



Invasive Plant Species Early Detection in the San Francisco Bay Area Network

2015 Annual Report

Natural Resource Data Series NPS/SFAN/NRDS—2017/1123



ON THE COVER

Invasive hanging sedge (*Carex pendula*, center of photo) on the bank of Redwood Creek, Muir Woods.
Photograph by: by Eric Wrubel, NPS

Invasive Plant Species Early Detection in the San Francisco Bay Area Network

2015 Annual Report

Natural Resource Data Series NPS/SFAN/NRDS—2017/1123

Eric Wrubel and Raphaela E. Floreani Buzbee

National Park Service
San Francisco Bay Area Network
Inventory & Monitoring Program
Fort Cronkhite Building 1063
San Francisco, California 94965

October 2017

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is used to disseminate results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service mission. The series provides contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the [San Francisco Bay Area Network Inventory and Monitoring website](#) and the [Natural Resource Publications Management website](#). To receive this report in a format that is optimized to be accessible using screen readers for the visually or cognitively impaired, please email irma@nps.gov.

Please cite this publication as:

Wrubel, E., and R. E. Floreani Buzbee. 2017. Invasive plant species early detection in the San Francisco Bay Area Network: 2015 annual report. Natural Resource Data Series NPS/SFAN/NRDS—2017/1123. National Park Service, Fort Collins, Colorado.

Contents

	Page
Tables.....	v
Appendices.....	v
Executive Summary	vi
Acknowledgments.....	vii
Introduction.....	1
Background.....	1
Objectives	1
Methods.....	3
Species List Revisions	3
Prioritization of Survey Areas	5
Prioritization of Species	5
Revisit Schedules.....	6
Field Methods.....	6
Database and Data Collection	8
Results.....	9
GOGA	9
Search Effort.....	9
Species Found.....	9
PORE.....	10
Search Effort.....	11
Species Found.....	11
PINN.....	12
Search Effort.....	12
Species Found.....	13
JOMU	14
Search Effort.....	14
Species Found.....	14
Discussion	15

Contents (continued)

	Page
Species Occurrences.....	15
New Taxa.....	15
Outreach	15
Database Development.....	15
Collaboration	16
Literature Cited	17
Glossary	19

Tables

	Page
Table 1. Revisions to the GOGA priority species list for 2015.	3
Table 2. Revisions to the PORE priority species list for 2015.	4
Table 3. Revisions to the JOMU priority species list for 2015.	5
Table 4. Tiered levels of data collection.	7
Table 5. GOGA 2015 survey results. Total new occurrences of priority species.	9
Table 6. PORE 2015 survey results. Total new occurrences of priority species.	11
Table 7. PINN 2015 survey results. Total occurrences of priority species in belt transects.	13
Table 8. JOMU 2015 survey results. Total new occurrences of priority species.	14

Appendices

	Page
Appendix A: 2015 lists of priority invasive species in SFAN parks.	20
Appendix B: New species recorded in SFAN parks during early detection surveys.	30
Appendix C: Revisions to protocol methods	38
Appendix D: Interactive web maps of 2015 survey results.	42

Executive Summary

This report summarizes the results of the 2015 season of the Invasive Plant Species Early Detection program (ISED) for the Inventory and Monitoring Program of the San Francisco Bay Area National Parks Network (SFAN). Invasive plants (see Glossary) represent a high priority vital sign for SFAN because of the negative effects they have on park resources, including altering ecosystem processes (fire regime, hydrology, soil biogeochemical cycling, etc.), reducing habitat quality and scenic value, and increasing trail maintenance needs. The 2015 early detection surveys were conducted in Golden Gate National Recreation Area (GOGA), John Muir National Historic Site (JOMU), Pinnacles National Monument (PINN), and Point Reyes National Seashore (PORE). Objectives and methods for the 2015 field season were revised from a peer-reviewed protocol published in the NPS Natural Resource Report series (Williams et al. 2009). The methods for survey frequency and prioritization of survey areas were revised in GOGA and PORE, and a belt transect method was piloted at PINN.

Including the years when pilot data was collected, 2015 was the seventh field season of data collection in PINN and JOMU, the eighth in PORE, and the ninth in GOGA. Ninety-six miles of trails and roadsides were surveyed within GOGA and 909 occurrences of target weed species were recorded. Fifty-two miles of trails and roadsides were surveyed at PORE and 216 occurrences of target weeds were recorded. Ten miles of trails and roadsides were surveyed at PINN and 16 occurrences of target weeds were recorded. Six miles of trails were surveyed at JOMU, and 29 priority weed occurrences were recorded. Three species that are new to the SFAN parks were recorded and collected during the 2015 early detection surveys. Volunteers played an important role in the implementation of the 2015 field surveys, contributing a total of 414 survey hours.

Priority plant populations were mapped using the new internet-based Calflora Weed Manager data system, which was used to display and communicate results to a broad audience. Survey results were reported on a monthly basis during the field season, and ISED collaborated on early detection/rapid response efforts with SFAN staff and partners, and worked with local land management agencies and non-profits to strengthen the regional early detection network.

Acknowledgments

In addition to the primary authors, many contributors provided critical assistance. We thank A. Williams for producing the first early detection annual report, which was used as a template to create this report. We also thank D. George, D. Adams, S. Mohren, M. Koenen, J. Rogers, and N. Howe for providing valuable comments on this manuscript or previous years' reports; M. Alvarez and the Habitat Restoration Team for contributing records to the GeoWeed and Weed Manager databases; E. Hamingson and the Habitat Restoration Program for providing important insights into invasive plant issues at PORE; B. Johnson for providing important insights into invasive plant issues at PINN; F. Villalba for providing important insights into invasive plant issues at JOMU; the Golden Gate National Parks Conservancy and the Point Reyes National Seashore Association for support and partnership; the early detection seasonal biologists, N. Stevenson (2014), and R. Floreani Buzbee (2015), and the invaluable contributions of early detection interns, Kristofer Daum, Peter Ibsen, and Rachel Chen,.

Introduction

Background

Invasive plant species negatively affect park resources and visitor enjoyment in several ways, including altering landscapes and fire regimes, reducing native plant and animal habitat, blocking views, and increasing trail maintenance needs. Invasive species are second only to habitat loss as threats to global biodiversity (Scott and Wilcove 1998). Given the extraordinary biodiversity of the San Francisco Bay Area and urban development pressures, the San Francisco Bay Area Network (SFAN) parks serve as crucial habitat for native species. Over 100 rare plant species can be found in SFAN parks. Invasive plants threaten many of these rare species. For example, in Golden Gate National Recreation Area (GOGA), 25 species of exotic or non-native plants have been noted as directly threatening rare plant populations (NPS 2004). Trails, roads, and waterways are the main routes of infestation of new exotic species. Monitoring these routes is the most effective way to prevent the spread of existing species and the infestation of new species (McNeely et al. 2001).

During vital sign prioritization by SFAN I&M, invasive plant species early detection ranked as the second most important vital sign for the network (Adams et al. 2006). The Invasive Plant Species Early Detection protocol (ISED) was developed by SFAN I&M to locate new, isolated infestations of invasive plants before they become entrenched in the network parks (Williams et al. 2009). For this vital sign, SFAN I&M staff ranked species in each park to prioritize search efforts. Every year, exotic species lists for each park are re-prioritized, if necessary, based on previous survey data and updated management concerns. Appendix A contains the 2015 priority exotic species lists for each park unit.

Objectives

Objectives for the 2015 field season were revised from the early detection protocol (Williams et al. 2009). The annual survey frequency for subwatersheds in GOGA and PORE was modified beginning in 2015, and belt transects were piloted at PINN, as described in the methods section of this report. The revised objectives for the 2015 field season were as follows:

- 1) Survey all roads and trails in approximately one-third of all subwatersheds within GOGA and PORE, noting presence and absence of priority exotic species. Use visual assessment and GPS technology to accurately map populations of the top-priority exotic plant species based on ranked species lists.
- 2) Train interns and volunteers to conduct early detection surveys for top-priority SFAN exotic plants.
- 3) Train GOGA and PORE staff plus park-partners to identify top-priority SFAN exotic plants for opportunistic early detection of new populations during regular work activities.
- 4) Revise priority species lists based on information acquired during the previous season.
- 5) Contribute new species to park unit NPSpecies vascular plant lists.

- 6) Survey select roads and trails, for priority species at PINN, utilizing standard survey methods and pilot belt transect methods.
- 7) Survey all trails in the Mt Wanda section of JOMU.

Methods

Methodology follows the SFAN early detection of invasive plant species protocol (Williams et al. 2009), revised in 2015 as described below. The following section briefly describes sampling methods, scheduling, data management, and data collection detailed in the protocol, and summarizes changes to methodology implemented in 2015.

Species List Revisions

The 2015 priority lists for each park were revised in response to concerns of resource management staff based on results of the 2014 surveys. The GOGA and PORE priority lists were reconciled so that they both contained the same high priority species (Tables 1 and 2).

After each field season, the species priority lists for each park unit are updated for the following field season. The majority of list revisions were made immediately following the 2007 and 2008 seasons (Williams and Speith 2008, Williams and Jordan 2010). Minor list revisions were made in subsequent years (Williams et al. 2011, Steers et al. 2011, Wrubel and Steers 2012, Wrubel and Steers 2013, Wrubel 2015, Wrubel 2017). The species list revisions for 2015 are presented below. The full 2015 species lists for each park are included in Appendix A. Recent finds of species new to SFAN parks are documented in Appendix B.

Nine species were added to the GOGA 2015 priority list, and the nomenclature was revised for one species (Table 1). Fifteen species were added to the PORE 2015 priority list, and the nomenclature was revised for one species (Table 2). One species was added to the JOMU 2015 priority list, and the nomenclature was revised for one species (Table 3). No species were added or removed from the PINN priority list for 2015.

Table 1. Revisions to the GOGA priority species list for 2015.

Scientific Name	Common Name	2014 List	2015 List	Justification
<i>Aegilops triuncialis</i>	barbed goatgrass	N/A	1	From PORE list.
<i>Allium vineale</i>	vineyard onion	N/A	1	Previously only known from lawns at Fort Cronkhite. GOGA recent find on Miwok Trail (Spring 2014). California list B Noxious Weed (CDFA 2006).
<i>Clematis vitalba</i>	traveler's joy	N/A	1	GOGA recent identification (Fall 2014).
<i>Nassella tenuissima</i>	finestem needlegrass	N/A	1	GOGA recent find (June 2014).
<i>Acacia paradoxa</i>	kangaroo thorn	N/A	1	GOGA recent find (Spring 2014).
<i>Datura stramonium</i>	jimsonweed	N/A	2	From PORE list.
<i>Fallopia japonica</i>	Japanese knotweed	N/A	1	GOGA recent find. Observed in Lobos Creek in Summer 2013, and mapped in Spring 2014.

Table 1 (continued). Revisions to the GOGA priority species list for 2015.

Scientific Name	Common Name	2014 List	2015 List	Justification
<i>Solanum aviculare</i>	New Zealand nightshade	2	2	Revised name of synonym <i>Solanum laciniatum</i> per Baldwin et al. (2012).
<i>Sorghum halepense</i>	Johnson grass	N/A	2	GOGA recent find (July 2014) and on PORE list.
<i>Stipa miliacea</i>	smilo grass	N/A	2	GOGA recent find (July 2014).

Table 2. Revisions to the PORE priority species list for 2015.

Scientific Name	Common Name	2014 List	2015 List	Justification
<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	N/A	1	From GOGA list.
<i>Nassella tenuissima</i>	finestem needlegrass	N/A	1	GOGA recent find (June 2014).
<i>Spartium junceum</i>	Spanish broom	N/A	1	From GOGA list.
<i>Stipa chaetophora</i>	stipoid ricegrass	N/A	1	From GOGA list.
<i>Stipa manicata</i>	Andean tussockgrass	N/A	1	From GOGA list.
<i>Ammophila arenaria</i>	European beachgrass	N/A	2	From GOGA list. Widespread at PORE.
<i>Buddleja davidii</i>	butterfly bush	N/A	2	From GOGA list.
<i>Calendula arvensis</i>	field marigold	N/A	2	From GOGA list.
<i>Geranium purpureum</i>	herb Robert	N/A	2	From GOGA list
<i>Geranium robertianum</i>	Robert geranium	N/A	2	From GOGA list
<i>Ligustrum lucidum</i>	glossy privet	N/A	2	From GOGA list
<i>Ligustrum vulgare</i>	European privet	N/A	2	PORE recent find in Tocaloma area (July 2014).
<i>Rubus armeniacus</i>	Himalayan blackberry	2	2	Revised name of synonym <i>Rubus discolor</i> per Baldwin et al. (2012).
<i>Solanum aviculare</i>	New Zealand nightshade	N/A	2	PORE recent find along Limantour Road (November 2014).
<i>Stipa miliacea</i>	smilo grass	N/A	2	GOGA recent find (July 2014).
<i>Tradescantia fluminensis</i>	small leaved spiderwort	N/A	2	From GOGA list.

Table 3. Revisions to the JOMU priority species list for 2015.

Scientific Name	Common Name	2014 List	2015 List	Justification
<i>Xanthium spinosum</i>	spiny cocklebur	N/A	1	Species was not included in 2012-2014 priority lists because it was considered native at the time. However, it is reinstated on the list because its native range is in dispute, it is considered invasive worldwide, and has likely been spread by anthropogenic activities.
<i>Rubus armeniacus</i>	Himalayan blackberry	2	2	Revised name of synonym <i>Rubus discolor</i> per Baldwin et al. (2012).

Prioritization of Survey Areas

The use of subwatershed priority levels to inform survey frequency at GOGA and PORE was discontinued in 2015. Subwatersheds were originally prioritized by number and degree of current infestations, risk of further infestations, and priority of natural resources present (Williams et al. 2009). Higher priority subwatersheds were to be surveyed more frequently than lower priority subwatersheds, to increase the surveillance level in these areas. Subwatersheds at GOGA and PORE will now be surveyed with equal frequency, once in a three year survey cycle. Appendix C summarizes the rationales for changes to the survey frequency by subwatershed priority level.

PINN is divided into 18 management units that roughly correspond to subwatersheds. None of these units have been prioritized based on their risk of invasion and/or harm to significant biological resources. Instead, surveys are performed on roads, trails, pig fence, and riparian corridors that are of concern to the Pinnacles resource management division.

JOMU contains a small amount of natural vegetation centered on Mount Wanda. This area is not subdivided into smaller subwatersheds or management units. Roads and trails in the entire Mount Wanda open space can be surveyed each year. Surveys do not occur in the orchard and landscaped areas maintained at the historic Muir residence across the freeway (State Hwy. 4) to the north.

Prioritization of Species

Full prioritization methods can be found in the protocol and subsequent annual reports, but are summarized briefly here. The lists of target species for GOGA, PINN, and PORE were initially prioritized based on current knowledge and rankings. This included summing recognized invasiveness and stratifying by feasibility of control based on categories of actual or estimated infested acreage in a park. The priority levels were revised for some species in subsequent years, as more distribution information became available. The majority of these revisions were made immediately following the 2007 and 2008 seasons (Williams and Speith 2008, Williams and Jordan 2010).

Revisit Schedules

The survey schedule for GOGA and PORE subwatersheds was modified in 2015 based on results from the first five-year survey cycle. The survey schedule was evaluated, as recommended by the protocol, to determine if it was at the appropriate frequency given observed spread rates and rapid-response capabilities, and the rationale for unequal survey frequency among subwatersheds was re-examined (Appendix C).

In the modified survey schedule adopted in 2015 for GOGA and PORE, each subwatershed will have an equal sampling effort, and will be surveyed once within a three-year survey cycle. Approximately one-third of the total subwatersheds in both parks will be surveyed each year. GOGA and PORE have 234 subwatersheds combined, so approximately 78 subwatersheds will be sampled each year.

In the first five year survey cycle, the frequency of surveys in each subwatershed was determined by the subwatershed priority level (Williams et al. 2009). High priority subwatersheds were surveyed annually, significant priority were surveyed biennially, moderate priority were surveyed once every three years, and low priority were surveyed once every five years; approximately 55% of subwatersheds in each park were visited each year.

Baseline surveys at PINN were conducted from 2009 – 2014. All roads, trails, campgrounds, fence lines and major drainages were surveyed at least once by 2013. In 2015, ISED began pilot work for belt transect surveys along roads and trails. This method censuses discrete areas to better track spatial trends in presence and abundance of target species at the scale of the park. The results of the pilot work will be used to predict annual survey mileage, and the optimal number of years to complete a full survey cycle of all roads and trails.

At JOMU, all roads and trails at Mount Wanda have been surveyed annually since 2009. No change to this approach was made in 2015.

Field Methods

Searches were conducted by teams of one to four individuals along trails and roads within the parks. The official search area used for recording both positive (plant occurrence) and negative data (areas where target plants were not found) was restricted to 5 m on either side of the route.

At GOGA, PORE and JOMU observers recorded location and associated biological information (phenology, habitat, distribution) of priority target plant populations that were encountered along the survey route. The level of detail for data collection was dictated by the ranking of the plant on the priority list, and the extent of the infestation (Table 4).

Table 4. Tiered levels of data collection.

Priority Levels	Explanation	Data Collected
List 1 (High Priority Plants)	List 1 plants are highly invasive and are typically not widespread. Control or even eradication is often feasible	Polygon <i>assessments</i> are recorded for all patches, regardless of their size.
List 2 (Medium Priority Plants)	List 2 plants are highly invasive and usually more common than List 1 species. Small, outlier patches may be targeted for eradication or control. Uncommon species of concern are also listed here to improve our understanding of their distribution in the park.	Point <i>occurrences</i> are recorded for all patches, and buffered point <i>assessments</i> are recorded for patches smaller than 100 m ² .
List 3 (Lower Priority Plants)	This category includes all other non-native plants. These may be widespread invasives that are difficult to control at the scale of the park, or less common species that do not cause significant ecological harm.	<i>Presence/absence</i> is recorded by subwatershed. No points or polygons are mapped.

Target species encountered during surveys were recorded either as *assessments*, or *occurrences*, or by *presence/absence*. An assessment maps the spatial extent, estimated percent cover, number of plants, and phenology of a patch. An occurrence maps a point to indicate the presence of a patch at a specific location. Presence/absence is recorded for target species found within a subwatershed.

Polygon assessments were mapped for all list 1 species. Point occurrences were mapped for all list 2 species, and buffered point assessments were recorded for list 2 species if the patch size was less than 100 m². To create a buffered point, observers estimated the radius from the center of the patch to the farthest edge. Presence/absence by subwatershed was recorded for all list 3 species. All previously mapped observations were re-assessed according to the species priority level.

In 2015, ISED discontinued the mapping of point occurrences for List 3 species at GOGA, PORE, and JOMU. This priority level includes invasive non-native species that are abundant in the parks. Previously, presence/absence was recorded for all List 3 species, and point occurrences were only mapped if the patch size was less than 100 m². In practice, the mapping of List 3 species was often time consuming, and the data were difficult to interpret, because only a subset of small, outlier populations were recorded. In 2015, ISED continued to record presence/absence of List 3, and all other non-native species by subwatershed. The most recent tables of List 3 species for GOGA, PORE, and JOMU can be found in the 2014 ISED annual report (Wrubel 2017).

At PINN, ISED piloted a belt transect monitoring method in 2015. In this method, we segmented roads and trails into 100m transects, and collected data on presence or abundance of target species in each segment, within a distance of 5m from the edge of the road or trail feature. We recorded abundance for List 1 and 2 species observed in each transect, and presence for List 3 species. We also mapped polygon assessments in Weed Manager for each population of List 1 species observed. We used Arc Collector (ESRI, Redlands, California) on GPS-enabled tablets to locate the transects and record data.

All of the reported field data to date have been collected during surveys for the full list of species by observers with advanced identification skills. No data from unsupervised volunteers are entered into the database or are utilized for data analyses or incorporated into summaries reported herein. A detailed description of standard field methodology can be found in the early detection of invasive plants protocol: SOP 2- Mapping; SOP 3- Field Data Collection (Williams et al. 2009).

Database and Data Collection

In 2015 ISED discontinued use of the GeoWeed invasive plant mapping system and geodatabase, and migrated to the newly developed Calflora Weed Manager system (<http://calflora.org/entry/weed-mgr>). We migrated data to Weed Manager in winter 2014, and used it as the primary data collection and storage system for the 2015 field season. Weed Manager development is summarized in the discussion section of this report.

Results

The 2015 survey results are presented below. All data on species occurrences are based on the species lists for each park for the 2015 field season (Appendix A). Species nomenclature follows The Jepson Manual, Second Edition (Baldwin et al. 2012). Appendix D contains links to interactive web maps showing the location of occurrences, assessments and treatments mapped in each park in 2015.

GOGA

Search Effort

Ninety-six miles of trails and roadsides were surveyed within GOGA during the 2015 field season. In total, 6 people spent 473 hours to complete these surveys; 237 of these hours were contributed by four volunteers. Two of the volunteers were I&M interns, who worked for ISED at both GOGA and PORE for six months. The Golden Gate National Parks Conservancy (GGNPC) sponsored two additional interns, one through the GGNPC Academic Internship Program, and one through the GGNPC Advanced Youth Internship Program.

Species Found

In 2015, 896 new occurrences of target weed species (Lists 1 and 2) were recorded in GOGA during early detection surveys and entered into Weed Manager (Table 5). There were 231 occurrences of List 1 species and 665 occurrences of List 2 species. In total, 57 priority species were recorded during the GOGA surveys. No invasive plant species new to the park were documented in GOGA during 2015.

Table 5. GOGA 2015 survey results. Total new occurrences of priority species.

Priority	Scientific name	Common name	Occurrences
1	<i>Albizia lophantha</i>	Stink bean	3
1	<i>Ammophila arenaria</i>	European beachgrass	1
1	<i>Arctotheca prostrata</i>	Prostrate cape weed	14
1	<i>Carex pendula</i>	Hanging sedge	4
1	<i>Carpobrotus chilensis</i>	Sea fig	1
1	<i>Centaurea calcitrapa</i>	Purple star thistle	8
1	<i>Clematis vitalba</i>	Old man's beard	16
1	<i>Crataegus monogyna</i>	Hawthorn	5
1	<i>Cytisus scoparius</i>	Scotch broom	8
1	<i>Cytisus striatus</i>	Portuguese broom	1
1	<i>Dittrichia graveolens</i>	Stinkwort	2
1	<i>Euphorbia oblongata</i>	Eggleaf spurge	13
1	<i>Helichrysum petiolare</i>	Licorice plant	8
1	<i>Ilex aquifolium</i>	Holly	5
1	<i>Maytenus boaria</i>	Mayten	1

Table 5 (continued). GOGA 2015 survey results. Total new occurrences of priority species.

Priority	Scientific name	Common name	Occurrences
1	<i>Myriophyllum aquaticum</i>	Parrot's feather	3
1	<i>Nassella tenuissima</i>	Finestem needlegrass	1
1	<i>Pittosporum crassifolium</i>	Thick leaf box	7
1	<i>Pyracantha angustifolia</i>	Firethorn	14
1	<i>Robinia pseudoacacia</i>	Black locust	2
1	<i>Rytidosperma caespitosum</i>	Tufted wallaby grass	12
1	<i>Rytidosperma penicillatum</i>	Purple awned wallaby grass	48
1	<i>Scabiosa atropurpurea</i>	Pincushions	5
1	<i>Spartium junceum</i>	Spanish broom	1
1	<i>Stipa manicata</i>	Andean tussockgrass	11
1	<i>Stipa purpurata</i>	Bristly needle grass	1
1	<i>Trifolium angustifolium</i>	Narrow leaved clover	18
1	<i>Vinca major</i>	Vinca	18
2	<i>Acacia melanoxylon</i>	Blackwood acacia	39
2	<i>Ageratina adenophora</i>	Thoroughwort	25
2	<i>Agrostis avenacea</i>	Pacific bentgrass	1
2	<i>Bromus madritensis</i> ssp. <i>Rubens</i>	Foxtail brome	91
2	<i>Buddleja davidii</i>	Butterfly bush	1
2	<i>Calendula arvensis</i>	Field marigold	1
2	<i>Centaurea melitensis</i>	Tocalote	80
2	<i>Cestrum parqui</i>	Chilean jessamine	6
2	<i>Cynodon dactylon</i>	Bermuda grass	21
2	<i>Dactylis glomerata</i>	Orchardgrass	80
2	<i>Delairea odorata</i>	Cape ivy	23
2	<i>Dipsacus fullonum</i>	Wild teasel	10
2	<i>Eucalyptus globulus</i>	Blue gum	2
2	<i>Festuca arundinacea</i>	Reed fescue	78
2	<i>Fuchsia magellanica</i>	Hardy fuchsia	1
2	<i>Hedera helix</i>	English ivy	55
2	<i>Iris pseudacorus</i>	Horticultural iris	3
2	<i>Leptospermum laevigatum</i>	Australian tea tree	7
2	<i>Leucanthemum vulgare</i>	Oxe eye daisy	25
2	<i>Ligustrum lucidum</i>	Glossy privet	2
2	<i>Oxalis pes-caprae</i>	Bermuda buttercup	29

Table 5 (continued). GOGA 2015 survey results. Total new occurrences of priority species.

Priority	Scientific name	Common name	Occurrences
2	<i>Pennisetum clandestinum</i>	Kikuyu grass	31
2	<i>Phoenix canariensis</i>	Canary island date palm	2
2	<i>Rosa rubiginosa</i>	Sweet brier	6
2	<i>Rubus armeniacus</i>	Himalayan blackberry	37
2	<i>Salsola soda</i>	Alkali russian thistle	1
2	<i>Solanum aviculare</i>	New zealand nightshade	1
2	<i>Sparaxis tricolor</i>	Harlequin flower	6
2	<i>Tradescantia fluminensis</i>	Wandering jew	1
Total			896

PORE

Search Effort

Fifty-two miles of trails and roadsides were surveyed during the 2015 field season at PORE, including the PORE managed GOGA North District. In total, 5 people spent 231 hours to complete these surveys; 122 of those hours were contributed by three volunteers. Two of the volunteers were I&M interns, who worked for ISED at both GOGA and PORE for six months. The GGNPC sponsored one additional volunteer intern, through the GGNPC Academic Internship Program.

Species Found

In 2015, 212 new occurrences of target weed species (Lists 1 and 2) were recorded in PORE during early detection surveys and entered into Weed Manager (Table 6). There were 94 occurrences of List 1 species and 118 occurrences of List 2 species. In total, 30 priority species were recorded during the PORE surveys.

Two new non-native species were found during the 2015 early detection surveys that had not previously been documented on the PORE full list of vascular plants (NPSpecies 2015): broomcorn millet (*Panicum miliaceum* ssp. *miliaceum*), and purpletop vervain (*Verbena bonariensis*) Appendix B contains documentation for all species observed during early detection surveys from 2008-2015 that were new additions to the lists of vascular plants in SFAN parks.

Table 6. PORE 2015 survey results. Total new occurrences of priority species.

Priority	Scientific name	Common name	Occurrences
1	<i>Aegilops triuncialis</i>	goatgrass	2
1	<i>Albizia lophantha</i>	stink bean	1
1	<i>Anthoxanthum odoratum</i>	sweet vernal grass	11
1	<i>Brachypodium distachyon</i>	purple false brome	2
1	<i>Carthamus lanatus</i>	woolly distaff thistle	1
1	<i>Centaurea calcitrapa</i>	purple star thistle	1

Table 6 (continued). PORE 2015 survey results. Total new occurrences of priority species.

Priority	Scientific name	Common name	Occurrences
1	<i>Centaurea melitensis</i>	totalote	2
1	<i>Centaurea solstitialis</i>	yellow starthistle	1
1	<i>Cotoneaster franchetii</i>	cotoneaster	2
1	<i>Cotoneaster pannosus</i>	woolly cotoneaster	9
1	<i>Rytidosperma penicillatum</i>	purple awned wallaby grass	61
1	<i>Trifolium angustifolium</i>	narrow leaved clover	1
2	<i>Acacia melanoxylon</i>	blackwood acacia	1
2	<i>Arctotheca calendula</i>	cape weed	1
2	<i>Arctotheca prostrata</i>	prostrate cape weed	1
2	<i>Genista monspessulana</i>	French broom	5
2	<i>Glyceria declinata</i>	waxy mannagrass	1
2	<i>Hedera helix</i>	English ivy	11
2	<i>Ilex aquifolium</i>	holly	8
2	<i>Lathyrus latifolius</i>	sweet pea	14
2	<i>Leucanthemum vulgare</i>	ox-eye daisy	4
2	<i>Oxalis pes-caprae</i>	Bermuda buttercup	1
2	<i>Paspalum dilatatum</i>	dallis grass	21
2	<i>Pennisetum clandestinum</i>	kikuyu grass	4
2	<i>Phalaris elongata</i>	kolea grass	5
2	<i>Rubus armeniacus</i>	Himalayan blackberry	18
2	<i>Solanum aviculare</i>	New Zealand nightshade	7
2	<i>Tetragonia tetragonioides</i>	New Zealand spinach	4
2	<i>Vinca major</i>	bigleaf periwinkle	4
2	<i>Xanthium spinosum</i>	spiny cocklebur	8
Total			212

PINN

Search Effort

Ten miles of trails and roadsides were surveyed during the 2015 field season at PINN. ISED tested a pilot belt transect survey method, in which roads and trails were segmented into 100 m transects as described above in methods. In 2015 we surveyed 160 transects, or 16,000 m. In total, 4 people spent 88 hours conducting surveys; 44 of these hours were contributed by 2 volunteers, who were I&M interns working primarily for ISED at GOGA and PORE.

Species Found

In 2015, ISED recorded presence of 21 priority species in the belt transects. We recorded 20 List 1 species occurrences, 28 List 2 species occurrences, and 168 List 3 species occurrences, for a total of 216 species presence records (Table 7). All List 1 species and all treatments were also mapped in Weed Manager, for a total of 21 records.

No new non-native species were found during the 2015 early detection surveys that were not previously documented on the PINN full list of vascular plants (NPSpecies 2015).

Table 7. PINN 2015 survey results. Total occurrences of priority species in belt transects.

Priority	Scientific name	Common name	Occurrences
1	<i>Bromus tectorum</i>	cheatgrass	1
1	<i>Festuca perennis</i>	Italian ryegrass	1
1	<i>Festuca temulenta</i>	Darnel	15
1	<i>Malva parviflora</i>	Cheeseweed	1
1	<i>Poa bulbosa</i>	Bulbous bluegrass	1
1	<i>Tragopogon dubius</i>	yellow salsify	1
2	<i>Carduus pycnocephalus</i>	Italian thistle	2
2	<i>Carduus tenuiflorus</i>	slender-flowered thistle	2
2	<i>Centaurea solstitialis</i>	yellow starthistle	14
2	<i>Dactylis glomerata</i>	orchard grass	1
2	<i>Marrubium vulgare</i>	horehound	6
2	<i>Schismus arabicus</i>	Arabian schismus	3
3	<i>Amaranthus albus</i>	tumbleweed	1
3	<i>Brassica nigra</i>	black mustard	1
3	<i>Centaurea melitensis</i>	totalote	74
3	<i>Cirsium vulgare</i>	bull thistle	1
3	<i>Hirschfeldia incana</i>	shortpod mustard	30
3	<i>Lactuca serriola</i>	prickly lettuce	16
3	<i>Plantago lanceolata</i>	English plantain	5
3	<i>Rumex crispus</i>	curly dock	38
3	<i>Silybum marianum</i>	blessed milkthistle	2
Total			216

JOMU

Search Effort

Six miles of trails in the Mount Wanda section of JOMU were surveyed during the 2015 field season. In total, 4 people spent 21 hours conducting surveys; 11 of these hours were contributed by 2 volunteers, who were I&M interns working primarily for ISED at GOGA and PORE.

Species Found

In 2015, 29 new occurrences of target weed species (List 1 and 2) were recorded in JOMU during early detection surveys at Mt. Wanda and entered into Weed Manager (Table 8). There were 8 occurrences of List 1 species and 21 occurrences of List 2 species. In total, 17 priority species were recorded during the JOMU surveys.

One new non-native species, smilo grass (*Stipa miliacea* var. *miliacea*), was found during the 2015 early detection surveys that had not previously been documented on the JOMU full list of vascular plants (NPSpecies 2015). Appendix B contains documentation for all species observed during early detection surveys from 2008-2015, that were new additions to the lists of vascular plants in SFAN parks.

Table 8. JOMU 2015 survey results. Total new occurrences of priority species.

Priority	Scientific name	Common name	Occurrences
1	<i>Centaurea melitensis</i>	Tocalote	4
1	<i>Cynara cardunculus</i>	Cardoon	1
1	<i>Eucalyptus globulus</i>	Blue gum	1
1	<i>Genista monspessulana</i>	French broom	1
1	<i>Lepidium latifolium</i>	Perennial pepperweed	1
2	<i>Centaurea solstitialis</i>	Yellow starthistle	4
2	<i>Conium maculatum</i>	Poison hemlock	2
2	<i>Cotoneaster pannosus</i>	Woolly cotoneaster	2
2	<i>Cynodon dactylon</i>	Bermuda grass	1
2	<i>Dactylis glomerata</i>	Orchardgrass	2
2	<i>Foeniculum vulgare</i>	Fennel	1
2	<i>Hirschfeldia incana</i>	Mustard	1
2	<i>Lathyrus latifolius</i>	Sweet pea	1
2	<i>Olea europaea</i>	Olive	2
2	<i>Phalaris aquatica</i>	Harding grass	2
2	<i>Rubus armeniacus</i>	Himalayan blackberry	2
2	<i>Tribulus terrestris</i>	Puncture vine	1
Total			29

Discussion

Species Occurrences

As of 2014, all roads and trails in SFAN parks have been surveyed at least once. The occurrence data from 2015 and prior years reveal that collectively, invasive species are widespread throughout the park units of SFAN.

New records are only generated when a new patch is discovered, or the status of a known patch has changed, i.e. spatial extent, cover class or abundance class of a patch has changed. If a previously mapped patch is observed and its status is unchanged, no new data is recorded. Thus, if a species is actively recruiting in a park, the number of occurrences mapped each year should remain relatively constant or increase over time, while species that are not expanding their range in a park should show decreasing occurrences over time.

It should be noted that the number of occurrences reported indicates the frequency of patches detected, not the abundance of the species. For example, a patch may consist of a single plant, or a very large population. Assessments are also recorded in addition to occurrences for all List 1 species and also for all List 2 species that have a patch size < 100 m² (Table 4). These assessments include spatial extent, and estimated cover and number of individuals per patch. Assessments can be used to detect change in abundance of List 1 species over time; however, assessment data are not presented in this report.

New Taxa

In 2015, 3 plant taxa were discovered during early detection surveys that were new records for SFAN parks (NPSpecies 2015). Two of these three taxa were added to the 2016 park priority lists due to their potential invasiveness. Purpletop vervain was added to PORE priority list 2, and smilo grass was added to JOMU priority list 2. Appendix B contains documentation for all new taxa observed during early detection surveys from 2010–2015.

Outreach

Education and outreach play an important role in the engagement of a network of early detectors. Whenever possible, volunteers were trained in the field on an individual basis to conduct early detection surveys and map incipient populations of target invasive plants.

The monthly newsletter “Early Detection News” continued to be well received by network parks staff and other organizations involved in vegetation management throughout the Bay Area. The newsletter is sent via email in HTML format, so recipients can view it directly in their email client. The newsletter contains news of noteworthy early detections, with links to information about featured invasive species, and links to Calflora showing monthly survey results.

Database Development

In 2015 ISED adopted use of the newly developed Calflora Weed Manager system. Weed Manager enhances the capabilities of Calflora’s pre-existing mapping tools, including the Observer Pro mapping application for smartphones and tablets, and the online Plant Observation Entry tool. This

new cloud-based invasive plants database facilitates unprecedented data sharing within SFAN parks, and the wider community of invasive plant managers and researchers throughout California, while allowing users control over the publication of sensitive information. Weed Manager is based on the GeoWeed model, which allows weed infestations and treatments to be tracked over time, through history stacks. Subscribing organizations maintain private accounts, with the option of sharing data publicly, or with other subscribing organizations. Each organization can configure custom options, while core data fields remain standard across the platform, enabling data sharing and integration.

In 2013, SFAN initiated a cooperative agreement with Calflora to build a mapping system to replace GeoWeed (Williams et al. 2009). Staff solicited feedback from invasive plant managers throughout California, including NPS units, to build partnership and buy-in on the development of Weed Manager, a statewide, cloud-based weed population and treatment database hosted by Calflora. In 2014, ISED staff participated in technical development and beta-testing, and attended stakeholder's meetings attended by management agencies and other interested parties. ISED collaborated with the GOGA Habitat Restoration Team (HRT), who also used GeoWeed. SFAN migrated the ISED and HRT data in winter 2014, after extensive quality assurance measures. Weed Manager went live in March, 2015, and was used by ISED and HRT as the primary data collection and storage system for the 2015 field season.

Collaboration

Early detection surveys have the greatest utility to park management when coupled with rapid response to invasions. Invasive plant management teams exist in each of the SFAN parks. Collaboration and communication with these management teams is aided by both the implementation of the SFAN early detection program and the quality of its reporting products. Monthly survey results are reported to all SFAN vegetation staff via the Early Detection News.

ISED undertook several special projects in support of early detection/rapid response in network parks. At PORE, ISED conducted several days of targeted early detection surveys for perennial pepperweed (*Lepidium latifolium*) in Tomales Bay wetlands to support regional rapid response, and initiated a work day with HRP and restoration technicians from the GGNPC to treat a newly rediscovered infestation of barbed goatgrass (*Aegilops triuncialis*). At GOGA, ISED conducted targeted surveys for hanging sedge in Redwood Creek at Muir Woods (see cover photo).

ISED participated in ongoing Natural Resource Condition Assessments (NRCA's) at both GOGA and PORE by assisting with the scope of work, providing data, and reviewing draft chapters on invasive species.

As network parks share borders with many other land management agencies, an integrated approach is key to stopping the spread of new invaders. In addition to working with SFAN parks, ISED staff communicated regularly with California Invasive Plant Council staff (Cal-IPC), and regional agencies including California State Parks, Marin County Open Space District, Marin Municipal Water District, San Francisco Public Utilities commission, and San Mateo County Parks and Recreation.

Literature Cited

- Adams, D., S. Allen, J. Bjork, M. Coopridge, A. Fesnock, M. Koenen, T. Leatherman, S. O'Neil, D. Press, D. Schirokauer, B. Welch, and B. Witcher. 2006. San Francisco Bay Area Network Vital Signs Monitoring Plan. NPS/SFAN/NRR 2006/017. National Park Service, Fort Collins, Colorado.
- Baldwin, B. G., D. H. Goldman, D. J. Keil, R. Patterson, T. J. Rosatti, and D. H. Wilken (eds). 2012. The Jepson manual: Vascular plants of California, second edition. University of California Press, Berkeley, California.
- California. Department of Food and Agriculture [CDFA]. 2006. Encycloweediea: California State Noxious Weeds List. Available at http://www.cdfa.ca.gov/plant/ipc/encycloweediea/encycloweediea_hp.html (accessed 20 January 2015).
- Harris, S., J. Brown, and S. Timmins. 2001. Weed surveillance—how often to search? Science for Conservation. 175.
- McNeely, J. A., H. A. Mooney, L. E. Neville, P. J. Schei, and J. K. Waage (eds). 2001. Global strategy on invasive alien species. IUCN. Available at <http://www.iucn.org/> (accessed 31 August 2006).
- National Park Service [NPS]. 2004. Rare plant monitoring report. Unpublished Report. Golden Gate National Recreation Area, Ft. Cronkhite, California.
- NPSpecies. 2015. Park Species List – Category: Vascular Plants: Golden Gate National Recreation Area, John Muir National Historic Site, Pinnacles National Park, Point Reyes National Seashore. Available at <https://irma.nps.gov/NPSpecies> (accessed 20 December 2016).
- Scott, J. M., and D. S. Wilcove. 1998. Improving the future for endangered species. Bioscience 48:579-80.
- Steers, R., E. Wrubel, A. Williams, N. Howe, J. Jordan-Rogers. 2011. Invasive plant species early detection in the San Francisco Bay Area Network: 2010 annual report. Natural Resource Report NPS/PWR/SFAN/NRTR—2011/494. National Park Service, Fort Collins, Colorado.
- Williams, A. E., and E. Speith. 2008. Invasive plant species early detection in the San Francisco Bay Area Network: 2007 annual report. Natural Resource Report NPS/PWR/SFAN/NRTR—2008/135. National Park Service, Fort Collins, Colorado.
- Williams, A. E., S. O'Neil, E. Speith, and J. Rodgers. 2009. Early detection of invasive plant species in the San Francisco Bay Area Network: A volunteer-based approach. Natural Resource Report NPS/SFAN/NRR—2009/136. National Park Service, Fort Collins, Colorado.

- Williams, A. E., and J. Jordan. 2010. Invasive plant species early detection in the San Francisco Bay Area Network: 2008 annual report. Natural Resource Technical Report NPS/SFAN/NRTR—2010/308. National Park Service, Fort Collins, Colorado.
- Williams, A. E., J. J. Rogers, N. Howe, R. J. Steers, and E. C. Wrubel. 2011. Invasive plant species early detection in the San Francisco Bay Area Network: 2009 annual report. Natural Resource Technical Report NPS/SFAN/NRTR—2011/493. National Park Service, Fort Collins, Colorado.
- Wrubel, E., and R. J. Steers. 2012. Invasive plant species early detection in the San Francisco Area Network: 2011 annual report. Natural Resource Technical Report NPS/SFAN/NRTR—2012/620. National Park Service, Fort Collins, Colorado.
- Wrubel, E., and R. J. Steers. 2013. Invasive plant species early detection in the San Francisco Bay Area Network: 2012 annual report. Natural Resource Technical Report NPS/SFAN/NRTR—2013/797. National Park Service, Fort Collins, Colorado.
- Wrubel, E. 2015. Invasive plant species early detection in the San Francisco Bay Area Network: 2013 annual report. Natural Resource Technical Report NPS/SFAN/NRDS—2015/758. National Park Service, Fort Collins, Colorado.
- Wrubel, E. 2017. Invasive plant species early detection in the San Francisco Bay Area Network: 2014 annual report. Natural Resource Technical Report NPS/SFAN/NRDS—2017/1080. National Park Service, Fort Collins, Colorado.

Glossary

Assessments: An assessment for each occurrence can be recorded as a polygon, or a buffered point. Assessments will be used to depict the size, scale, and coverage of an occurrence and therefore will be used as a basis for evaluating change with or without management actions.

Exotic: Occurring in a given place as a result of direct or indirect, deliberate or accidental actions by humans. Synonyms: alien, introduced, non-native, and non-indigenous.

Invasive species: Official term for an exotic species whose introduction can cause economic or environmental harm or harm to human health. This definition originated in Presidential Executive Order 13112 issued February 3, 1999.

Management unit: An area to be monitored for new species/infestations. A management unit may be the entire park, critical habitat within a park, or areas of concern given their proximity to known entry points. Some parks define areas by watershed, others use site names—both are considered a management unit.

Occurrence: The weed occurrence is the basic unit of mapping and assessing a singular weed or weed population/infestation within WIMS, GeoWeed, and Weed Manager. Each occurrence defines the presence of a single species and is recorded at a specific location. The occurrence location is recorded as a point in space, although each occurrence may actually be a population of plants covering an extensive area.

SOP: Standard Operating Procedures. These are the detailed steps explaining how to carry out the monitoring protocol.

Subwatershed: A subunit of a watershed, based largely on drainages, and used to track weed work in GOGA.

Treatment: A treatment is any weed management activity that occurs at a specific time over a defined geographical area. Calflora's Weed Manager database tracks all types of weed control methods and how much staff and/or volunteer time has been spent controlling weeds.

Weed: A plant that causes economic losses or ecological damage, creates health problems for humans or animals, or is undesirable where it is growing (Weed Science Society of America). The term “noxious weed” is an official designation for weeds which cause economic harm.

Appendix A: 2015 lists of priority invasive species in SFAN parks.

Table A-1. 2015 list of priority invasive species at GOGA.

Priority	Scientific Name	Common Name	Family
1	<i>Aegilops triuncialis</i>	Barbed oatgrass	Poaceae
1	<i>Ailanthus altissima</i>	tree-of-heaven	Simaroubaceae
1	<i>Albizia lophantha</i>	silk tree	Fabaceae
1	<i>Allium vineale</i>	Vineyard onion	Alliaceae
1	<i>Ammophila arenaria</i>	European beachgrass	Poaceae
1	<i>Ammophila breviligulata</i>	American beachgrass	Poaceae
1	<i>Anthoxanthum odorata</i>	sweet vernal grass	Poaceae
1	<i>Aptenia cordifolia</i>	heartleaf iceplant	Aizoaceae
1	<i>Arctotheca calendula</i>	fertile capeweed	Asteraceae
1	<i>Arctotheca prostrata</i>	creeping capeweed	Asteraceae
1	<i>Arundo donax</i>	giant reed	Poaceae
1	<i>Berberis darwinii</i>	Darwin's berberis	Berberidaceae
1	<i>Carduus acanthoides</i>	plumeless thistle	Asteraceae
1	<i>Carex pendula</i>	hanging sedge	Cyperaceae
1	<i>Carpobrotus chilensis</i>	sea fig	Aizoaceae
1	<i>Carthamus lanatus</i>	woolly distaff thistle	Asteraceae
1	<i>Centaurea calcitrapa</i>	purple starthistle	Asteraceae
1	<i>Centaurea solstitialis</i>	yellow starthistle	Asteraceae
1	<i>Cirsium arvense</i>	Canada thistle	Asteraceae
1	<i>Conicosia pugioniformis</i>	narrow-leaved iceplant	Aizoaceae
1	<i>Cortaderia selloana</i>	pampas grass	Poaceae
1	<i>Crataegus monogyna</i>	singleseed hawthorn	Rosaceae
1	<i>Cynara cardunculus</i>	cardoon	Asteraceae
1	<i>Cytisus scoparius</i>	Scotch broom	Fabaceae
1	<i>Cytisus striatus</i>	Portuguese broom	Fabaceae
1	<i>Digitalis purpurea</i>	purple foxglove	Scrophulariaceae
1	<i>Dittrichia graveolens</i>	stinkweed	Asteraceae
1	<i>Drosanthemum floribundum</i>	showy dewflower	Aizoaceae
1	<i>Echium plantagineum</i>	salvation jane	Boraginaceae
1	<i>Ehrharta calycina</i>	perennial veldt grass	Poaceae
1	<i>Eichhornia crassipes</i>	water hyacinth	Pontederiaceae
1	<i>Euphorbia oblongata</i>	oblong spurge	Euphorbiaceae
1	<i>Hedera canariensis</i>	Algerian ivy	Araliaceae
1	<i>Helichrysum petiolare</i>	licorice plant	Asteraceae
1	<i>Hypericum grandifolium</i>	largeleaf St. Johnswort	Clusiaceae

Priority	Scientific Name	Common Name	Family
1	<i>Hypericum perforatum</i>	Klamathweed	Clusiaceae
1	<i>Ilex aquifolium</i>	English holly	Aquifoliaceae
1	<i>Lepidium latifolium</i>	perennial pepperweed	Brassicaceae
1	<i>Limonium ramosissimum</i>	Algerian sea lavender	Plumbaginaceae
1	<i>Ludwigia hexapetala</i>	six-petal water primrose	Onagraceae
1	<i>Ludwigia peploides</i> ssp. <i>montevidensis</i>	floating water primrose	Onagraceae
1	<i>Maytenus boaria</i>	Chilean mayten	Celastraceae
1	<i>Mesembryanthemum crystallinum</i>	ice plant	Aizoaceae
1	<i>Myriophyllum aquaticum</i>	parrot's-feather	Haloragaceae
1	<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	Haloragaceae
1	<i>Nasella tenuissima</i>	Finestem needlegrass	Poaceae
1	<i>Nicotiana glauca</i>	tree tobacco	Solanaceae
1	<i>Phalaris arundinacea</i>	reed canary grass	Poaceae
1	<i>Pittosporum crassifolium</i>	stiffleaf cheesewood	Pittosporaceae
1	<i>Pyracantha angustifolia</i>	narrowleaf firethorn	Rosaceae
1	<i>Rhamnus alaternus</i>	Italian buckthorn	Rhamnaceae
1	<i>Robinia pseudoacacia</i>	black locust	Fabaceae
1	<i>Romulea rosea</i> var. <i>australis</i>	rosy sandcrocus	Iridaceae
1	<i>Rytidosperma caespitosum</i>	common wallaby grass	Poaceae
1	<i>Rytidosperma penicillatum</i>	hairy wallaby grass	Poaceae
1	<i>Scabiosa atropurpurea</i>	mourningbride	Dipsacaceae
1	<i>Spartina alterniflora</i>	smooth cordgrass	Poaceae
1	<i>Spartium junceum</i>	Spanish broom	Fabaceae
1	<i>Stipa manicata</i>	Andean tussockgrass	Poaceae
1	<i>Trifolium angustifolium</i>	narrowleaf clover	Fabaceae
1	<i>Ulex europaeus</i>	gorse	Fabaceae
1	<i>Vinca major</i>	periwinkle	Apocynaceae
2	<i>Acacia melanoxylon</i>	blackwood acacia	Fabaceae
2	<i>Acacia paradoxa</i>	Kangaroo thorn	Fabaceae
2	<i>Ageratina adenophora</i>	thoroughwort	Asteraceae
2	<i>Agrostis avenacea</i>	Pacific bentgrass	Poaceae
2	<i>Bromus madritensis</i> ssp. <i>rubens</i>	red brome	Poaceae
2	<i>Bromus tectorum</i>	cheat grass	Poaceae
2	<i>Buddleja davidii</i>	butterfly bush	Scrophulariaceae
2	<i>Calendula arvensis</i>	field marigold	Asteraceae
2	<i>Centaurea melitensis</i>	tochalote	Asteraceae
2	<i>Cestrum parqui</i>	orange jessamine	Solanaceae
2	<i>Cynodon dactylon</i>	Bermudagrass	Poaceae

Priority	Scientific Name	Common Name	Family
2	<i>Dactylis glomerata</i>	orchard grass	Poaceae
2	<i>Datura stramonium</i>	Jimsonweed	Solanaceae
2	<i>Delairea odorata</i>	cape ivy	Asteraceae
2	<i>Dipsacus fullonum</i>	Fuller's teasel	Dipsacaceae
2	<i>Eucalyptus globulus</i>	bluegum eucalyptus	Myrtaceae
2	<i>Fallopia japonica</i>	Japanese knotweed	Polygonaceae
2	<i>Festuca arundinacea</i>	tall fescue	Poaceae
2	<i>Fuchsia magellanica</i>	Hardy fuchsia	Onagraceae
2	<i>Geranium purpureum</i>	herb robert	Geraniaceae
2	<i>Geranium robertianum</i>	Robert geranium	Geraniaceae
2	<i>Glyceria declinata</i>	waxy mannagrass	Poaceae
2	<i>Hedera helix</i>	English ivy	Araliaceae
2	<i>Iris pseudacorus</i>	yellow flag iris	Iridaceae
2	<i>Lamiasium galeobdolon</i>	Yellow archangel	Lamiaceae
2	<i>Leptospermum laevigatum</i>	Australian teatree	Myrtaceae
2	<i>Leucanthemum vulgare</i>	oxeye daisy	Asteraceae
2	<i>Ligustrum lucidum</i>	glossy privet	Oleaceae
2	<i>Mentha pulegium</i>	pennyroyal	Lamiaceae
2	<i>Mercurialis annua</i>	annual mercury	Rubiaceae
2	<i>Oxalis pes-caprae</i>	Bermuda buttercup	Oxalidaceae
2	<i>Pennisetum clandestinum</i>	Kikuyu grass	Poaceae
2	<i>Phoenix canariensis</i>	Canary Isl. Date palm	Arecaceae
2	<i>Roldana Petasitis</i>	velvet groundsel	Asteraceae
2	<i>Rosa rubiginosa</i>	sweetbriar rose	Rosaceae
2	<i>Rubus armeniacus</i>	Himalayan blackberry	Rosaceae
2	<i>Salsola soda</i>	oppositeleaf Russian thistle	Chenopoiaceae
2	<i>Solanum aviculare</i>	New Zealand nightshade	Solanaceae
2	<i>Sorghum halapense</i>	Johnson grass	Poaceae
2	<i>Sparaxis tricolor</i>	Harlequin flower	Iridaceae
2	<i>Stipa miliacea</i>	Smilo grass	Poaceae
2	<i>Tradescantia fluminensis</i>	Wandering jew	Commelinaceae

Table A-2. 2015 list of priority invasive species at PORE.

Priority	Scientific Name	Common Name	Family
1	<i>Acroptilon repens</i>	Russian knapweed	Asteraceae
1	<i>Aegilops triuncialis</i>	barbed goatgrass	Poaceae
1	<i>Ageratina adenophora</i>	thoroughwort	Asteraceae
1	<i>Albizia lophantha</i>	silk tree	Fabaceae
1	<i>Alisma lanceolatum</i>	lanceleaf water plantain	Alismataceae
1	<i>Ammophila arenaria</i>	European beachgrass	Poaceae
1	<i>Anthoxanthum odoratum</i>	sweet vernalgrass	Poaceae
1	<i>Arundo donax</i>	giant reed	Poaceae
1	<i>Brachypodium distachyon</i>	purple false brome	Poaceae
1	<i>Carduus acanthoides</i>	plumeless thistle	Asteraceae
1	<i>Carex pendula</i>	hanging sedge	Cyperaceae
1	<i>Carthamus lanatus</i>	woolly distaff thistle	Asteraceae
1	<i>Centaurea calcitrapa</i>	purple starthistle	Asteraceae
1	<i>Centaurea iberica</i>	Iberian starthistle	Asteraceae
1	<i>Centaurea melitensis</i>	Napa thistle, tocalote	Asteraceae
1	<i>Centaurea solstitialis</i>	yellow starthistle	Asteraceae
1	<i>Conicosia pugioniformis</i>	narrow-leaved iceplant	Aizoaceae
1	<i>Cotoneaster franchetii</i>	orange cotoneaster	Roseaceae
1	<i>Cotoneaster pannosus</i>	silverleaf cotoneaster	Roseaceae
1	<i>Dittrichia graveolens</i>	stinkweed	Asteraceae
1	<i>Egeria densa</i>	Brazilian waterweed	Hydrocharitaceae
1	<i>Ehrharta calycina</i>	perennial veldt grass	Poaceae
1	<i>Euphorbia oblongata</i>	oblong spurge	Euphorbiaceae
1	<i>Helichrysum petiolare</i>	licorice plant	Asteraceae
1	<i>Hypericum grandifolium</i>	largeleaf St. Johnswort	Clusiaceae
1	<i>Hypericum perforatum</i>	Klamathweed	Hypericaceae
1	<i>Iris pseudacorus</i>	yellow flag iris	Iridaceae
1	<i>Lepidium latifolium</i>	perennial pepperweed	Brassicaceae
1	<i>Limonium ramosissimum</i>	Algerian sea lavender	Plumbaginaceae
1	<i>Ludwigia hexapetala</i>	six-petal water primrose	Onagraceae
1	<i>Ludwigia peploides</i> ssp. <i>montevedensis</i>	floating water primrose	Onagraceae
1	<i>Marrubium vulgare</i>	horehound	Lamiaceae
1	<i>Myriophyllum aquaticum</i>	parrot's-feather	Haloragaceae
1	<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	Haloragaceae
1	<i>Phalaris arundinacea</i>	reed canary grass	Poaceae
1	<i>Robinia pseudoacacia</i>	black locust	Fabaceae
1	<i>Romulea rosea</i> var. <i>australis</i>	rosy sandcrocus	Iridaceae
1	<i>Rytidosperma penicillatum</i>	hairy wallaby grass	Poaceae
1	<i>Salsola soda</i>	oppositeleaf Russian thistle	Chenopodiaceae

Priority	Scientific Name	Common Name	Family
1	<i>Senecio jacobaea</i>	tansy ragwort	Asteraceae
1	<i>Spartina alterniflora</i>	Smooth cordgrass	Poaceae
1	<i>Spartium junceum</i>	Spanish broom	Fabaceae
1	<i>Stipa chaetophora</i>	Stipoid ricegrass	Poaceae
1	<i>Stipa manicata</i>	Andean tussockgrass	Poaceae
1	<i>Stipa purpurata</i>	Bristly needle grass	Poaceae
1	<i>Trifolium angustifolium</i>	narrowleaf clover	Fabaceae
1	<i>Ulex europaeus</i>	gorse	Fabaceae
2	<i>Acacia melanoxylon</i>	blackwood acacia	Fabaceae
2	<i>Arctotheca calendula</i>	fertile capeweed	Asteraceae
2	<i>Arctotheca prostrata</i>	creeping capeweed	Asteraceae
2	<i>Berberis darwinii</i>	Darwin's berberis	Berberidaceae
2	<i>Cakile edentula</i>	European searocket	Brassicaceae
2	<i>Calendula arvensis</i>	Field marigold	Asteraceae
2	<i>Cystisus scoparius</i>	Scotch broom	Fabaceae
2	<i>Datura stramonium</i>	jimsonweed	Solanaceae
2	<i>Delairea odorata</i>	cape ivy	Asteraceae
2	<i>Echium candicans</i>	pride of Madeira	Boraginaceae
2	<i>Fallopia japonica</i>	Japanese knotweed	Polygonaceae
2	<i>Genista monspessulana</i>	French broom	Fabaceae
2	<i>Geranium purpureum</i>	Herb Robert	Geraniaceae
2	<i>Geranium robertianum</i>	Robert geranium	Geraniaceae
2	<i>Glyceria declinata</i>	waxy mannagrass	Poaceae
2	<i>Hedera helix</i>	English ivy	Araliaceae
2	<i>Ilex aquifolium</i>	English holly	Aquifoliaceae
2	<i>Lamium galeobdolon</i>	Yellow archangel	Lamiaceae
2	<i>Lathyrus latifolius</i>	everlasting pea	Fabaceae
2	<i>Leucanthemum vulgare</i>	oxeye daisy	Asteraceae
2	<i>Ligustrum lucidum</i>	Glossy privet	Oleaceae
2	<i>Ligustrum vulgare</i>	European privet	Oleaceae
2	<i>Linaria vulgaris</i>	butter and eggs	Scrophulariaceae
2	<i>Maytenus boaria</i>	Chilean mayten	Celastraceae
2	<i>Oxalis pes-caprae</i>	Bermuda buttercup	Oxalidaceae
2	<i>Paspalum dilatatum</i>	dallis grass	Poaceae
2	<i>Pennisetum clandestinum</i>	Kikuyu grass	Poaceae
2	<i>Phalaris elongata</i>	Kolea grass	Poaceae
2	<i>Pittosporum undulatum</i>	Victorian box	Pittosporaceae
2	<i>Rhamnus alaternus</i>	Italian buckthorn	Rhamnaceae
2	<i>Rubus armeniacus</i>	Himalayan blackberry	Rosaceae
2	<i>Solanum aviculare</i>	New Zealand nightshade	Solanaceae

Priority	Scientific Name	Common Name	Family
2	<i>Stipa miliacea</i>	Smilo grass	Poaceae
2	<i>Tetragonia tetragonoides</i>	New Zealand spinach	Aizoaceae
2	<i>Vinca major</i>	periwinkle	Apocynaceae
2	<i>Xanthium spinosum</i>	spiny cocklebur	Asteraceae

Table A-3. 2015 list of priority invasive species at PINN.

Priority	Scientific Name	Common Name	Family
1	<i>Acroptilon repens</i>	Russian knapweed	Asteraceae
1	<i>Ailanthus altissima</i>	tree-of-heaven	Simaroubaceae
1	<i>Arundo donax</i>	giant reed	Poaceae
1	<i>Bromus tectorum</i>	cheatgrass	Poaceae
1	<i>Centaurea benedictus</i>	Blessed thistle	Asteraceae
1	<i>Dittrichia graveolens</i>	stinkweed	Asteraceae
1	<i>Dysphania ambrosioides</i>	Mexican-tea	Chenopodiaceae
1	<i>Elymus caput-medusae</i>	Medusahead	Poaceae
1	<i>Festuca perennis</i>	Italian ryegrass	Poaceae
1	<i>Festuca temulentum</i>	Darnel	Poaceae
1	<i>Helminthotheca echinoides</i>	Bristly ox tongue	Asteraceae
1	<i>Iris pseudacorus</i>	yellow flag Iris	Iridaceae
1	<i>Lepidium latifolium</i>	perennial pepperweed	Brassicaceae
1	<i>Malva parviflora</i>	cheeseweed	Malvaceae
1	<i>Melilotus alba</i>	white sweetclover	Fabaceae
1	<i>Nicotiana glauca</i>	tree tobacco	Solanaceae
1	<i>Poa bulbosa</i>	bulbous bluegrass	Poaceae
1	<i>Rubus armeniacus</i>	Himalayan blackberry	Rosaceae
1	<i>Salsola tragus</i>	oppositeleaf Russian thistle	Chenopodiaceae
1	<i>Tamarix ramosissima</i>	saltcedar	Tamaricaceae
1	<i>Tragopogon dubius</i>	yellow salsify	Asteraceae
1	<i>Tribulus terrestris</i>	puncturevine	Zygophyllaceae
1	<i>Trifolium hirtum</i>	rose clover	Fabaceae
1	<i>Verbascum blattaria</i>	moth mullein	Scrophulariaceae
1	<i>Verbascum thapsus</i>	woolly mullein	Scrophulariaceae
1	<i>Xanthium spinosum</i>	spiny cocklebur	Asteraceae
2	<i>Carduus pycnocephalus</i>	Italian thistle	Asteraceae
2	<i>Carduus tenuiflorus</i>	slender-flowered thistle	Asteraceae
2	<i>Centaurea solstitialis</i>	yellow starthistle	Asteraceae
2	<i>Conium maculatum</i>	poison hemlock	Apiaceae
2	<i>Cotula coronopifolia</i>	brassbuttons	Asteraceae
2	<i>Cyperus schoenoides</i>	swamp prickly grass	Poaceae
2	<i>Cynodon dactylon</i>	Bermudagrass	Poaceae
2	<i>Cyperus difformis</i>	variable flatsedge	Cyperaceae
2	<i>Dactylis glomerata</i>	orchard grass	Poaceae
2	<i>Marrubium vulgare</i>	horehound	Lamiaceae
2	<i>Phalaris aquatica</i>	Harding grass	Poaceae
2	<i>Schismus arabicus</i>	Arabian schismus	Poaceae
2	<i>Veronica persica</i>	birdseye speedwell	Scrophulariaceae

Priority	Scientific Name	Common Name	Family
2	<i>Vinca major</i>	periwinkle	Apocynaceae
3	<i>Amaranthus albus</i>	tumbleweed	Amaranthaceae
3	<i>Brassica nigra</i>	black mustard	Brassicaceae
3	<i>Brassica rapa</i>	field mustard	Brassicaceae
3	<i>Centaurea melitensis</i>	totalote	Asteraceae
3	<i>Cirsium vulgare</i>	bull thistle	Asteraceae
3	<i>Hirschfeldia incana</i>	shortpod mustard	Brassicaceae
3	<i>Lactuca serriola</i>	prickly lettuce	Asteraceae
3	<i>Mentha spicata</i> var. <i>spicata</i>	spearmint	Lamiaceae
3	<i>Mentha Xpiperita</i>	peppermint	Lamiaceae
3	<i>Plantago lanceolata</i>	English plantain	Plantaginaceae
3	<i>Polygonum aviculare</i> ssp. <i>depressum</i>	oval-leaf knotweed	Polygonaceae
3	<i>Raphanus sativus</i>	wild radish	Brassicaceae
3	<i>Rumex acetosella</i>	sheep sorrel	Polygonaceae
3	<i>Rumex crispus</i>	curly dock	Polygonaceae
3	<i>Silybum marianum</i>	blessed milkthistle	Asteraceae

Table A-4. 2015 list of priority invasive species at JOMU.

Priority	Scientific Name	Common Name	Family
1	<i>Acroptilon repens</i>	Russian knapweed	Asteraceae
1	<i>Aegilops triuncialis</i>	barbed goatgrass	Poaceae
1	<i>Arundo donax</i>	giant reed	Poaceae
1	<i>Calendula arvensis</i>	field marigold	Asteraceae
1	<i>Cardaria draba</i>	Whitetop	Brassicaceae
1	<i>Carthamus baeticus</i>	Smooth distaff thistle	Asteraceae
1	<i>Centaurea calcitrapa</i>	Purple star thistle	Asteraceae
1	<i>Centaurea melitensis</i>	Napa star thistle	Asteraceae
1	<i>Cynara cardunculus</i>	cardoon	Asteraceae
1	<i>Cytisus striatus</i>	striated broom	Fabaceae
1	<i>Dittrichia graveolens</i>	stinkwort	Asteraceae
1	<i>Ehrharta erecta</i>	panic veldt grass	Poaceae
1	<i>Eucalyptus globulus</i>	bluegum eucalyptus	Myrtaceae
1	<i>Euphorbia oblongata</i>	oblong spurge	Euphorbiaceae
1	<i>Ficus carica</i>	common fig	Moraceae
1	<i>Genista monspessulana</i>	French broom	Fabaceae
1	<i>Geranium robertianum</i>	Robert geranium	Geraniaceae
1	<i>Lepidium latifolium</i>	broadleaved pepperweed	Brassicaceae
1	<i>Lythrum salicaria</i>	purple loosestrife	Lythraceae
1	<i>Nicotiana glauca</i>	tree tobacco	Solanaceae
1	<i>Oxalis pes-caprae</i>	sourgrass	Oxalidaceae
1	<i>Schinus molle</i>	Peruvian peppertree	Anacardiaceae
1	<i>Sesbania punicea</i>	rattlebox	Fabaceae
1	<i>Tamarix parviflora</i>	Fourstamen tamarisk	Tamaricaceae
2	<i>Bellardia trixago</i>	Mediterranean linseed	Scrophulariaceae
2	<i>Brachypodium distachyon</i>	False brome	Poaceae
2	<i>Centaurea solstitialis</i>	yellow star thistle	Asteraceae
2	<i>Cestrum parqui</i>	Chilean jessamine	Solanaceae
2	<i>Cirsium vulgare</i>	bull thistle	Asteraceae
2	<i>Conium maculatum</i>	poison hemlock	Apiaceae
2	<i>Cotoneaster lacteus</i>	milkflower cotoneaster	Rosaceae
2	<i>Cotoneaster pannosus</i>	silverleaf cotoneaster	Rosaceae
2	<i>Cynodon dactylon</i>	Bermudagrass	Poaceae
2	<i>Dactylis glomerata</i>	orchard grass	Poaceae
2	<i>Foeniculum vulgare</i>	sweet fennel	Apiaceae
2	<i>Hirschfeldia incana</i>	shortpod mustard	Brassicaceae
2	<i>Olea europaea</i>	olive	Oleaceae
2	<i>Phalaris aquatica</i>	Harding grass	Poaceae
2	<i>Piptatherum miliaceum</i>	smilo grass	Poaceae

Priority	Scientific Name	Common Name	Family
2	<i>Rubus armeniacus</i>	Himalayan blackberry	Rosaceae
2	<i>Tribulus terrestris</i>	puncturevine	Zygophyllaceae

Appendix B: New species recorded in SFAN parks during early detection surveys.

These following tables list the species were newly recorded in SFAN parks during ISED surveys. Prior to their discovery, they were not recorded on the NPSpecies full vascular plant list for the indicated parks. Reporter indicates person who initially reported presence of the species to I&M staff. .

Table B-1. New species recorded at GOGA.

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
2011	<i>Cotoneaster lacteus</i> W.W. Sm.	Rosaceae	Robert Steers, I&M	Widespread	non-native	Voucher
2011	<i>Agrostis avenacea</i> J.F. Gmel.	Poaceae	Eric Wrubel, I&M	Muir Beach; Conzelman Road	non-native	Voucher
2011	<i>Buddleja davidii</i> Franch.	Scrophulariaceae	Eric Wrubel, I&M	Sausalito	non-native	No
2011	<i>Crassula multicava</i> Lem.	Crassulaceae	Eric Wrubel, I&M	Marin Headlands, Youth Hostel; Land's End	non-native	Photo
2011	<i>Dittrichia Graveolens</i> (L.) Greuter	Asteraceae	Eric Wrubel, I&M	Marin Headlands, Marine Mammal Center	non-native	Photo
2011	<i>Echinochloa muricata</i> (P. Beauv.) Fernald var. <i>microstachya</i> Wiegand	Poaceae	Eric Wrubel, I&M	Conzelman Road	non-native	Voucher
2011	<i>Elymus ponticus</i> (Podp.) N. Snow	Poaceae	Eric Wrubel, I&M	McCullough Road	non-native	No
2011	<i>Erigeron sumatrensis</i> Retz.	Asteraceae	Eric Wrubel, I&M	Marin Headlands, Marine Mammal Center	non-native	Voucher
2011	<i>Heliotropium amplexicaule</i> Vahl	Boraginaceae	Eric Wrubel, I&M	Slide Ranch	non-native	Photo
2011	<i>Iris pseudacorus</i> L.	Iridaceae	Eric Wrubel, I&M	Marin Headlands, Rodeo Lagoon	non-native	Voucher
2011	<i>Kickxia elatine</i> (L.) Dumort.	Plantaginaceae	Eric Wrubel, I&M	Marin Headlands, Alexander Avenue	non-native	No
2011	<i>Ludwigia peploides</i> (Kunth) P. H. Raven ssp. <i>montevidensis</i> (Spreng.) P. H. Raven	Onagraceae	Doreen Smith, CNPS	Marin Headlands, Rodeo Lake	non-native	Voucher
2011	<i>Mercurialis annua</i> L.	Euphorbiaceae	Eric Wrubel, I&M	Sweeney Ridge	non-native	No
2011	<i>Nymphaea odorata</i> Aiton	Nymphaeaceae	Eric Wrubel, I&M	Tennessee Valley, Backdoor Pond.	non-native	Photo
2011	<i>Rhamnus alaternus</i> L.	Rhamnaceae	Eric Wrubel, I&M	Mori Point	non-native	Photo

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
2011	<i>Roldana Petasitis</i> (Sims) H. Rob. & Brettell	Asteraceae	Eric Wrubel, I&M	Marin Headlands, Rodeo Avenue; Muir Woods, Camino del Canyon Road	non-native	Voucher
2011	<i>Rytidosperma caespitosum</i> (Gaudich.) Connor & Edgar	Poaceae	Eric Wrubel, I&M	Sweeney Ridge	non-native	Voucher
2011	<i>Soleirolia soleirolii</i> (Req.) Dandy	Urticaceae	Eric Wrubel, I&M	Mori Point	non-native	Photo
2011	<i>Stipa manicata</i> E. Desv.	Poaceae	Alisa Shor, GGNPC	Marin Headlands, Fort Baker, Fort Cronkhite, Capeheart Housing	non-native	Voucher
2011	<i>Teucrium fruticans</i> L.	Lamiaceae	Eric Wrubel, I&M	Marin Headlands, Battery Townsley	non-native	Photo?
2011	<i>Trifolium angustifolium</i> L.	Fabaceae	Eric Wrubel, I&M	Marin Headlands, Alexander Avenue; Mori Point; Rancho Corral de Tierra	non-native	Voucher
2011	<i>Trifolium striatum</i> L.	Fabaceae	Eric Wrubel, I&M	Nicasio Ridge, Cheda Ranch Road	non-native	Photo
2011	<i>Trifolium tomentosum</i> L.	Fabaceae	Eric Wrubel, I&M	Marin Headlands, Fort Cronkhite	non-native	Photo
2012	<i>Allium vineale</i> L.	Alliaceae	Eric Wrubel, I&M	Marin Headlands, Fort Cronkhite	non-native	No
2012	<i>Antirrhinum orontium</i> L.	Scrophulariaceae	Neal Kramer, Independent Consultant	Rancho Corral de Tierra, top of Alta Vista Trail	non-native	Photo
2012	<i>Carex nudata</i> W. Boott	Cyperaceae	Eric Wrubel, I&M	Muir Woods, Redwood Creek; Lagunitas Creek	native	No
2012	<i>Coreopsis tinctoria</i> Nutt.	Asteraceae	Eric Wrubel, I&M	Marin Headlands; Hwy 1 at Green Gulch	non-native	Voucher
2012	<i>Cotoneaster integrifolius</i> (Roxb.) G. Klotz	Rosaceae	Eric Wrubel, I&M	Marin Headlands, Hwy 1 at Miwok Trailhead	non-native	Photo
2012	<i>Freesia laxa</i> (Thunb.) Goldblatt & J.C. Manning	Iridaceae	Eric Wrubel, I&M	Muir Woods, Druid Heights	non-native	No
2012	<i>Geranium robertianum</i> L.	Geraniaceae	Eric Wrubel, I&M	Muir Woods, entrance	non-native	Voucher
2012	<i>Geranium rotundifolium</i> L.	Geraniaceae	Eric Wrubel, I&M	Marin Headlands, Conzelman at Alexander Ave.	non-native	Voucher

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
2012	<i>Glyceria declinata</i> Brébiss.	Poaceae	Dan Glusenkamp, BAEDN	Muir Beach, equipment staging area		Voucher
2012	<i>Iris foetidissima</i> L.	Iridaceae	Eric Wrubel, I&M	Stinson Beach, Hwy 1 ; Marin Headlands, Rodeo Valley Trail	non-native	Photo
2012	<i>Lamium galeobdolon</i> (L.) Ehrend. & Polatschek	Lamiaceae	Eric Wrubel, I&M	Muir Woods, Druid Heights	non-native	Photo
2012	<i>Melanthus major</i> L.	Melanthaceae	Chris Friedel, GOGA	Muir Woods, Druid Heights	non-native	Voucher
2012	<i>Oxalis hirta</i> L.	Oxalidaceae	Neal Kramer, Independent Consultant	Rancho Corral de Tierra, Kanoff Street entrance	non-native	Photo
2012	<i>Parietaria judaica</i> L.	Urticaceae	Eric Wrubel, I&M	Marin Headlands, Battery Spencer; Lands end; Mori Point	non-native	No
2012	<i>Prunus caroliniana</i> Ait.	Rosaceae	Eric Wrubel, I&M	above Marin City	non-native	Voucher
2012	<i>Salsola soda</i> L.	Chenopodiaceae	Eric Wrubel, I&M	Bolinas Lagoon	non-native	Photo
2012	<i>Tradescantia fluminensis</i> Vell.	Commelinaceae	Eric Wrubel, I&M	Muir Woods, Druid Heights	non-native	Photo
2013	<i>Elodea canadensis</i> Michx.	Hydrocharitaceae	Eric Wrubel, I&M	Marin Headlands, Rodeo Lake	native	Voucher
2013	<i>Fallopia japonica</i> (Houtt.) Ronse Decr.	Polygonaceae	Andrea Williams, MMWD; Eric Wrubel I&M	Lagunitas Creek; Presidio, Lobos Creek	non-native	Photo
2013	<i>Montanoa hibiscifolia</i> (Benth.) Standl.	Asteraceae	Eric Wrubel, I&M	Presidio, Lobos Creek, Fort Point	non-native	No
2013	<i>Passiflora tarminiana</i> Coppens & V.E. Barney	Passifloraceae	Eric Wrubel, I&M	Land's End	non-native	Photo
2013	<i>Sporobolus airoides</i> (Torr.) Torr.	Poaceae	Eric Wrubel, I&M	Marin Headlands, Hill 88	non-native	Voucher
2014	<i>Hyacinthoides hispanica</i> (Mill.) Rothm.	Asparagaceae	Eric Wrubel, I&M	Marin Headlands	non-native	Photo
2014	<i>Ligustrum vulgare</i> L.	Oleaceae	Eric Wrubel, I&M	Sir Francis Drake Blvd, at Tocaloma	non-native	Voucher
2014	<i>Juncus acuminatus</i> Michx.	Juncaceae	Eric Wrubel, I&M	Marin Headlands, Hawk	native	Voucher

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
				Camp		
2014	<i>Prunella vulgaris</i> var. <i>vulgaris</i> L.	Lamiaceae	Eric Wrubel, I&M	Lagunitas Creek	non-native	Voucher
2014	<i>Sorghum halepense</i> (L.) Pers.	Poaceae	Eric Wrubel, I&M	Sir Francis Drake Blvd., at SPAWN Headquarters	non-native	Photo
2014	<i>Stipa miliacea</i> (L.) Hoover var. <i>miliacea</i>	Poaceae	Eric Wrubel, I&M	Fort Baker, at Hwy. 101, Sir Francis Drake Blvd., at Tocaloma	non-native	No
2014	<i>Symphytum officinale</i> L.	Boraginaceae	Eric Wrubel, I&M	Lagunitas Creek	non-native	Photo

Table B-2. New species recorded at PORE.

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
2008	<i>Cotoneaster lacteus</i> W.W. Sm.	Rosaceae	Melissa Potter, I&M	Numerous	non-native	No
2011	<i>Glyceria declinata</i> Bréb.	Poaceae	Eric Wrubel, I&M	Mount Vision Road	non-native	Voucher
2011	<i>Kickxia elatine</i> (L.) Dumort.	Plantaginaceae	Eric Wrubel, I&M	Limantour Road	non-native	No
2011	<i>Prunus caroliniana</i> Ait.	Rosaceae	Eric Wrubel, I&M	Limantour Road	non-native	Voucher
2011	<i>Trifolium angustifolium</i> L.	Fabaceae	Eric Wrubel, I&M	Highway 1, Sir Francis Drake Blvd., Mount Vision Road	non-native	No
2012	<i>Elymus ponticus</i> (Podp.) N. Snow	Poaceae	Eric Wrubel, I&M	Bear Valley Headquarters	non-native	Voucher
2012	<i>Phalaris elongata</i> Braun-Blanq.	Poaceae	Eric Wrubel, I&M	Limantour Beach	non-native	Voucher
2013	<i>Tragopogon porrifolius</i> L.	Asteraceae	Christine Davis, I&M	Bear Valley Headquarters	non-native	Photo
2014	<i>Lychnis coronaria</i> (L.) Descr.	Caryophyllaceae	Nicholas Stevenson, I&M	Mount Vision Road	non-native	Photo
2015	<i>Panicum miliaceum</i> (L.) ssp. <i>miliaceum</i>	Poaceae	Raphaela Floreani Buzbee, I&M	Pierce Point Road	non-native	Voucher
2015	<i>Verbena bonariensis</i>	Verbenaceae	Raphaela Floreani Buzbee, I&M	Limantour Beach	non-native	Photo

Table B-3. New species recorded at PINN.

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
2012	<i>Agrostis avenacea</i> J.F. Gmel.	Poaceae	Eric Wrubel, I&M	West entrance. Revegetation site.	non-native	Voucher
2012	<i>Alopecurus pratensis</i> L.	Poaceae	Eric Wrubel, I&M	McCabe Canyon.	non-native	Voucher
2012	<i>Bromus catharticus</i> var. <i>catharticus</i>	Poaceae	Eric Wrubel, I&M	Campground. Swimming pool area.	non-native	Voucher
2012	<i>Bromus tectorum</i> L.	Poaceae	Robert Steers, I&M	Balconies trail. Condor Gulch Trail.	non-native	Voucher
2012	<i>Crepis vesicaria</i> L. ssp. <i>taraxacifolia</i> (Thuill.) Thell.	Asteraceae	Eric Wrubel, I&M	Campground. Group camp sites.	non-native	Voucher
2012	<i>Dactylis glomerata</i>	Poaceae	Eric Wrubel, I&M	McCabe Canyon.	non-native	No
2012	<i>Lathyrus jepsonii</i> var. <i>californicus</i>	Fabaceae	Eric Wrubel, I&M	North Fork Chalone Tr; South Wilderness Tr.	native	Voucher
2012	<i>Phalaris aquatica</i>	Poaceae	Eric Wrubel, I&M	Campground. By gate to fire road at site 18.	non-native	No
2012	<i>Phalaris paradoxa</i>	Poaceae	Eric Wrubel, I&M	West entrance. Revegetation site.	non-native	No
2012	<i>Schismus arabicus</i>	Poaceae	Eric Wrubel, I&M	Campground. Bottomland Roads.	non-native	No
2012	<i>Sisymbrium altissimum</i>	Brassicaceae	Eric Wrubel, I&M	Highway 146, Bottomlands	non-native	No
2013	<i>Atriplex suberecta</i>	Chenopodiaceae	Sean Zweifler, I&M	Unverified	native	No
2013	<i>Carex densa</i>	Cyperaceae	Eric Wrubel, I&M	McCabe Canyon	native	Voucher
2013	<i>Carex globosa</i>	Cyperaceae	Eric Wrubel, I&M	Bear Gulch	native	Voucher
2013	<i>Carex schottii</i>	Cyperaceae	Eric Wrubel, I&M	McCabe Canyon	native	Voucher
2013	<i>Oxalis corniculata</i>	Oxalidaceae	Sean Zweifler, I&M	Highway 146	non-native	No
2013	<i>Rumex conglomeratus</i>	Polygonaceae	Sean Zweifler, I&M	Unverified	non-native	No
2013	<i>Sorghum halepense</i>	Poaceae	Sean Zweifler, I&M	Highway 146	non-native	No
2013	<i>Verbena bracteata</i>	Verbenaceae	Sean Zweifler, I&M	Unverified	native	No

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
2014	<i>Sisymbrium irio</i>	Brassicaceae	Eric Wrubel, I&M	West side employee housing	non-native	Photo

Table B-4. New species recorded at JOMU.

Year	Scientific name	Family	Reporter	Location(s)	Nativity	Evidence
2010	<i>Dittrichia graveolens</i> (L.) Greuter	Asteraceae	Eric Wrubel, I&M	Mount Wanda Trailhead	non-native	Voucher
2011	<i>Lepidium latifolium</i> L.	Brassicaceae	Eric Wrubel, I&M	Strentzel Creek	non-native	Photo
2011	<i>Ehrharta erecta</i> Lam.	Poaceae	Eric Wrubel, I&M	Strentzel Creek	non-native	No
2014	<i>Carduus tenuiflorus</i> Curtis	Asteraceae	Desmond Murray, JOMU	Mount Wanda, south of Nature Trail	non-native	Voucher
2014	<i>Pinus pinea</i> L.	Pinaceae	Eric Wrubel, I&M	West of Alhambra Ave.	non-native	Photo
2014	<i>Pinus radiata</i> D. Don	Pinaceae	Eric Wrubel, I&M	West of Alhambra Ave.	Native to California, introduced in Contra Costa Co.	Photo
2015	<i>Stipa miliacea</i> (L.) Hoover var. <i>miliacea</i>	Poaceae	Nicholas Stevenson, I&M	Northwest border of Mt Wanda, near Franklin Canyon Road	non-native	No

Appendix C: Revisions to protocol methods

Introduction

This document summarizes the revisions made in 2015 to methodology of the early detection of invasive plant species protocol (Williams et al. 2009). A revision of the protocol itself is underway, but these changes are documented here to directly relate the changes to the results of the 2015 surveys.

Survey frequency by subwatershed priority

The use of subwatershed priority levels to inform survey frequency at GOGA and PORE was discontinued in 2015. Subwatersheds were originally prioritized by number and degree of current infestations, risk of further infestations, and priority of natural resources present (Williams et al. 2009). Higher priority subwatersheds were surveyed more frequently than lower priority subwatersheds in order to increase the surveillance level in these areas. Approximately 55% of subwatersheds in each park were surveyed annually, and all subwatersheds in each park were surveyed at least once within a five year survey cycle (Table C-1).

Table C-1. Annual frequency of surveys in a five year survey cycle by subwatershed priority level (Williams et al. 2009).

Subwatershed Priority	Frequency of surveys
High	5
Significant	2
Moderate	1
Low	1

The primary goal of this survey design was to increase the probability of detections in high value/high risk subwatersheds. When the protocol was written, it was not known if this survey frequency was appropriate for the rapid-response capabilities of the parks, and invasive species spread rates. The protocol stated that the revisit frequency should be evaluated against these factors upon completion of the first five year data cycle, which was completed in GOGA in 2012 and in PORE in 2013.

The rate of early detections far exceeded the rate of response by park management programs from 2008 – 2013. For example, ISED mapped an average of 1,020 patches of priority invasive species per year in GOGA, while the GOGA Habitat Restoration Team (HRT) only treated an average of 4% of these patches per year – as recorded in the GeoWeed database shared by the two programs (Figure C-1). The PORE Habitat Restoration Program (HRP) does not share a geodatabase with ISED, but the rapid response rate was expected to be comparable, or lower.

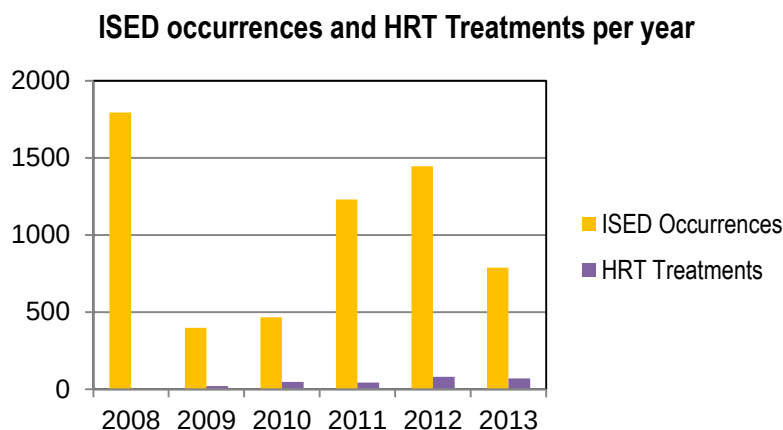


Figure C-1. Number of occurrences mapped by ISED and treated by HRT per year, 2008-2013.

During the first five year survey cycle, no small populations of priority species were observed to spread beyond control within one year of their first assessment, indicating that an annual survey frequency is excessive. The original revisit schedule was in part based on survey efficiency models from New Zealand (Harris et al. 2001), in which early detection of small populations informs rapid response before the populations can spread beyond control. However, the spread rates modelled for New Zealand are more rapid than spread rates observed in SFAN parks.

The survey schedule was re-evaluated and revised in 2015. All subwatersheds in each park will be surveyed with equal frequency, once every three years in a triennial survey cycle (one-third of all subwatersheds visited each year).

These revisions were based on the following rationale:

- 1) The rate of early detections far exceeded the rate of response by park management programs from 2008 – 2013. A triennial survey return interval is expected to achieve an appropriate ratio of surveillance to response.
- 2) Observed spread rates were not rapid enough to warrant high frequency, annual surveys. A three year survey cycle is anticipated to detect small populations within an adequate timeframe for rapid response.
- 3) Unequal sampling of the landscape. Some subwatersheds were surveyed annually while others were only surveyed once or twice in a five year cycle. While the primary objectives of this protocol are surveillance, detection, and reporting; the status of priority plant species, spatial analysis of invasion patterns is also an objective. The unequal sampling effort in different subwatersheds confounds comparison because increased detections in a given area may be an effect of increased sampling, rather than a response variable.
- 4) High frequency surveys within the first five year survey cycle established a baseline for the distribution and status of priority species populations along roads and trails within the parks. The survey frequency can now be reduced to monitor these populations more efficiently.

- 5) Reducing the annual ISED survey effort will free up funding to support the field effort for the Plant Community Monitoring protocol which is an important component of invasive species monitoring, providing trend-based data for more widespread species.
- 6) By condensing the survey cycle to three years instead of five years, the entire road and trail network in each park can be surveyed more frequently, and landscape-scale status can be assessed sooner.

Species priority levels

In 2015, ISED discontinued the mapping of point occurrences for List 3 species. This category includes widespread invasives that are difficult to control at the scale of the park. Previously, presence/absence was recorded for all List 3 species, and point occurrences were only mapped if the patch size was less than 100 m². The most recent tables of List 3 species for GOGA, PORE, and JOMU can be found in the 2014 ISED annual report (Wrubel 2017).

This revision is based on the following rationale:

- 1) Limited utility of data. Since ISED only mapped a subset of small, outlier populations for List 3 species, the data were of limited utility for assessing status and distribution, and it was difficult to interpret and communicate the results. Park vegetation programs already actively map and manage many List 3 species, and the point occurrences mapped by ISED did not add significantly to existing mapping efforts for these species.
- 2) Survey efficiency. Mapping List 3 species was often time consuming, due to their abundance. In landscapes with high frequencies of List 3 species, mapping decisions needed to be made often, significantly slowing down the pace of surveys, and detracting from the detection of higher priority species.
- 3) Presence/absence by subwatershed. Presence of List 3 species will continue to be recorded at the subwatershed level, which is appropriate for assessing park-wide distribution of these widespread species.

Discussion

The ISED program regularly reports significant early detections to park managers via direct communication, monthly newsletters, and annual reports. The SFAN I&M program is integrated with park resource programs, and ISED staff work closely with park vegetation management teams. The highest priority species with lowest abundance are often immediately prioritized for treatment by park vegetation managers. However, there is no formalized system for prioritizing rapid response targets, and treatments have been on an ad-hoc basis. Furthermore, park treatments of ISED detections have not been consistently tracked, making it difficult to assess the ratio of rapid response treatments to reported early detections. The ISED field crews treat small patches of high priority species when time allows, but early detection is the primary objective of ISED surveillance efforts, and rapid response must primarily be the responsibility of park managers rather than the Inventory and Monitoring Program

After prevention, early detection and rapid response (EDDR) is the most efficient and effective method for controlling invasive species (McNeely et al. 2001). The effectiveness of this approach improves with increased rapid response rates, and declines with a lack of response. Park vegetation management programs have ongoing projects that occupy most of their field time, and rapid response to ISED reports is not yet formally integrated into weed control efforts in the parks. To insure that early detection is followed by rapid response, populations of priority early detection species must be prioritized for eradication, and a portion of each park's weed management efforts must be dedicated to rapid response. Rapid response treatments should also be routinely tracked in the Weed Manager system. This would enable our program to assess the efficiency of ISED survey efforts in relation to rapid response rates.

Appendix D: Interactive web maps of 2015 survey results.

The links below provide access to interactive web maps in the Calflora Database Observation Hotline tool. These maps show the location of occurrences, assessments and treatments mapped by ISED in 2015 in SFAN parks (Figure D-1). Zoom in to your area of interest and refresh the search. For instructions on use of the Observation Hotline go to: <http://www.calflora.org/entry/help/observ-help.html>

GOGA, PORE and JOMU 2015 Observations

<http://www.calflora.org/entry/observ.html#srch=t&src=SFNPS+Early+Detection&before=2015-12-31&after=2015-01-01&inma=t&y=37.8524&x=-122.615&z=9>

PINN 2015 Observations

<http://www.calflora.org/entry/observ.html#srch=t&src=SFNPS+Early+Detection&before=2015-12-31&after=2015-01-01&inma=t&y=36.4846&x=-121.1837&z=12>

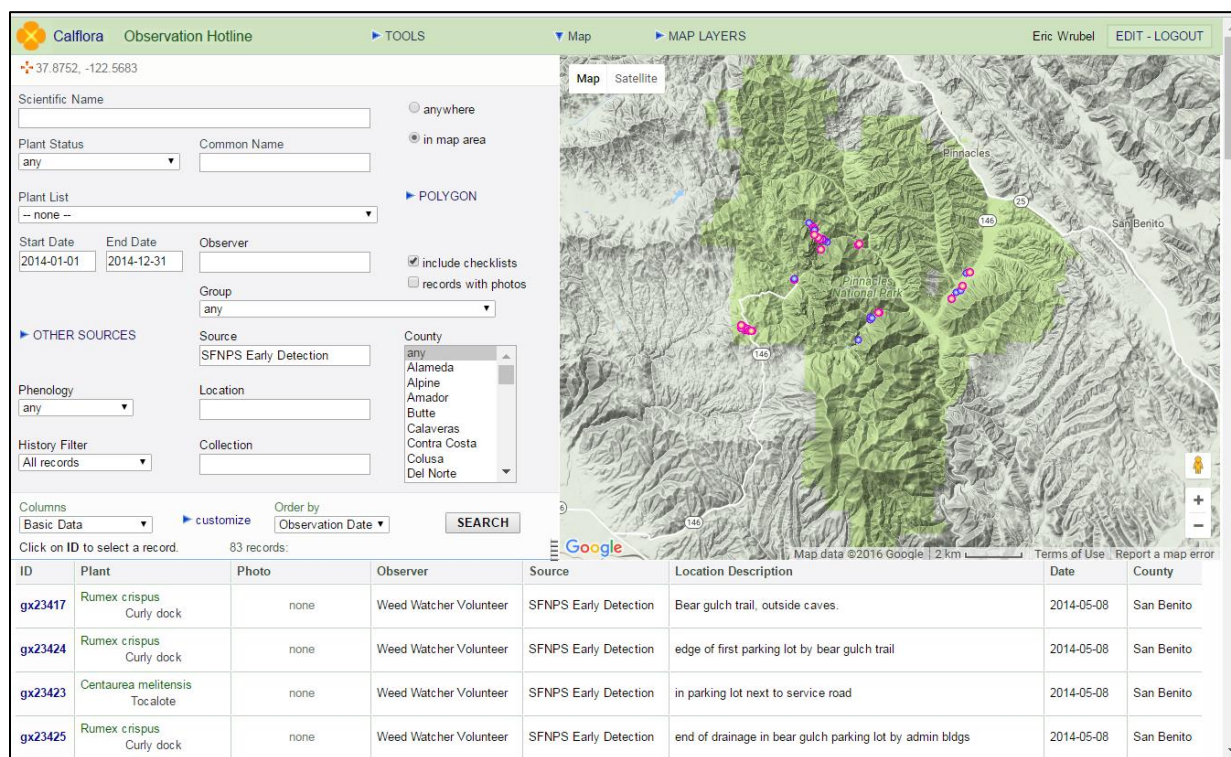


Figure D-1. Screenshot of interactive web map showing ISED occurrences mapped at PINN.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 114/140446, 426/140446, 612/140446, 641/140446, October 2017

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA TM