberry	41
<i>Rumex acetosella</i>	sheep sorrel	37
<i>Scabiosa atropurpurea</i>	pinchusion flower	3
<i>Spartina alterniflora</i>	spartina	1

SFWMA “Watchlist Weeds”

In addition to the SFWMA Priority Weeds designated above, there are several species that are currently priority weeds of major concern that are prevalent in neighboring WMAs, but either not currently present in San Francisco or in a limited area (Table 8). These species were selected through discussion among weed experts at SFWMA meetings. As they have shown to be problematic in areas adjacent to the SFWMA and could potentially enter San Francisco and spread if appropriate attention is not given, these species should be monitored closely in the SFWMA.

Table 7: List of "Watchlist Weeds" that are considered to be problematic in other WMAs, and are either not present in San Francisco County, or exist in small numbers. SM = San Mateo; M-S = Marin Sonoma; AL = Alameda. Information on presence in other county was obtained through CalFlora (2009) and WMA websites of neighboring counties.

Species Name	Common Name	Number of Occurrences	Neighboring Counties
<i>Chondrilla juncea</i>	skeletonweed	1	M-S, AL, SM
<i>Taeniatherum caput-medusae</i>	medusahead	3	M-S, SM
<i>Hypericum canariense</i>	Canary Island's St. John's wort	0	SM, M-S,
<i>Cirsium arvense</i>	Canada thistle	1	M-S, AL
<i>Dittrichia graveolens</i>	stinkwort	1	M-S, AL, SM
<i>Phalaris aquatic</i>	Harding grass	3	M-S, AL, SM
<i>Lepidium latifolium</i>	perennial pepperweed	3	M-S, AL, SM
<i>Ulex eropaea</i>	gorse	1	M-S, AL, SM
<i>Ageratina adenophora</i>	eupatory, thoroughwort	3	M-S, AL
<i>Salsola soda</i>	salt marsh thistle	3	AL
<i>Arundo donax</i>	giant reed	1	AL

Data Needs for Further Prioritization

Establishing the above Priority Weed List for Management in the SFWMA is a critical first step in directing WMA efforts toward the eradication and/or control of specific weed populations. To design specific action plans for projects, several pieces of information need to be collected on each of the occurrences. These are listed below:

- Options for treatment techniques and appropriate treatment seasons will be determined on a species-by-species level.
- Because this database implies simply the presence of a weed in a particular location, information on the size and condition of each infestation is needed. This detailed information exists in the database for some of the occurrences, however it may be outdated, and for the majority of species occurrences this information is currently absent.
- The feasibility of each infestation will need to be assessed. Feasibility will be determined by the ecophysiology of the species, the available treatment options, and the accessibility of the infestation for treatment.
- The number of reported occurrences for each particular species can be used to assess the potential for *eradication* (few occurrences) or *control* (many occurrences) efforts.

Prioritizing Weed Species and/or Populations for High-Resolution Mapping

The SFWMA weed geodatabase now contains 3,161 records of 351 different non-native species occurrences in San Francisco. However, due to the issues with the varying spatial resolution of the data submitted to this database, the spatial detail of this information is fairly coarse. In an effort to improve on the spatial resolution and utility of this information, we present several recommendations for future mapping endeavors. Due to the enormity of the weed occurrences in San Francisco, fine scale mapping is only feasible on a small subset of the weed populations. Therefore, the following suggestions could aid in identifying specific populations of weeds for high-detail mapping. In addition, by including data on several other variables in the geospatial dataset available to SFWMA members, analyses could be performed which would aid in identifying populations of weeds that are of particular threat to native plants based on their location.

a. Filling Fine-Scale Data Gaps

Using the Priority Weed List for Management, populations of species that are at or near the top of the list for which there is no accurate fine-scale spatial data could be selected as future mapping projects. Since these species would theoretically be at the top of the list for eradication and/or weed control projects, this data will prove crucial to the planning of projects as well as the monitoring of weed populations.

b. Identifying “High-Value” Sites

If natural area sites in San Francisco that were of particularly high habitat value were determined, these areas could be prioritized for high resolution mapping to be conducted on the highest rated priorities in these areas, or within a certain distance of these areas.

c. Combining Weed and Rare Plant / Wildlife Spatial Data for Analysis

Information on the location of rare and/or sensitive plants / wildlife could be used in concert with the existing coarse-scale weed data to identify weeds that are in particularly close proximity and pose a significant threat to rare plant/wildlife habitat. This could potentially be done through a Euclidean distance GIS analysis from known rare plant locations to identify the nearest weed population that meets desired criteria. The information could be derived from the California Natural Diversity Database (CDFG 2009), or other local agency data regarding rare plant locations.

d. Expanding Opportunities for Further Data Collection and Analysis

Due to the limited resources of the SFWMA, it would be a great benefit to identify other interested groups who could participate in the mapping of additional weed populations and collecting fine-scale data on the extant populations. One possible

opportunity would be to advertise project ideas to graduate and undergraduate students in the San Francisco State University (SFSU) Geography, Environmental Studies, and Biology departments. Students are often looking for project ideas in various GIS, natural resource management, and field method classes; this setup could be a mutually beneficial relationship between SFSU students and the SFWMA.

Outstanding Considerations for SFWMA Geodatabase

Due to the nature of a project such as this, where data were collected from multiple sources, in various formats, and covering an extended period of time, there are many inherent gaps and limitations for the utility of this data for analysis.

Data Gaps

While every effort was made to contact and solicit data from any relevant organization and/or individual within San Francisco with information on weeds and/or non-native species, there are some considerable gaps in the data collected. Some significant natural areas exist from which no data was entered into the database (e.g. Candlestick Point State Recreation Area). Additionally, the data recorded constitute a list of weeds and non-native plants observed and recorded at one point in time. However, because a plant was not observed does not confirm that it does not exist in an area.

Limitations

Because the information contained in the SFWMA weed geodatabase was collected from a multitude of sources, any potential user must be aware of several important limitations of this dataset. The spatial resolution of this dataset ranges from detailed descriptions of the number of individual plants in some cases, to a mere record of a species being present in an open space in other cases. It therefore goes without saying that all occurrences even of a particular species should not be treated as equal in extent and impact. In addition to the variable spatial resolution of the data, the manner and intensity in which weeds were surveyed is likely to be very inconsistent within the entire dataset. The survey intensity ranges from comprehensive biological inventories of natural areas to incidental casual observations reported by individuals.

The time-sensitive nature of the species occurrence record data in the database presents another significant limitation to the use and interpretation of this report. While every attempt will be made by the SFWMA to keep the non-native species database current and updated as new records come in, the information contained within this report represents a snapshot-in-time of 2009. Just as new occurrences of weeds are appearing all the time, old records of weeds within the database may have spread considerably or become eradicated since the time the observation was recorded.

Together, these limitations need not render this database useless, but only are noted to emphasize the need to collect or verify detailed information on each occurrence before any treatment project plans are finalized.

Conclusions

Recommended Updates to SFWMA Strategic Plan

Now that a Priority Weed List has been systematically developed for the SFWMA, there are several recommended updates to the SFWMA Strategic Plan.

- Because there are now two lists of weeds for San Francisco, the 2005 list should be referred to as the “Priority Weed List,” while the list produced in 2009 should be referred to as the “Priority List for Management,” as it is a subset of the larger “Priority Weed List.”
- A critical update would be to include the Priority Weed List for Management (Table 7), as this list helps to focus the SFWMA efforts on a small subset of species present in San Francisco known to be most problematic.
- Using the Priority Weed List for Management and the Watchlist Weed List, WMA projects can now be directed toward suppression and containment of widespread weeds, while weeds with few reported occurrences should be targeted for eradication.
- The “Survey, Inventory, and Mapping” section of the Strategic Plan should be updated now that data collection from SFWMA members has been conducted. These updates should reflect future needs of mapping the highest priority species at a fine resolution for more detailed monitoring and management planning.
- Based on the minimum data standards for BAEDN/CalFlora, an agreed upon set of attributes to be recorded at each future weed observation should be determined. One of the biggest challenges of the Preliminary Mapping and Assessment Project was the melding together of data in widely varying formats. A SFWMA or regional mapping standard for weed occurrences could alleviate the need for data processing. These standards should be discussed in the Strategic Plan.
- Examine the Priority Weed List created by the SFWMA in 2005 for any proposed changes to rankings (1, 2, and 3) based on the quantitative data on number of occurrences now available in this geodatabase. No major omissions in the 2005 Initial Priority List were noted, and the results of the geodatabase creation indicate that there is quantitative justification for the Initial Priority Weeds. However, any species with a high frequency in the SFWMA database that are not listed in the Priority Weed List should be considered for assignment of a SFWMA Priority ranking.

- Information about accessing the SFWMA database at the CalFlora/BAEDN website (once it has been submitted and the transfer completed) should be included in both the Strategic Plan and the SFWMA website.
- Any agencies or individuals who have contributed weed location information (Appendix A) to the SFWMA geodatabase, but are not currently SFWMA members, should be recruited to join the SFWMA and sign the Memorandum of Understanding.

Coordination with Regional Weed Mapping Efforts

Coordinating weed control efforts at multiple scales is critical to gaining ground in the effort to protect native biodiversity. Just as the SFWMA now houses this geodatabase representing the collective weed occurrence information from various land managers in San Francisco, the SFWMA is a piece of a larger regional, statewide, and federal system. To assist in coordinating weed control projects beyond the borders of San Francisco County, the SFWMA weed geodatabase will be uploaded to the BAEDN database and to the CalFlora database; thus weaving SFWMA into the Regional and Statewide effort. This transfer of data is expected to occur in early 2010, after which point the CalFlora/BAEDN Weed Observation Entry portal (<http://www.calflora.org/app/wentry/wentry.html>) will serve as the main interface for users to interact with this dataset and future records.

Future Additions to the SFWMA website

In addition to the updated Strategic Plan, the SFWMA website serves as a critical gateway for communicating weed management data to a broader interested audience in San Francisco and the Bay Area. Therefore several recommendations are suggested for the SFWMA website.

- This report (either in its entirety or in smaller sections) should be made available in PDF form on the SFWMA website.
- The information from the geodatabase could be used to create static distribution maps on the website for users to investigate.
- A section can be added to the SFWMA website for the newly created “Watchlist Weeds”; this link would be updated regularly as new species arise.
- A list of suggested research project topics and ideas for SFSU students could be supplied on the website based on current SFWMA needs and information gaps.

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