

Results of PlantRight 2016 Spring Retail Nursery Survey

Prepared For
Sustainable Conservation

Prepared By
Learning for Action

September 2016



Learning for Action enhances the impact and sustainability of social sector organizations through highly customized research, strategy development, and evaluation services.

Introduction

About PlantRight

In 2004, [Sustainable Conservation](#) brought together a group of leaders in the horticultural industry, academia, botanical gardens, environmental groups, and government agencies to form the [California Horticultural Invasives Prevention](#) (Cal-HIP) partnership. Recognizing that invasive plants are still introduced through California's horticultural trade and that prevention is the most effective way to combat their spread, the partnership created [PlantRight](#) in 2005.

PlantRight uses a collaborative, science-based, data-driven, and voluntary approach to stop the propagation, distribution and sale of invasive ornamental plants in ways that are good for business and the environment. In addition to helping protect California's open spaces and native habitats, this work contributes to the state's economic well-being, as California spends more than \$82 million annually on the removal of invasive plants. With fewer invasive plants in our open spaces, the factors that contribute to wildfire risk, flood risk, and compromised real estate and recreational values are reduced.

Cal-HIP acts as a steering committee for PlantRight and convenes quarterly. As its first act of business, Cal-HIP produced a list identifying 19 of the most commonly sold horticultural invasive plants, along with multiple non-invasive alternatives for each. This list is reviewed annually and updated as progress is made and new threats emerge: today, PlantRight is partnering with the nursery industry to stop the sale of seven invasive species ([see list here](#)). In addition to providing educational content for retail nurseries and landscape professionals through its [Retail Nursery Partnership](#) and [Continuing Education](#) programs, PlantRight is working to equip the horticultural industry with the knowledge to screen new horticultural plants for invasiveness, through a recently developed [Plant Risk Evaluation \(PRE\) tool](#).

To help measure its impact, update its plant list, and inform its strategies, PlantRight surveys California's retail nurseries for horticultural invasive plants each spring, with the help of volunteers from the University of California Master Gardener Program and other gardening and conservation groups.

About this Report

Learning for Action, a professional third-party evaluation firm, was engaged to (1) assist in the development of a statistically sound sampling plan for the annual spring survey, and (2) analyze the results of the 2016 Spring Nursery Survey, in comparison to past years' results. This report focuses on the results of the survey. For details of the sampling plan, please see the In-Depth Methods in Appendix A.

About Learning for Action

Established in 2000, Learning for Action (LFA) provides highly customized research, strategy, and evaluation services that enhance the impact and sustainability of social sector organizations across the U.S. and beyond. LFA's technical expertise and community-based experience ensure that the insights and information we deliver to nonprofits, foundations, and public agencies can be put directly into action. In the consulting process, we build organizational capacity, not dependence. We engage deeply with organizations as partners, facilitating processes to draw on strengths, while also providing expert guidance. Our high quality services are accessible to the full spectrum of social sector organizations, from grassroots community-based efforts to large-scale national and international foundations and initiatives.

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I. Methods

Data Collection Methods

PlantRight uses an annual Spring Nursery Survey to track the retail market for invasive plants in California.¹ The survey is conducted using a sample of retail nurseries across the state and is administered at individual stores by volunteers. Since the pilot survey in 2010, PlantRight has conducted the survey annually for the past six years. Exhibit 1 shows the number of stores surveyed each year.

Exhibit 1. Number of Stores Surveyed Each Year

Year	Stores Surveyed
2010	73
2011	226
2012	238
2013	223
2014	226
2015	265
2016	302

The goal of the Spring Nursery Survey is to provide an annual snapshot of the statewide prevalence of invasive plants in nurseries. With these data, PlantRight can track trends in the prevalence of invasive plants over time.²

From 2010 to 2012, the PlantRight survey tracked the same nineteen plants. The list has been revised every year since:

Exhibit 2. Number of Plant Species in Each Year's Survey List

Year	Total Plants Surveyed from Previous Year	Plants Removed from Official List	Candidate Plants Removed	Plants Added to Official List	Candidate Plants	Total Plants Surveyed in Current Year
2010	N/A	N/A	N/A	N/A	N/A	19
2011	19	0	0	0	0	19
2012	19	0	0	0	0	19
2013	19	7	0	0	6	18
2014	18	5	3	3	4	14
2015	14	4	0	0	8*	18
2016	18	3	6	0	6**	15

*Three of eight were previously retired; re-surveyed in 2015.

**The 2016 report includes eight candidate plants: six new to the list and two remaining from the 2015 list.

¹ PlantRight currently tracks invasive plants that are among the most ecologically destructive and most commonly sold by the nursery industry in California. While more may be found in the nursery industry, this survey tracks only a select set of plants, which are listed in Appendix D.

² This survey tracks the prevalence of plants for sale, not the volume of plants for sale. Some stores may sell many species of invasive plants, but only have a few plants of each species for sale. Others may only sell one type of invasive plant, but have large numbers of that species available. In short, not all stores have an equal impact on the prevalence of invasive plants; a small decrease in stores that sell large quantities of invasive species could have a larger effect than a large decrease in stores that sell small quantities of invasive species.

The changes to PlantRight’s survey plant list from 2011-2016 are summarized in the table below.

Exhibit 3. Plant Species in Each Year’s Survey List

Common Name	Scientific Name	2010, 2011, and 2012	2013	2014	2015	2016
African daisy	<i>Osteospermum fruticosum</i>				✓	
Arundo/giant reed	<i>Arundo donax</i>	✓				
Blackwood acacia	<i>Acacia melanoxylon</i>					✓
Blue gum eucalyptus	<i>Eucalyptus globulus</i>	✓				
Brazilian pepper tree	<i>Schinus terebinthifolius</i>		✓		✓	✓
Brazilian waterweed	<i>Egeria densa</i>			✓		
Bridal veil broom	<i>Retama monosperma</i>	✓				
Canary Island date palm	<i>Phoenix canariensis</i>					✓
Capeweed	<i>Arctotheca calendula</i>	✓	✓			
Chinese tallow tree	<i>Sapium sebiferum</i>	✓	✓	✓	✓	
Crystalline iceplant	<i>Mesembryanthemum crystallinum</i>	✓	✓			
English (common) holly	<i>Ilex aquifolium</i>					✓
Evergreen (shamel) ash	<i>Fraxinus udei</i>				✓	✓
Flowering rush	<i>Butomus umbellatus</i>		✓			
French broom	<i>Genista monspessulana</i>	✓	✓	✓	✓	
Glossy privet	<i>Ligustrum lucidum</i>				✓	
Grassland sedge ³	<i>Carex divulsa</i>			✓	✓	
Green fountain grass	<i>Pennisetum setaceum</i>	✓	✓	✓	✓	✓
Highway iceplant	<i>Carpobrotus edulis</i>	✓	✓	✓	✓	✓
Italian buckthorn	<i>Rhamnus alaternus</i>					✓
Jubata grass	<i>Cortaderia jubata</i>	✓				
Mexican feathergrass	<i>Stipa tenuissima</i> (also called <i>Nassella tenuissima</i>)		✓	✓	✓	✓
Myoporum	<i>Myoporum laetum</i>	✓	✓		✓	
Ox-eye daisy	<i>Leucanthemum vulgare</i>			✓		
Pampas grass	<i>Cortaderia selloana</i>	✓	✓	✓	✓	✓
Parney’s (milkflower) cotoneaster	<i>Cotoneaster lacteus</i>					✓
Periwinkle	<i>Vinca major</i>	✓	✓	✓	✓	✓
Petite licorice, cobweb bush	<i>Plecostachys serpyllifolia</i>					✓
Portuguese broom	<i>Cytisus striatus</i>	✓			✓	
Russian olive	<i>Elaeagnus angustifolia</i>	✓	✓			
Saltcedar	<i>Tamarix ramosissima</i>	✓				
Scarlet wisteria	<i>Sesbania punicea</i>	✓			✓	
Scotch broom	<i>Cytisus scoparius</i>	✓	✓	✓	✓	
Southern catalpa	<i>Catalpa bignonioides</i>			✓		
Spanish broom	<i>Spartium junceum</i>	✓	✓			
Victorian box	<i>Pittosporum undulatum</i>		✓			
Water hyacinth	<i>Eichhornia crassipes</i>		✓	✓	✓	✓
Yellow water iris	<i>Iris pseudacorus</i>		✓	✓	✓	✓

This report focuses primarily on **changes over time for the seven plants surveyed each year since 2013** (green fountain grass, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, water hyacinth, and yellow water iris) to ensure that findings are comparable across years.

The questions addressed in the Results chapter for the seven Cohort 1 and 2 plants are:

- What percentage of stores carries one or more species of locally invasive plants?
- What is the average number of locally invasive species carried by stores?
- Considering each invasive species separately, what percentage of stores carries that species in the region(s) that it is locally invasive?

The eight candidate plants (Blackwood acacia, Brazilian pepper tree, Canary Island date palm, English holly, evergreen ash, Italian buckthorn, Parney's cotoneaster, and petite licorice) are included in the third section of the Results chapter:

- Considering each invasive species separately, what percentage of stores carries that species in the region(s) that it is locally invasive?

In order for the annual snapshots to provide accurate information about the prevalence of invasive plants, PlantRight needs to be confident that it can draw valid inferences from the survey results. There are several approaches that PlantRight employed to ensure the collection of high quality survey data:

- **Developing a rigorous sampling plan.** LFA created a tailored sampling plan to support the goal of maximizing the extent to which the nurseries in the survey represent the retail nursery industry in California as a whole. The sampling plan was also crafted so that stores of each store type (box retailers, chain retailers, and independent retailers), and stores within each county, were adequately represented.
- **Recruiting and training highly skilled surveyors.** PlantRight recruited UC Master Gardener volunteers – surveyors who already have extensive plant recognition skills – and volunteers from other gardening and conservation groups. To prepare them to carry out the survey, PlantRight held trainings that taught volunteers about invasive plants in California and how to recognize the plants on PlantRight's survey list. In 2016, 175 volunteers participated in the survey, with each volunteer spending an average of 59 minutes surveying a nursery. The majority of volunteers – 58% – surveyed more than one store.
- **Conducting a quality assurance review on the results.** Survey volunteers were asked to take photographs of the plants that they identified as invasive species. PlantRight staff and a botanist then reviewed the photos to verify the results that volunteers submitted.

For details about each of these approaches, please consult Appendix A.

Data Analysis

Because a sample was drawn based on a high-quality sampling plan, it is possible to infer population characteristics from the sample. Thus LFA used frequency distributions to describe the full sample and sample subgroups.³ The frequency distributions for the sample provide unbiased estimates⁴ of the frequency distributions within the population (and population subgroups).

This report presents the results of ANOVAs and t-tests, statistical tests designed to show the level of confidence in specific types of between-group comparisons. ANOVAs and t-tests are designed to test for difference across multiple groups (e.g. the prevalence of an invasive species across multiple years or the prevalence of invasive species in a set of stores, when those stores are grouped by climate zone).

Focus on Locally Invasive Regions

Plants on PlantRight's survey list are not necessarily invasive across *all* of California. California is a large and geographically diverse state, and a plant's invasiveness depends on the climate and the ecosystem of its particular location.

PlantRight classifies California according to five distinct climate zones (Central Valley, Desert, North & Central Coast, Sierra & Coastal Mountains, and South Coast), and plants are *locally invasive* only in specific climate zones. For example, highway iceplant is locally invasive in the South Coast and North & Central Coast, but not in the Central Valley, Desert or Sierra & Coastal Mountains. (For information on which plant species are considered invasive in which climate zones, please see Appendix C.)

PlantRight is most effective when it is able to report statistics that take into account where plants are locally invasive, because those are the areas where the plants have the most potential negative environmental impact. Therefore, this report focuses on rates of invasive species in the regions that they are considered locally invasive.

³ Prior to analysis, LFA weighted the data. For details on weighting, see Appendix A.

⁴ To say an estimate is *unbiased* does not mean that the true population characteristic *perfectly matches* the estimate. Rather, "unbiased" has a technical meaning which is: if an infinite number of samples were drawn using this sampling method, the average of that sample would equal the true average. (And other descriptive statistics would equal the descriptive statistics for the population.) If we have an unbiased estimate, we can be confident that there are no factors systematically distorting our results.

II. Results

PlantRight commissioned the 2016 Annual Spring Nursery Survey in order to answer the following research questions:

1. What percentage of stores carries one or more species of locally invasive plants?
2. What is the average number of locally invasive species carried by all stores?
3. Considering each invasive species separately, what percentage of stores carries that species in the region(s) where it is locally invasive?

For each of these research questions, PlantRight also wanted to know:

- How do these results vary by climate zone?
- How do these results vary by store type?

Because the list of invasive plants that PlantRight monitors has changed over time, the plant list for the 2016 survey is organized into three categories:

- **Cohort 1.** This cohort includes four plants that have been on PlantRight's list continuously since 2011: green fountain grass, highway iceplant, pampas grass, and periwinkle. The number of plants in Cohort 1 has decreased over time as plants have been retired from the plant list.
- **Cohort 2.** This cohort includes three plants that have been on PlantRight's list since 2014 and surveyed since 2013: Mexican feathergrass, water hyacinth, and yellow water iris.
- **Candidate plants.** This group includes eight plants that are under review for PlantRight's list: blackwood acacia, Brazilian pepper tree, Canary Island date palm, English holly, evergreen ash, Italian buckthorn, Parney's cotoneaster, and petite licorice. A new group of candidate plants is surveyed for each year, and candidate plants may be surveyed for multiple years as PlantRight evaluates whether to add them to the plant list. Two of the 2016 candidate plants (Brazilian pepper tree and evergreen ash) were also surveyed in 2015.

Exhibit 4 on the following page shows the breakdown of plants by category.

Exhibit 4. Plants on 2016 Survey List by Category

Common Name	Cohort 1 Plants (Surveyed Since 2011)	Cohort 2 Plants (Surveyed Since 2013)	Candidate Plants (Species Under Consideration)
Green fountain grass	✓		
Highway iceplant	✓		
Pampas grass	✓		
Periwinkle	✓		
Mexican feathergrass		✓	
Water hyacinth		✓	
Yellow water iris		✓	
Blackwood acacia			✓
Brazilian pepper tree			✓
Canary Island date palm			✓
English (common) holly			✓
Evergreen (shamel) Ash			✓
Italian buckthorn			✓
Parney's (milkflower) cotoneaster			✓
Petite licorice, cobweb bush			✓

The remainder of this section contains the survey results, organized by research question. All results concern the *presence or absence* of locally invasive plants for sale, not the *volume* of plants for sale at any individual store. Some stores may sell many species of invasive plants but have only a few plants of each species for sale. Others may sell only one type of invasive plant, but have large numbers of that species available.

For information that focuses specifically on the statistical findings from 2011-2015, please refer to LFA's reports from each of those years ([view on PlantRight's website](#)).⁵ Survey results are also available for 2010, but this report does not use the 2010 data. LFA, in partnership with PlantRight, determined that the 2010 survey does not include sufficient data to confidently draw meaningful conclusions about California's retail nursery industry. Thus, 2010 is considered a pilot year and is not strictly comparable to subsequent years' results.

For a full list of statistically significant results, please see Appendix E.

⁵ The 2013-2015 information in this report does not always perfectly match the information in past reports because of adjustments made each year to PlantRight's locally invasive plant list (i.e. plants are added or removed). For this report, 2013-2015 analyses were re-calculated to reflect the current list of seven Cohort 1 and Cohort 2 plants.

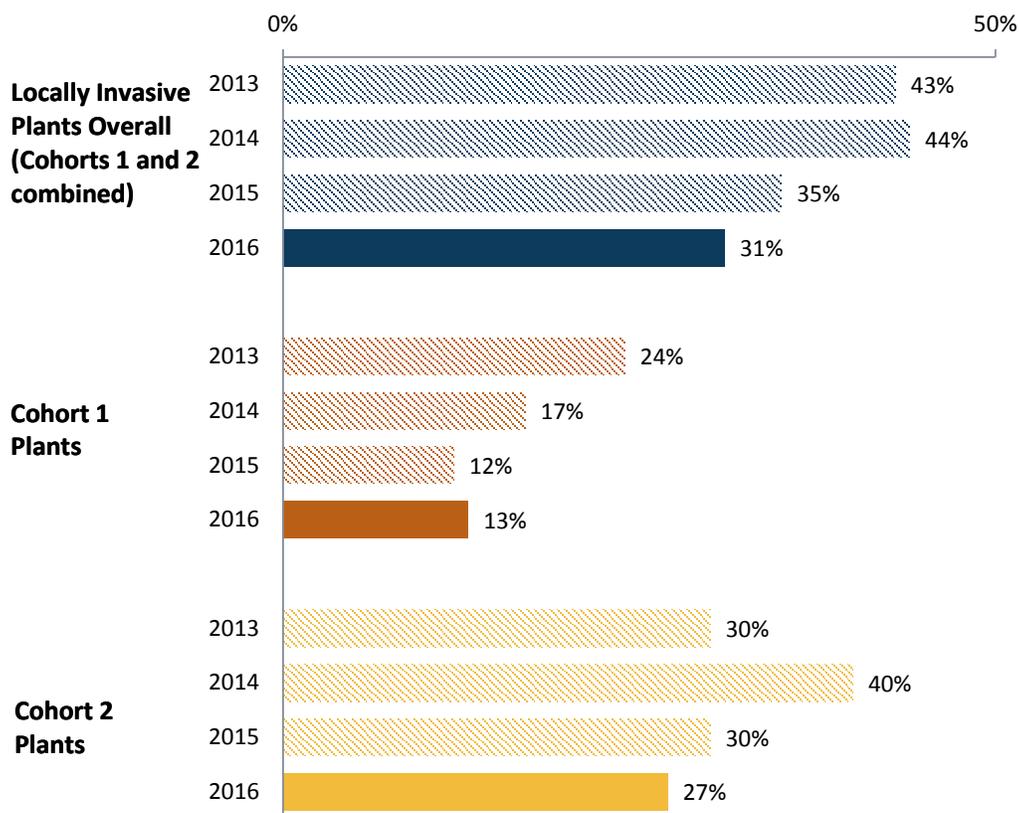
1. What percentage of stores carries one or more species of locally invasive plants?⁶

The rate of nurseries that are selling locally invasive plants continues to decline. In 2014, 44% of nurseries sold locally invasive plants; this rate dropped to 35% of nurseries in 2015, and fell further to 31% in 2016. Exhibit 5 below shows the prevalence of locally invasive plants found in each cohort for each year since 2013, the year that Cohort 2 plants were first surveyed.

The drop in locally invasive plants overall from 2015 to 2016 can be traced to Cohort 2 plants. The rate of locally invasive Cohort 2 plants for sale dropped from 40% in 2014 to 30% in 2015 to 27% in 2016. This finding is in contrast to the rate of locally invasive Cohort 1 plants for sale, which showed a slight uptick in 2016, after continuous years of decline.

None of the changes from 2015 and 2016 rates (Cohort 1, Cohort 2, or overall) were found to be statistically significant.⁷

Exhibit 5. 2013-2016 Results:
Percentage of Stores Carrying Locally Invasive Plants by Cohort



⁶ Note: as previously discussed, this section only includes Cohort 1 and 2 plants: green fountain grass, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, water hyacinth, and yellow water iris.

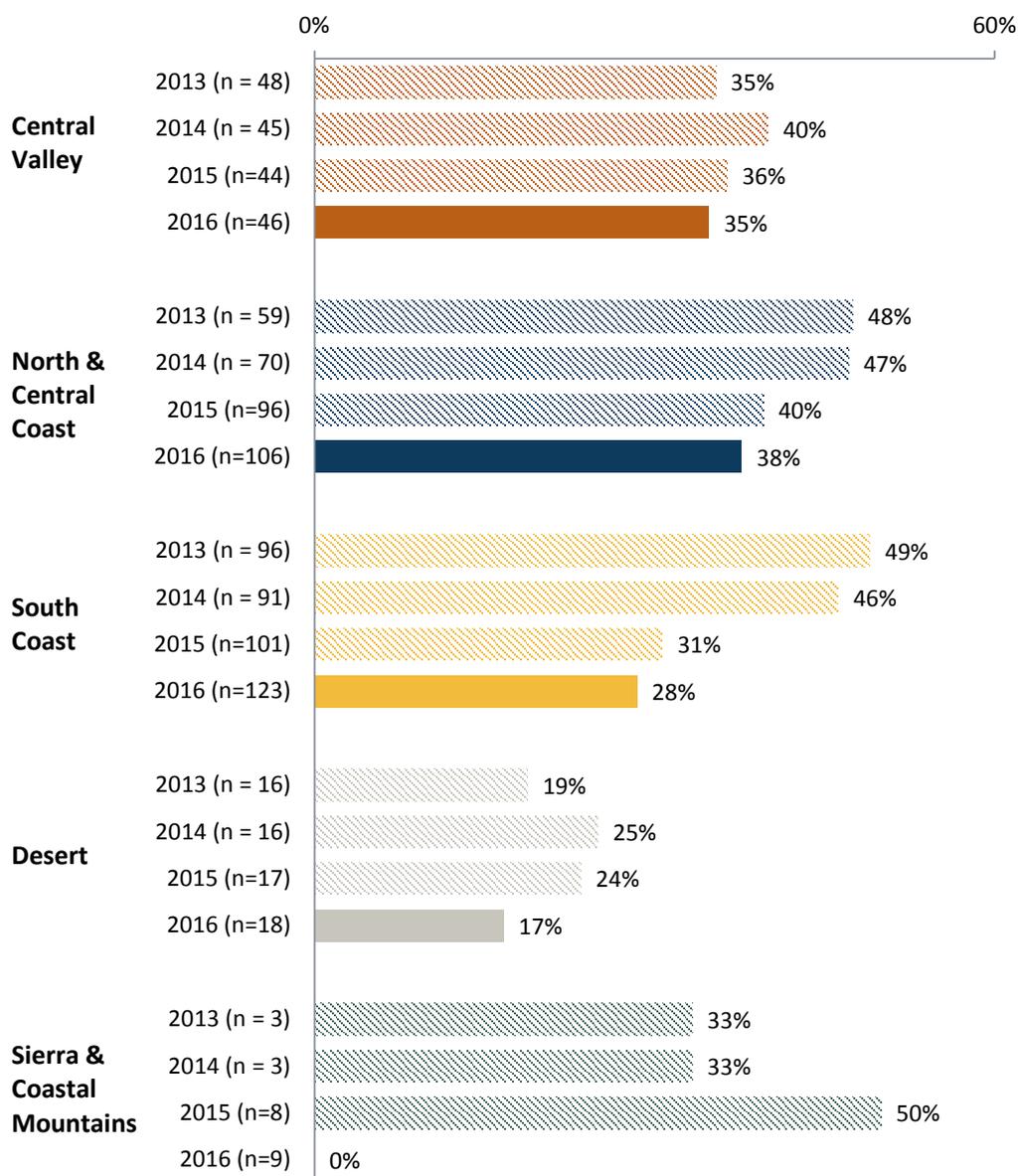
⁷ Lack of statistical significance does not mean, in and of itself, that the over-time change is not *real*. It means that the “margin of error” for 2015 overlaps with the 2016 margin of error enough so that we cannot be sufficiently confident to *infer* that the drop signals a *true* drop in the population. The over-time change we see is still our best estimate of what is happening in the nursery population, given available data.

By Climate Zone

The availability of locally invasive plants for sale varies across climate zones. In 2016, stores in all climate zones had lower rates of locally invasive plants for sale compared to 2015.

In 2016, locally invasive plants were found at the highest rate at stores in the North & Central Coast (38%), followed by the Central Valley (35%), South Coast (28%), and Desert (17%) climate zones. No locally invasive plants were found at any stores in the Sierra & Coastal Mountains. While the drop in the Sierra & Coastal Mountains between 2015 and 2016 looks substantial, only nine stores in that region were surveyed. The small number in the sample leads to higher “sampling variability,” so that even random sampling can paint a somewhat skewed picture – so we should not take the results at face value. And, in line with the small sample, the change from 50% to 0% is not statistically significant (so we cannot be confident that the drop reflects a *true* decrease in the population).

Exhibit 6. 2013-2016 Results:
Percentage of Stores Selling Locally Invasive Plants by Climate Zone



By Store Type

Prevalence of locally invasive species for sale varies by store type. Stores are categorized by PlantRight as Box Stores (Lowe's, Home Depot, Orchard Supply Hardware, and Wal-Mart); Chain Retailers (Armstrong Garden Centers and other stores with three or more locations); or Independent Retailers (independently- or locally-owned stores, usually with just one or two locations).

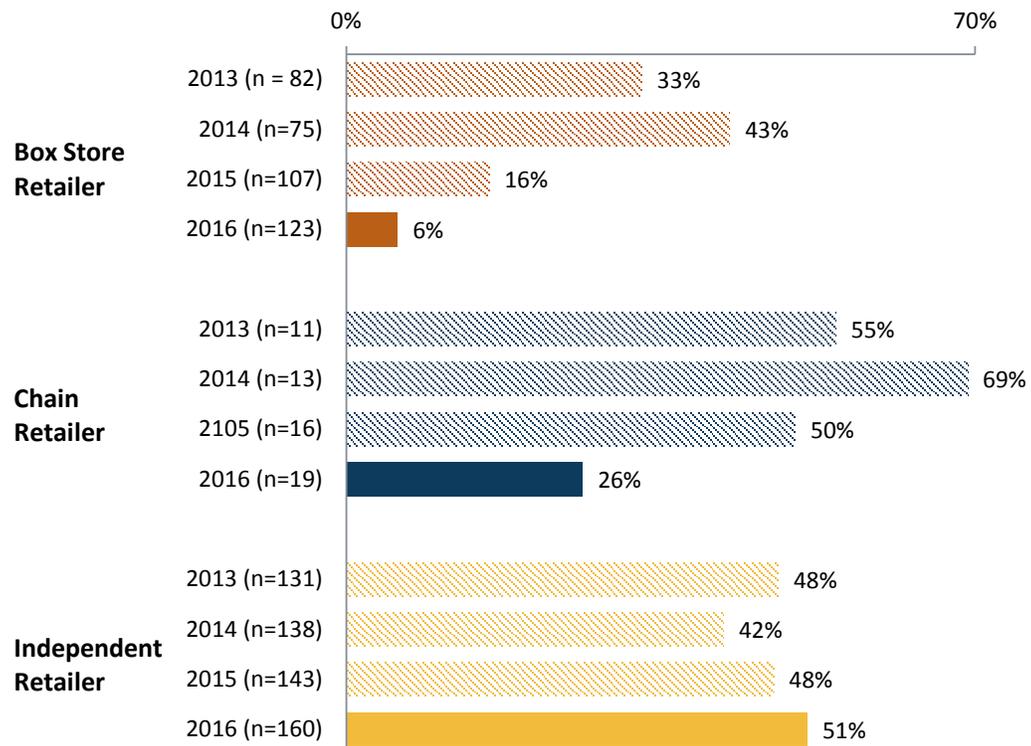
Independent Retailers were the store type most likely to sell a locally invasive plant species in 2016, with 51% of stores selling at least one species of invasive plant. The rate of Independent Retailers selling locally invasive plants has increased each year since 2014. This finding underscores PlantRight's challenge in reaching the sizeable population of small, independent nurseries and persuading them to commit to selling non-invasive alternatives instead of invasive plants.

Box Stores experienced a large – and statistically significant – decrease in stores selling locally invasive plants. The considerable decline, from 43% in 2014 to 16% in 2015 and now to 6% in 2016, shows that PlantRight's targeted efforts to partner with major retailers continues to pay off.⁸ Home Depot California partnered with PlantRight in January of 2015, and Lowe's and Orchard Supply Hardware (OSH) joined PlantRight's efforts in the spring of 2016.

Chain Retailers also showed a large drop in stores offering at least one locally invasive species for sale, from 50% in 2015 to 26% in 2016. There are relatively few Chain Retailers in the sample, however (19 stores), and the decrease between years is not statistically significant.

⁸ Sustainable Conservation, 2015. *Alliance to Combat Invasive Plants Grows*. <http://suscon.org/plantright/alliance.php>.

Exhibit 7. 2013-2016 Results:
 Percentage of Stores Selling Locally Invasive Plants by Store Type



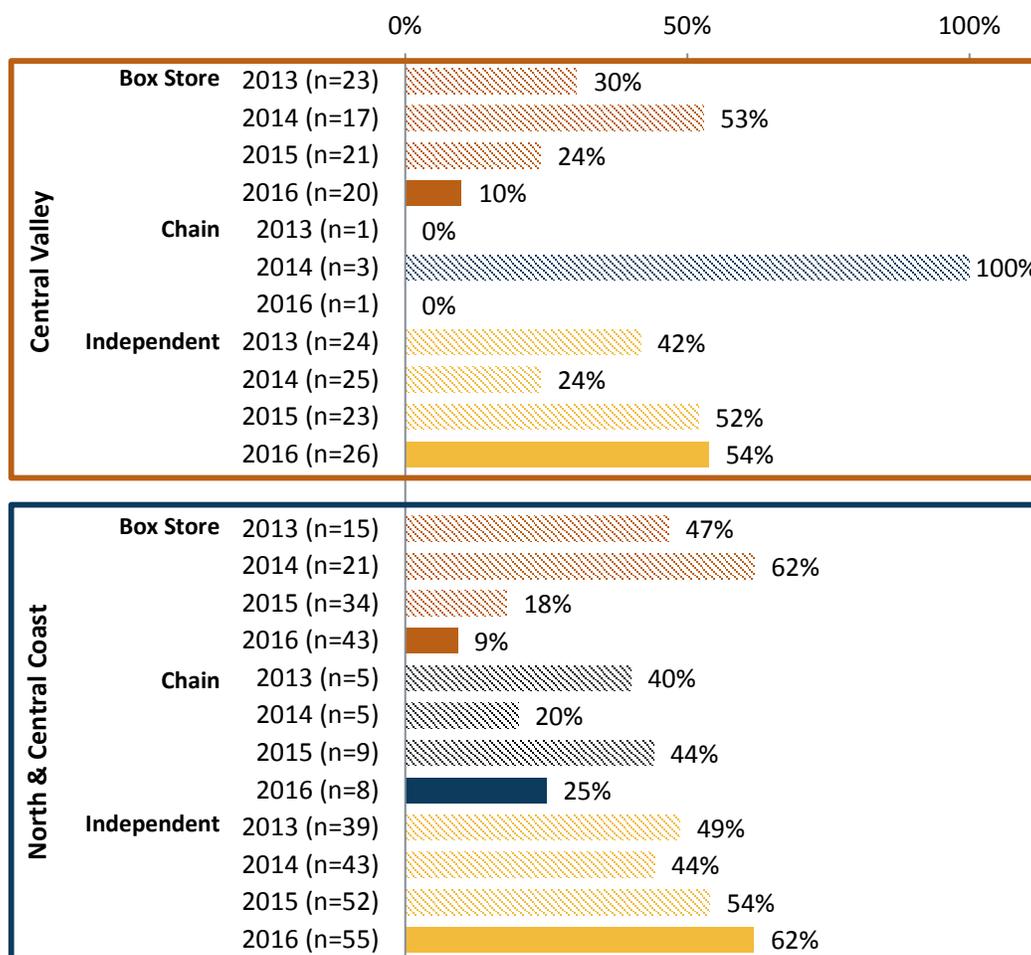
By Climate Zone and Store Type

Across all climate zones (with the exception of the Sierra & Coastal Mountains), locally invasive plants were most likely to be found for sale at Independent Retailers.

In 2016, locally invasive plants were found most often at Independent Retailers in the North & Central Coast (62%), followed by Independent Retailers in the Central Valley (54%), Independent Retailers in the South Coast (48%), Chain Retailers in the South Coast (33%), and Independent Retailers in the Desert (30%). No locally invasive plants were found for sale at Chain Stores in the Central Valley, Box Stores in the Desert, or any store type in the Sierra & Coastal Mountains.

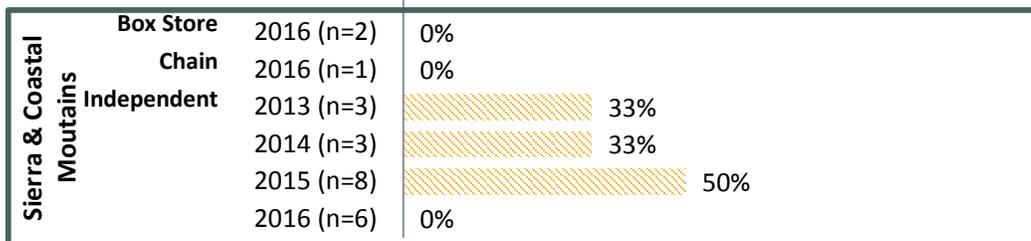
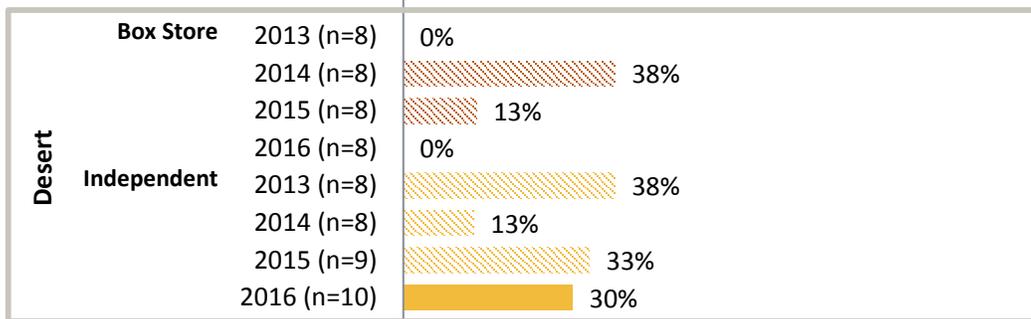
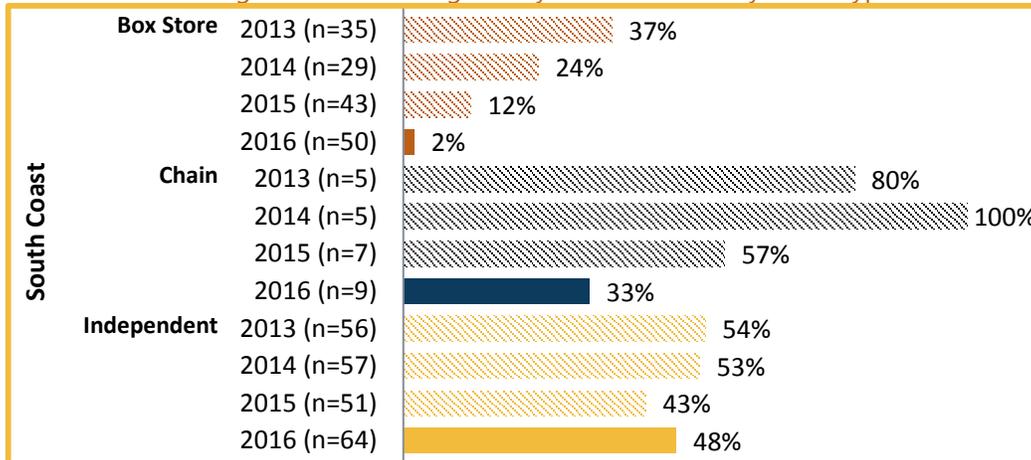
It is important to note that the sample sizes for some of these categories are quite small. It is therefore difficult to draw strong conclusions from these patterns.

Exhibit 8. 2013-2016 Results:
Percentage of Stores Selling Locally Invasive Plants by Store Type⁹



⁹ Stores for which there were no data points (n=0) are not included in this chart. These include: Chain Retailers in the Central Valley in 2015; Chain Stores in the Desert, 2013-2016; and Box Stores and Chain Retailers in the Sierra & Coastal Mountains, 2013-2015.

Exhibit 8. 2013-2016 Results:
Percentage of Stores Selling Locally Invasive Plants by Store Type⁹



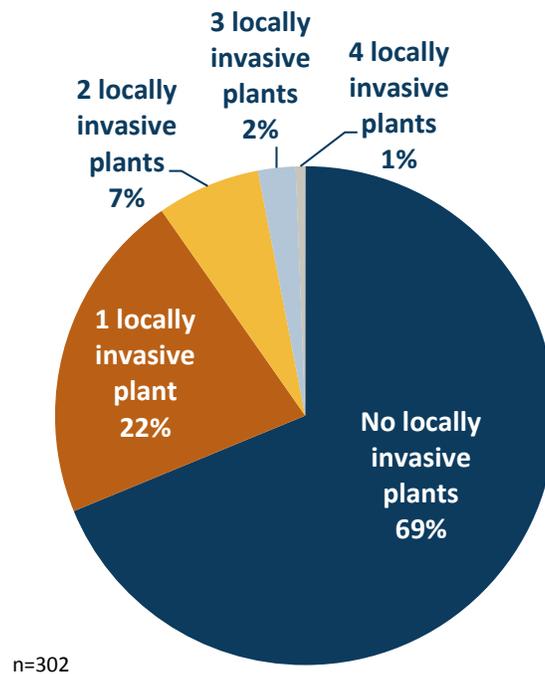
2. What is the average number of locally invasive species carried by stores?¹⁰

The maximum number of locally invasive species found at any one store was four. Two stores had four locally invasive species present. Exhibit 9 below shows the number of locally invasive plants found in surveyed stores.

The average number of locally invasive species carried by stores was 0.45 plant types per store. This is a slight decrease from 2015, in which the average number of locally invasive species carried was 0.47 species of plant types per store.

Of the 94 stores that carried a locally invasive species, 31% (29 stores) had more than one locally invasive species. This figure is higher than in 2015, when 23% of stores (21 out of 93) carried more than one locally invasive plant. Among the 94 stores in 2016 where *at least* one locally invasive plant was found, the average number of species present was 1.43.

Exhibit 9. 2016 Results:
Number of Locally Invasive Plants Sold in Stores

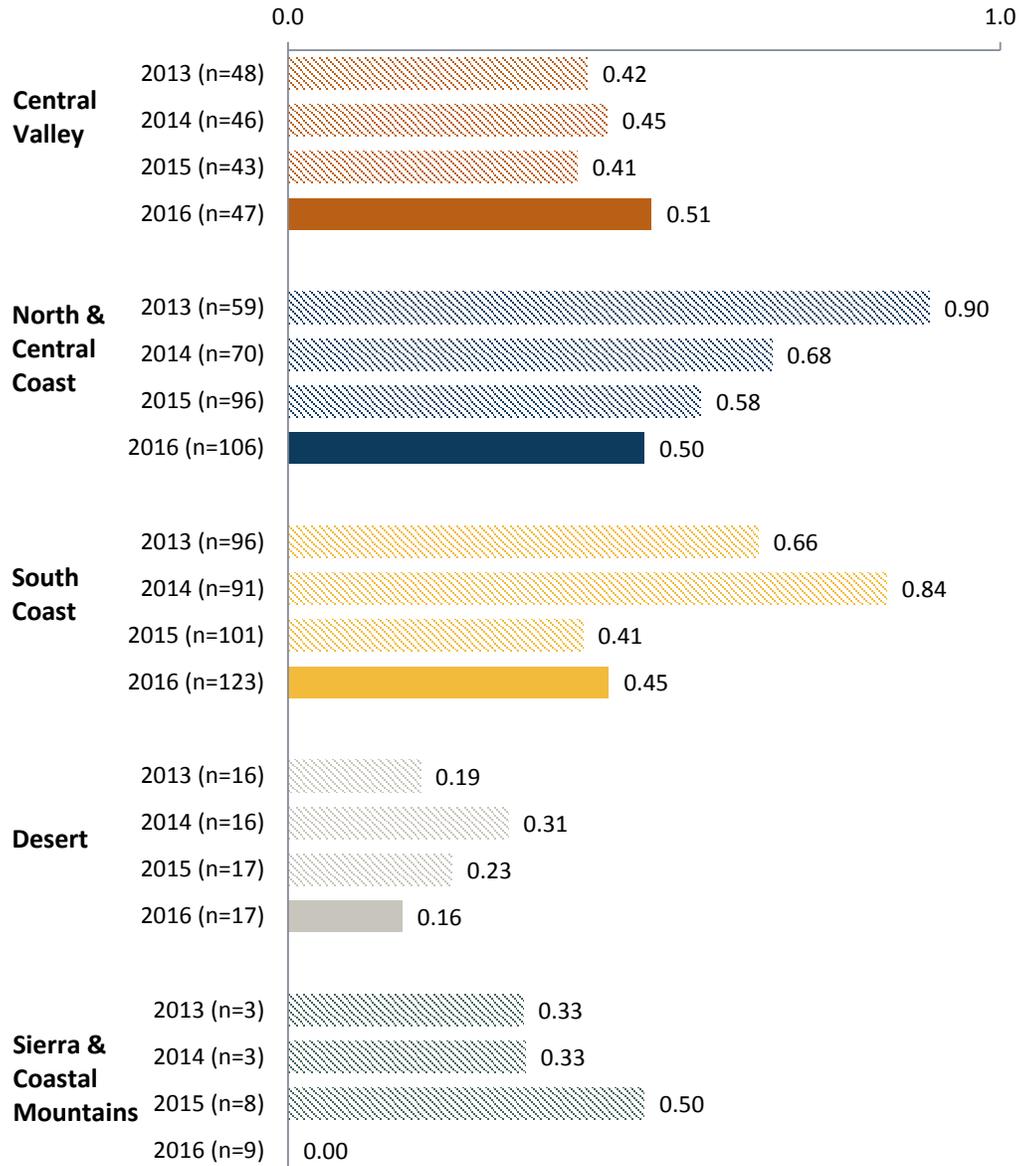


¹⁰ Note: These results include only Cohort 1 and 2 plants: green fountain grass, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, water hyacinth, and yellow water iris.

By Climate Zone

In 2016, the average number of locally invasive species sold per store was highest in the Central Valley climate zone, with an average of 0.51 plant species per store, followed closely by stores in the North & Central Coast (0.50) and South Coast (0.45).

Exhibit 10. 2013-2016 Results:
Average Number of Locally Invasive Plants Sold by Climate Zone

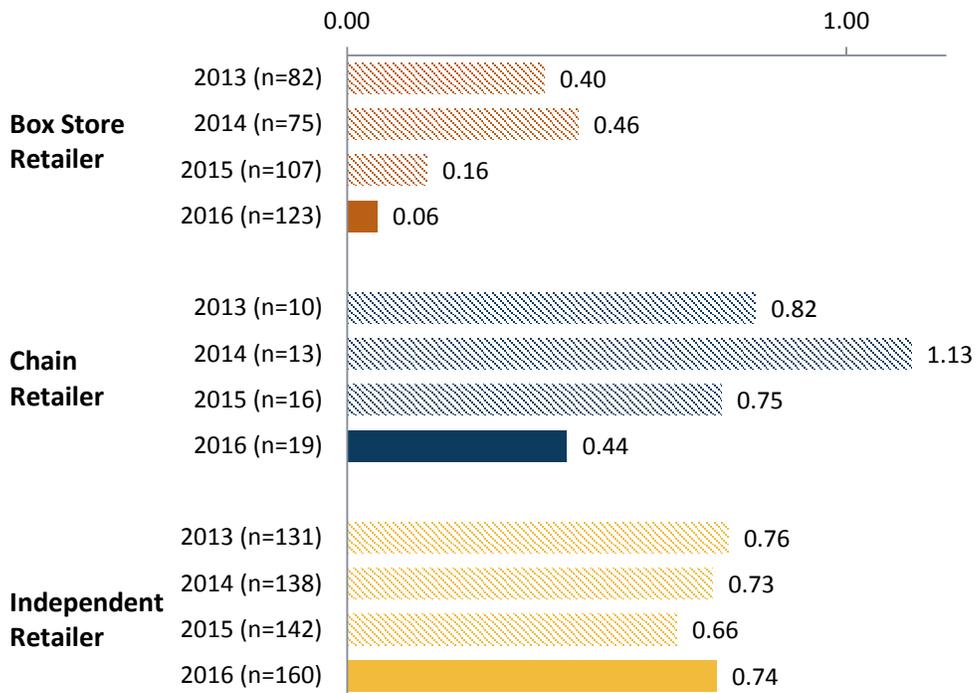


By Store Type

In 2016, Independent Retailers had the highest average number of locally invasive species per store at 0.74. The large rate difference between Independent Retailers and Box Stores (0.06 locally invasive species per store) is statistically significant.

From 2013 to 2015, Chain Retailers had the highest average number of locally invasive species per store, and that rate has shown a steep decline since 2014. As previously stated, there are relatively few Chain Retailers in the sample and the difference between 2015 and 2016 is not statistically significant.

Exhibit 11. 2013-2016 Results:
Average Number of Locally Invasive Plants Sold by Store Type



3. Considering each invasive species separately, what percentage of stores carries that species?

While the previous section included results for only the seven species that have been tracked over the last three years of the survey (Cohort 1 and Cohort 2 plants), the next two sections include results for all 15 plants included in the 2016 Nursery Survey.

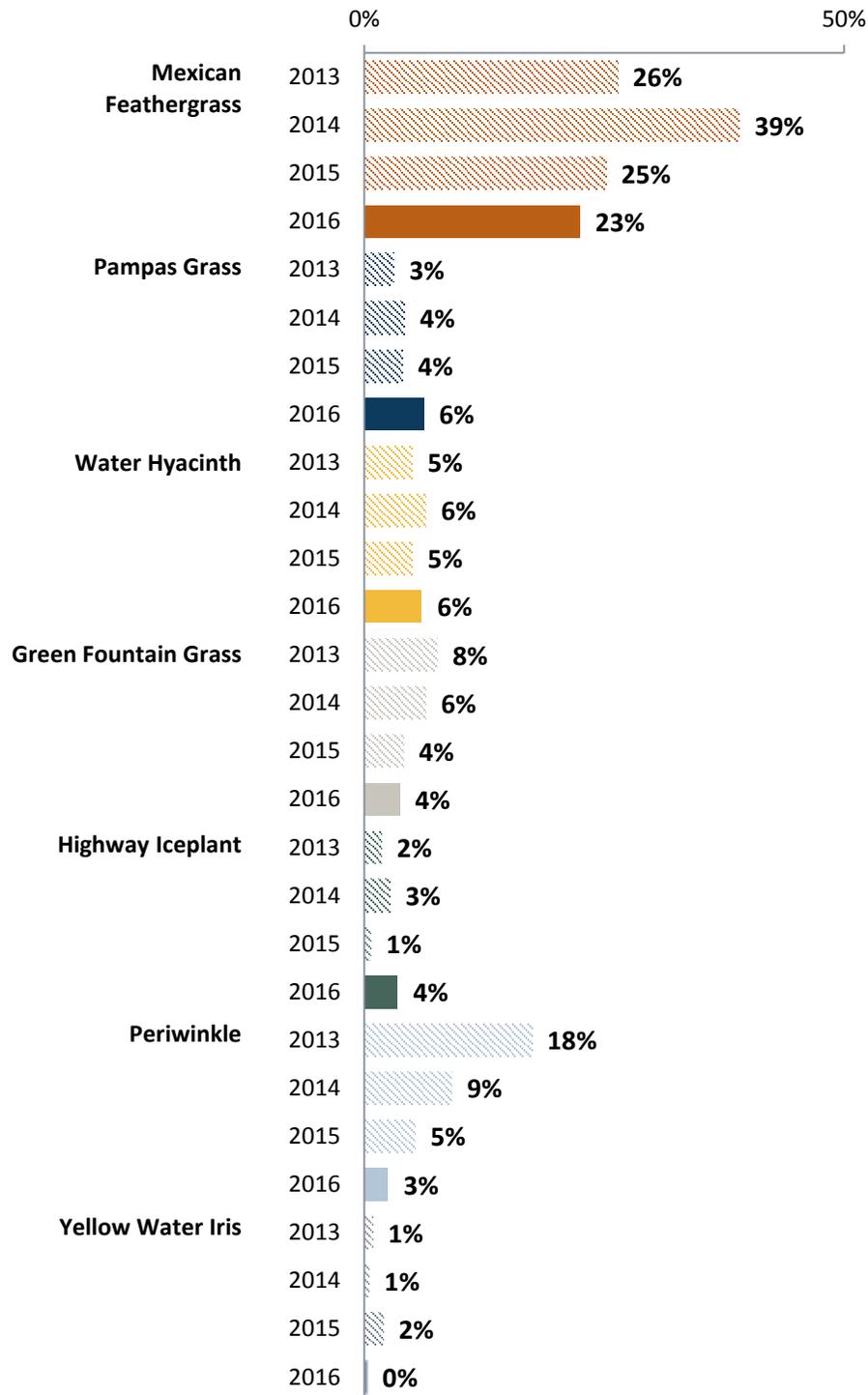
All plant species on the 2016 Nursery Survey were found for sale in at least one store. 2013 through 2016 results for the prevalence of the seven locally invasive Cohort 1 and 2 plant species are summarized in Exhibit 12. The 2016 rates of candidate plants are displayed separately in Exhibit 13.

Please see Appendix B for an in-depth look at each individual plant and the rate at which it was found for sale in the climate zones where it is locally invasive.

Prevalence of Cohort 1 and 2 Plant Species

The most frequently found locally invasive Cohort 1 and 2 plants in 2016 were (in descending order): Mexican feathergrass, pampas grass, water hyacinth, green fountain grass, highway iceplant, periwinkle, and yellow water iris.

Exhibit 12. Percentage of all Stores Selling a Locally Invasive Cohort 1 or 2 Plant (2013, n=223; 2014, n=226; 2015, n=265; 2016, n=302)

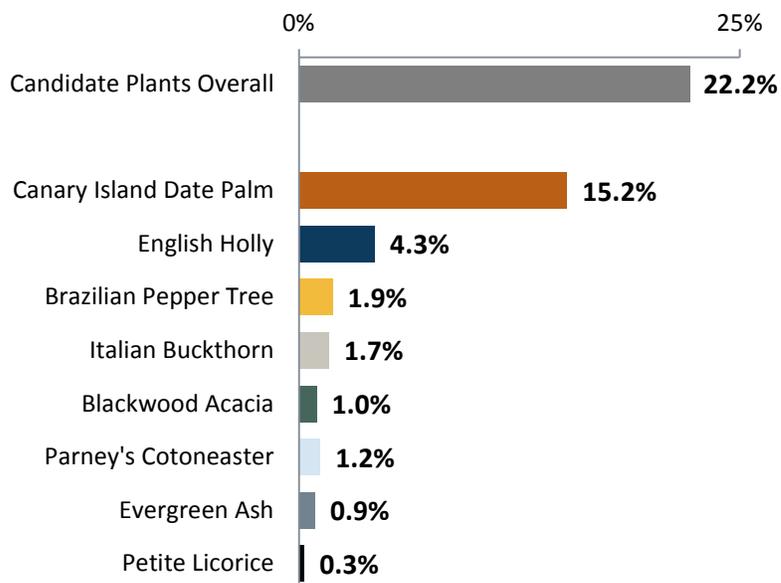


Prevalence of Candidate Species

Collectively, candidate plants were found in 22% of stores.

The most frequently found candidate species in 2016 were (in descending order): Canary Island date palm, English holly, Brazilian pepper tree, Italian buckthorn, blackwood acacia, Parney's cotoneaster, evergreen ash, and petite licorice.

Exhibit 13. 2016 Results:
Percentage of Stores Selling a Candidate Plant
(n=302)



This survey data is just one of the criteria considered when determining new plants to include in PlantRight's official plant list during its next update. More information about these criteria is available on [PlantRight's website](#).

III. Conclusions

Locally invasive plants were found at a lower rate in 2016 than in previous years.

In the aggregate, the seven Cohort 1 and Cohort 2 plants on PlantRight's 2016 survey list were found at a lower rate in 2016 than in any other surveyed year. The rate has been steadily declining since 2014 when 44% of stores carried a locally invasive plant. The rate dropped to 35% in 2015 and to 31% in 2016. Looking at the cohorts separately, Cohort 1 plants were found at a slightly higher rate in 2016 (13% of stores) than 2015 (12% of stores). Cohort 2 plants were found at a lower rate in 2016 (27%) than in 2015 (30%). Despite the minor uptick in the percentage of Cohort 1 plants, the overall findings suggest that PlantRight's efforts to curb the sale of invasive species are working.

Rates of the most commonly sold locally invasive plants in prior years continue to decline.

Mexican feathergrass has been the most commonly found locally invasive species on PlantRight's list for all years surveyed. Fortunately, the percentage at which it has been found for sale has been decreasing since 2014, when PlantRight led a campaign to stop a major grower from growing and selling the plant. The drop between 2014 (39%) and 2015 (25%) was especially impressive. These gains have held steady for 2016, when locally invasive Mexican feathergrass was found in 22% of stores. After Mexican feathergrass, periwinkle was the second most commonly found locally invasive species from 2013-2015 – and it has also shown impressive declines. Locally invasive periwinkle was found at 17% of stores in 2013, 9% of stores in 2014, and 5% of stores in 2015. In 2016, it was the sixth most common locally invasive plant, found for sale at 3% of stores.

Independent Retailers are the store type most likely to carry locally invasive plants.

In 2016, 51% of Independent Retailers carried at least one locally invasive plant species, overtaking Chain Retailers as the store type most frequently selling locally invasive plants. The percentage of Independent Retailers selling locally invasive plants remains high and has increased each year since 2014, rising from 42% in 2014 to 48% in 2015 to 51% in 2016. This trend is unfortunate, but unsurprising. From its recent outreach to independent stores, PlantRight has learned of their reluctance to join the campaign to reduce the sale of locally invasive plant species. While a few stores have agreed to join in the effort to discourage their customers from buying invasive plants, most independent nurseries said they will not stop selling invasive species. Store managers give two main reasons: (1) taking these popular plants out of their inventory will hurt their sales; and (2) since they are a small business (and their sales volume is low relative to all the plants sold), their plant sales will have no appreciable impact on the ecosystem. Their point of view is understandable: they profit from selling invasives, and they do not believe there are ecological downsides. Their perspective is fundamentally different from that of large stores: each independent store's "piece of the market" is tiny; and they are less likely than large corporations to find a way make up any revenue lost by not carrying popular plants.

Retail Partnerships with Box Stores continue to pay off.

The percentage of Box Stores carrying one or more species of locally invasive plants decreased in 2016 to 6%, compared to 43% in 2014 and 16% in 2015. The substantial drop from 2014 to 2015 can largely be attributed to PlantRight's partnership efforts, and in particular the alliance with The Home Depot, a major Box Retailer with over 200 locations throughout California. The difference between 2015 and 2016 indicates that major retailers remain committed to ridding the nursery industry of locally invasive plants.

Appendix A: Methods

The goal of the Spring Nursery Survey is to provide annual snapshots of the statewide prevalence of invasive plants in nurseries. With this data, PlantRight can track trends in the prevalence of invasive plants over time. In order for the annual snapshots to provide accurate information, PlantRight needs to be confident that it can draw valid inferences from the survey results. There are several approaches that PlantRight employed to ensure the collection of high quality survey data:

- A rigorous sampling plan. LFA created a tailored sampling plan to support the goal of maximizing the extent to which the nurseries in the survey represent the retail nursery industry in California as a whole. The sampling plan was also crafted so that stores of each store type, and stores within each county, were adequately represented.
- Recruiting and training highly-skilled surveyors. PlantRight recruited Master Gardener volunteers – surveyors who already have extensive plant recognition skills. To build their skills for this particular survey, PlantRight trained the volunteers to further hone their skills in carrying out this survey and recognizing candidate plants and the invasive plants on PlantRight’s list.
- Conducting a quality assurance review on the results. Survey volunteers were asked to take pictures of the plants that they identified as invasive species. PlantRight staff and a botanist then reviewed the pictures to verify the results that volunteers submitted. When plants were unidentifiable from the photos, a conservative approach was taken and the plants were not counted as being present.

Each of these approaches is described in this appendix. The sampling plan section includes an addendum for how sampling looked in practice, in those cases where it was not feasible to conduct sampling exactly as designed. Following these descriptions, the appendix explains an important step taken in the analysis: weighting the data.

Sampling Plan

Overview of Sampling Approach

There are over 1,500 plant nurseries (or stores with nurseries) in California. Without the resources available to conduct a census, PlantRight’s survey makes use of a sample that is designed to be as representative as possible of the state as a whole. This section of the sampling plan discusses: (1) strategies for maximizing sample representativeness; (2) working within resource constraints; and (3) creative possibilities for expanding sample size.

Methods for Maximizing Sample Representativeness

The more representative the sample, the more confident PlantRight can be that the description of the nurseries reflects the actual nursery population in California. The sampling plan incorporates several strategies to maximize representativeness, and these are explained below.

Collecting Data Statewide

Ideally, the PlantRight survey would cover all 58 counties (or rather, the 56 counties that have plant nurseries). The sampling plan, therefore, takes this “coverage” goal into account and calculates the sub-samples to be drawn from each county.

Drawing a Random Sample

Random samples are needed to enable the analysts to use the data to confidently describe the population as a whole. Random samples avoid bias: the systematic over- or under-representation of specific subgroups.

Stratified Random Sampling

Stratified random sampling is a specific type of random sampling. In stratified random sampling, the population is divided into groups (called strata), and random samples are then drawn from within these strata. Stratified random sampling offers several advantages over simple random sampling:

- It provides greater precision (a higher likelihood of statistically significant findings) with the same sample size.
- It helps avoid an “unrepresentative” sample (for example, if a simple random sample were drawn from all nurseries in the state, it would likely produce a sample without representation from several counties – however, if the data is stratified by county, all counties will be represented).

This sampling plan will employ stratified random sampling along two dimensions: county (each county is a stratum), and three different store types. The store types are:

- **Box Stores:** Big box stores with nursery or garden centers, e.g. Home Depot, Lowe’s, and Wal-Mart.
- **Chain Retailers:** Large retailers with multiple locations. They include stores such as Green Thumb Nursery and Armstrong Garden Centers.
- **Independent Retailers:** Independent nurseries and garden stores unique to certain communities, e.g. Yamagami’s Nursery, Roger’s Gardens, Berkeley Horticultural Nursery, etc.

In the 2010 survey, Sustainable Conservation surveyed CVS and Rite-Aid stores as part of the Chain Retailers category, and Costco as part of the Box Stores category. All three of these chains have licenses to sell plants, and are widespread in California. However, these stores do not have a dedicated plant section and are generally inconsistent with regard to whether they offer plants or whether they know when and for how long the plants will be in stock. In 2010, none of the CVS, Rite-Aid, or Costco stores surveyed had invasive plants present. For all these reasons, these stores were left out of all subsequent years’ surveys.

Multi-Stage Sampling

Because the goals are to optimize representation of each stratum, as well as to have statewide coverage (include as many counties as possible), the stratified sample was drawn in two stages. First, the sample was divided (stratified) according to store type. Then, within store type, the data was stratified by county. When this stratification is completed, stores are uniquely assigned to a store type/county combination (e.g. all Box Stores in Los Angeles County).

Resource Constraints

If there were no resource constraints, Sustainable Conservation would conduct a survey in which the prevalence of invasive species could be estimated with great precision not only for the state as a whole, but also for sub-samples. However, the sample size needed for making such precise estimates for subgroups is not feasible given available resources (UC Master Gardener volunteers).

In advance of the survey, the target number of stores to survey was 250.

Disproportionate Stratified Sampling

The first efficient use made of the full sample was to use disproportionate rather than proportionate stratified sampling when stratifying by county. In using proportionate stratified sampling, the units in every stratum have the same probability of selection (e.g. one out of 200 for the subsample of box retailers, dominant large retailers, etc.). In using disproportionate sampling, the probabilities of being selected in different strata are allowed to vary. By allowing the probabilities to vary, we can choose the optimal percentage of stores in each stratum, thus making better use of limited resources.

Using "Surplus Volunteers" from Neighboring Counties

PlantRight staff members recruit Master Gardeners as expert volunteer surveyors. They are recruited within each county that has nurseries to survey. In advance of the survey, PlantRight staff has projected numbers of how many volunteers are in each county. Using those numbers, in conjunction with the per-county sample size, it can be determined where there are surpluses and deficits of surveyors. PlantRight staff deployed "surplus volunteers" in neighboring counties where there is a "volunteer deficit." This maximized the probability that PlantRight would reach its target number of surveys for each county.

Description of Sampling Procedure

Step One: Generate a List of Retail Nurseries in California

PlantRight used the Directory of Licensed Nurseries, updated by the California Department of Food and Agriculture (CDFA), to identify 8,730 licensed nursery retailers operating in California. An image of the search field, with checks in the boxes we selected as search filters, is shown on the next page. The search was conducted in January 2016.

California Department of Food and Agriculture
Directory of Licensed Nurseries

[CDFA Home](#) [CDFA Nursery](#)

Show Location Details

Search by Nursery and/or License number, County, City

Nursery: <input type="text"/>	Search Type: Starts With <input type="button" value="v"/>	County: <input type="button" value="v"/>	Location City: <input type="text"/>
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Search by any of the above and/or Type of Business

C Cut flowers <input type="checkbox"/>	L Landscaper <input type="checkbox"/>
I Incidental Retailer <input checked="" type="checkbox"/>	P Producer <input type="checkbox"/>
J Jobber Merchant <input checked="" type="checkbox"/>	R Retailer <input checked="" type="checkbox"/>

Search by any of the above and/or Type of Stock

1 Coniferous evergreens <input type="checkbox"/>	A Deciduous fruit and nut trees <input type="checkbox"/>
2 Broad-leaved evergreens <input type="checkbox"/>	B Grapevines and kiwi plants <input type="checkbox"/>
3 Deciduous shade trees <input type="checkbox"/>	C Citrus fruit trees <input type="checkbox"/>
4 Deciduous shrubs <input type="checkbox"/>	D Other subtropical and tropical fruit trees <input type="checkbox"/>
5 Rose plants <input type="checkbox"/>	E Strawberry and bushberry, etc. <input type="checkbox"/>
6 Herbaceous ornamental plants <input type="checkbox"/>	F Vegetable plants <input type="checkbox"/>
7 Bulbs, corms, rhizomes, pips, etc <input type="checkbox"/>	G Sod (turfgrass) <input type="checkbox"/>
8 Decorative plants <input type="checkbox"/>	H Groundcover <input type="checkbox"/>
9 Cacti and succulents <input type="checkbox"/>	J Palms <input type="checkbox"/>

The invasive plants on PlantRight’s list fall under the following categories above: 1, 2, 3, 4, 6, 8, 9, A & H. Because key retail businesses did not classify their plants as falling under any of the 18 categories of “stock” listed above, however, the search included vendors of all plant types, even those PlantRight is not interested in (as shown above by the lack of check-marks in the lower level fields).

PlantRight staff then removed retailers from the list that did not meet the criteria, based on their familiarity with the company (e.g. 99 Cent Stores) and the companies’ names (e.g. Richie’s Wholesale Florist). As a rule, they took out orchid merchants, cut flower sellers, landscapers, grocery stores, department stores, individuals, and producers of other non-plant goods. PlantRight staff also removed stores that had been included in previous years’ samples but had failed to meet the requirements of the survey (as determined by PlantRight staff upon calling the store). The final number of stores that met the criteria was 1,523.

Step Two: Determine the Projected Full Sample Size

To determine the sample size, LFA began with the known (or estimated) constraint: the projected number of stores the volunteers would be able to survey. In January 2016, PlantRight staff projected the total number of volunteers to be around 125, and that many volunteers would choose to visit more than one store. Based on these numbers and on last year’s total stores surveyed, PlantRight determined a target sample size of 250 stores. To account for predicted drop-off (volunteers sampled 77% of stores in the 2015 sample), PlantRight requested a final sample size of 300 stores.

Step Three: Using Disproportionate Stratified Sampling in the First Stage, Calculate the Sample Size for each Stratum on the "Store Type" Dimension

The Sample Planning Wizard at the Stat Trek website was used to enter parameters and calculate the sample sizes for each store type stratum. The parameters needed to calculate the sub-sample sizes are:

- **Maximum sample size (for the full sample).** This is equal to the projected number of nurseries expected to be surveyed (250, rounded up to 300 to account for drop off).
- **Proportion of store types carrying invasive species.** This was taken from our 2015 findings.
- **Population size for each stratum.** This was provided by PlantRight staff, and the values are shown in Exhibit 14 below.
- **Confidence level.** The confidence level is the probability that the true value lies between two values: the sample percentage minus the margin of error, and the sample percentage plus the margin of error. By convention, this is set to 0.95.

Inputting the values of the required parameters into the Sample Planning Wizard, and not constraining the sampling to be proportionate, the following sub-sample sizes were calculated (shown in the far right column):

Exhibit 14. Sample Size Per Stratum, Given Population Size

Stratum (Store Type)	Population Size	Sample Size per Stratum
Box Stores	618	100
Chain Retailers	97	22
Independent Retailers	808	178

Step Four: Using Proportionate Stratified Sampling in the Second Stage, Calculate the Sample Sizes for Each County Within Each Store Type Stratum

Proportionate sampling is appropriate for the second stage of sampling. With no specific information about variation differences among counties, there is no additional information to use disproportionate sampling. With proportionate stratified sampling, each store has an equal probability of being selected into the sub-sample, no matter which county the store is in.

Please see Exhibit 15 for the target number of nurseries to be surveyed in each county.

Due to rounding, the number of surveys calculated for each stratum was slightly off the suggested total number of surveys in the stratum. For example, while the sample planning software calculated that 100 surveys of Box Stores should be surveyed, with rounding our allocation came to 95 surveys total. To compensate for these differences, surveys were added or subtracted from specific counties, as follows:

- One survey of a Box Store was added to five counties (Los Angeles, Madera, Placer, Tuolumne, and Sutter).
- One survey of a Chain Retailer was subtracted from one county (Riverside).
- One survey of an Independent Retailer was subtracted from one county (Stanislaus).

These counties were chosen because – before rounding – they were closest to adding (or subtracting, in the case of the Independent Retailers) one more store to the suggested number. For example, the formula may have calculated that the correct number of Box Stores to be surveyed in this county was 1.49. This was rounded down to 1 store, but when "extra" stores needed to be distributed, this county would be an obvious choice to "absorb" an extra store.

Final Sampling Plan: Goals for Number of Surveys in Each County

The table below shows the number of surveys that the sampling plan recommends for PlantRight volunteers to conduct in each county.

Exhibit 15. Target Number of Surveys, by County and Store Type

County	Box Store	Chain Retailer	Independent Retailer
Alameda	4	0	6
Amador	0	0	0
Butte	1	0	4
Calaveras	0	0	2
Colusa	0	0	0
Contra Costa	3	1	5
Del Norte	0	0	0
El Dorado	0	0	2
Fresno	3	0	5
Glenn	0	0	0
Humboldt	0	0	3
Imperial	1	0	1
Inyo	0	0	1
Kern	3	1	4
Kings	1	0	1
Lake	0	0	1
Lassen	0	0	0
Los Angeles	18	4	22
Madera	1	0	1
Marin	0	2	2
Mariposa	0	0	1
Mendocino	0	0	4
Merced	1	0	1
Modoc	0	0	0
Mono	0	0	0
Monterey	1	0	3
Napa	1	0	1
Nevada	0	0	3
Orange	7	3	6

County	Box Store	Chain Retailer	Independent Retailer
Placer	2	0	4
Plumas	0	0	1
Riverside	7	0	11
Sacramento	5	1	2
San Benito	0	0	0
San Bernardino	7	0	9
San Diego	8	3	20
San Francisco	0	1	4
San Joaquin	2	0	4
San Luis Obispo	1	2	4
San Mateo	2	0	3
Santa Barbara	1	0	6
Santa Clara	6	2	4
Santa Cruz	1	0	3
Shasta	1	0	2
Sierra	0	0	0
Siskiyou	0	0	1
Solano	2	0	1
Sonoma	1	1	8
Stanislaus	2	0	1
Sutter	1	0	0
Tehama	0	0	1
Trinity	0	0	1
Tulare	2	0	3
Tuolumne	1	0	1
Ventura	2	1	3
Yolo	1	0	1
Yuba	0	0	1
Total	100	22	178

Sampling in Practice

Randomly Selecting Stores

Using the full list of stores in the population, LFA used the “RAND” function in Excel to assign a random number to each of the stores. The full list was then grouped into county, and separate lists for each county were made for each store type. The stores were listed from lowest to highest by their randomly generated number. The number of stores to be surveyed of a particular store type within the county was used to “pull” the sample for that particular stratum. (For example, 22 was the target sample size for Independent Retailers in Los Angeles. For this stratum, the 22 stores with the lowest random number were identified for surveying.)

Deviations from the Originally Selected Sample

The stores designated for the sample were not always included in practice. This could be for one of three reasons:

- Upon calling the store prior to administering the survey, PlantRight determined that the store did not sell plants that met its criteria (e.g. outdoor, perennial plants) or did not sell these plants at a retail level.
- The stores identified for the sample were further away from the homes of the volunteers than they could feasibly travel; and
- The volunteers visited the stores and found out that they did not conform to the original criteria by which the stores were included in the population (e.g. it was discovered they were wholesalers rather than retailers).

When a store had to be removed from the sample for any of these three reasons, PlantRight simply substituted the next store on the random list for that stratum. There is no reason to believe that removal of these stores from the sample and replacing them with the “next random store” introduced any systematic bias into the sample.

The stores in the final sample deviated from the original for a second reason: sometimes the number of volunteers in a county did not match the number of stores in the sampling plan. For some counties, this meant fewer stores were sampled than were identified; for other counties, this meant that more stores were sampled than were identified. Again, there is no reason to believe that this deviation introduced any bias into the sample. The “next store added” was always the next on the randomly selected list.

For information on how many stores were surveyed in each county compared to the original sample, please see Exhibit 17.

Exhibit 16. Map of Surveyed Stores



Exhibit 17. Count of Surveyed Stores by County

County	Stores Surveyed
El Dorado	1 of 2
Fresno	8 of 8
Glenn	0 of 0
Humboldt	1 of 3
Imperial	2 of 2
Inyo	1 of 1
Kern	7 of 8
Kings	2 of 2
Lake	1 of 1
Lassen	0 of 0
Los Angeles	43 of 44
Madera	2 of 2
Marin	4 of 4
Mariposa	1 of 1
Mendocino	3 of 4
Merced	2 of 2
Modoc	0 of 0
Mono	0 of 0
Monterey	4 of 4
Napa	2 of 2
Nevada	2 of 3
Orange	21 of 16
Placer	5 of 6
Plumas	0 of 1
Riverside	16 of 18
Sacramento	8 of 8
San Bernardino	15 of 16
San Diego	31 of 31
San Francisco	5 of 5
San Joaquin	6 of 6
San Luis Obispo	10 of 7
San Mateo	6 of 5
Santa Barbara	7 of 7
Santa Clara	15 of 12
Santa Cruz	3 of 4
Shasta	2 of 3
Sierra	0 of 0
Solano	7 of 3
Sonoma	9 of 10
Stanislaus	3 of 3
Sutter	1 of 1
Tehama	1 of 1
Trinity	1 of 1
Tulare	4 of 5
Tuolumne	3 of 2
Ventura	6 of 6
Yolo	2 of 2
Yuba	1 of 1
TOTAL¹¹	302 of 300

Recruiting and Training Highly-Skilled Surveyors

Participant Recruitment

Recognizing the importance of obtaining statistically significant survey data in 2016, PlantRight actively recruited participants for the survey in winter 2015-2016. Calls were made to confirm the participation of Master Gardener programs in counties across California. Where Master Gardener groups did not exist or decided not to participate, outreach was conducted to other plant enthusiast or conservation groups. Examples include Weed Management Areas, Resource Conservation Districts, collegiate horticulture programs and California Native Plant Society chapters.

Exhibit 17. Count of Surveyed Stores by County

County	Stores Surveyed
Alameda	10 of 10
Amador	0 of 0
Butte	5 of 5
Calaveras	4 of 2
Colusa	0 of 0
Contra Costa	9 of 9
Del Norte	0 of 0

¹¹ Due to deviations from the originally selected sample, the total stores selected over the course of the survey was 302.

Survey Procedure

All participants in PlantRight's 2016 Spring Nursery Survey viewed a prerequisite webinar containing educational information about invasive plants and a training module for how to complete the survey.

The live webinar was conducted in late February for Southern California participants and in mid-April for those in Northern California (divided by the northern border of San Luis Obispo, Kern, and San Bernardino counties). A recording of the webinars was also made available for later viewing. After watching the webinar, survey participants:

- Created an account on www.plantright.org,
- Passed an online quiz to verify they watched the webinar,
- Signed up to survey one or more of the randomly selected nurseries,
- Downloaded and printed a set of instructions, a survey form, and a plant identification guide,
- Visited the nursery to collect information and take pictures of invasive plants they found, and
- Submitted the information and pictures online.

For all invasive plants found at stores, volunteers submitted information, about the company that grew the plant (when available), its price and container size, its common and scientific name, the number for sale at that time, and also took a picture of the plant and its label for verification purposes. For many invasive plants found, the name of the grower was not available.

Volunteers were asked to submit data and photos for all cultivars of species included in the survey. Ultimately, some of these cultivars were counted as invasive plants and some were not, but it is still important to collect data on all of them to track what cultivars are being developed and sold. Below is a description of how cultivars were or were not counted in the survey.

- English (common) holly (*Ilex aquifolium*): All cultivars were counted. Some may be sterile but can produce viable seeds in the presence of a male plant
- Green fountain grass (*Pennisetum setaceum*): Only the straight species is counted as invasive; cultivars are considered sterile based on current information and therefore not invasive.
- Italian buckthorn (*Rhamnus alaternus*): The cultivar 'John Edwards' is not described as sterile, and so it was counted as an invasive plant
- Pampas grass (*Cortaderia selloana*): All cultivars are considered invasive, including 'Ivory Feathers' 'Rosea' and 'Pumila.'
- Periwinkle (*Vinca major*): Cultivars, including 'Variegata' and 'Maculata' are not considered invasive.

Conducting a Quality Assurance Review of the Survey Results

By the end of the survey period in late June, PlantRight collected the data and pictures submitted by its volunteers and reviewed the results for accuracy. Each picture submitted was cross-referenced with the written data for the plant and a determination was made whether the plant being sold was an invasive from PlantRight's list. This was especially important for plants with many cultivars or with limited labeling.

Procedure for Verifying Plants' Identification

No standard for the labeling of plant tags and containers exists in California and, as a result, it can be difficult to determine the identity of horticultural plants at retail nurseries. Identification is especially challenging when plants are found without labels, or with labels that are damaged or inaccurate.

Because poor labeling can make identification of horticultural plants challenging, survey participants were provided with a "plant identification guide" with pictures of the 15 plants included in PlantRight's 2016 survey. This allowed surveyors to visually identify plants at stores, and cross reference their findings with the provided pictures.

Participants were encouraged to submit data for all plants they felt could be a plant on PlantRight's survey list, with the thinking that too much data would be better than too little. In addition to submitting recorded data, survey participants submitted pictures of each plant and, when possible, its label(s).

Using the surveyors' pictures and the contracted help of an independent plant expert, PlantRight staff verified the identity of each plant found during the nursery survey. When pictures were not submitted, PlantRight was unable to confirm whether the store was selling a plant that was invasive. In those instances, data from the store was not counted in this year's overall analysis; a handful of surveyed stores were removed from the analysis for this reason. In instances in which some (but not all) pictures were submitted, the information available was used for the analysis of those specific plants, but not in the overall analysis.

Weighting the Data

Weighting a sample is necessary when two things are the case:

- The sample over- or under-represents specific sub-groups (strata) relative to the frequency with which units from that subgroup appear in the population; *and*
- The goal of using the data is to accurately *describe* the population characteristics.

Weighting the data is necessary, in the case of the PlantRight survey, because the frequency of particular store types in the sample does not match the frequency of particular store types in the population. The sample is not perfectly representative for two reasons: (1) the sampling plan used *disproportionate sampling* (see the sampling plan above for an explanation); and (2) not all stores included in the sample were reached, while some additional stores in particular counties were included in the final sample.

Box Stores were slightly under-represented relative to their presence in the population (so they needed to be “weighted up”), while Chain and Independent Retailers were over-represented (so they needed to be “weighted down”). The weights ultimately assigned are shown below.

Exhibit 18. Weights Used for Analyzing Store Types, 2016

Store Type	Weight Assigned
Box Stores	1.17
Chain Retailers	0.77
Independent Retailers	0.93

The sample sizes reported in this report are actually weighted sample sizes, rather than *actual* (unweighted) sample sizes. Attention is not called to this in the report because it is not necessary in order to understand the results, and is likely to raise more questions than it answers. Note that weighting *does not change the final sample size*. The full sample size remains at 302.

Appendix B: Results by Plant Species

Volunteers searched for 15 different plant species in 2016; all 15 were found in at least one store. Findings categorized by individual plants are summarized in the following pages.

For each plant, the prevalence at which it was found for sale is broken down by:

- Statewide rate, only including climate zone(s) where the plant is locally invasive
- Climate zone
- Store type, only including the climate zone(s) where the plant is locally invasive.

All climate zone information is included for each plant species. An asterisk is next to the region(s) in which the plant is locally invasive.

The results for the seven locally invasive species in Cohorts 1 and 2 are presented first in alphabetical order, followed by the eight candidate plants. Historical data from 2013 through 2015 is included for Cohort 1 and 2 plants. 2015 data is included for the two candidate plants that were surveyed last year.

The n's for statewide rate and store types vary because locally invasive regions vary by plant. There may also be small differences across plants due to weighting and rounding of data.

Please note that the scale for each plant varies to best display the data.

Green Fountain Grass – By Climate Zone and by Store Type

Green fountain grass (Cohort 1) is locally invasive in all climate zones except for the Central Valley. In 2016, it was found for sale only at Independent Retailers in the North & Central Coast and South Coast regions.

Exhibit 19. 2013-2016 Results: Percentage of Stores at Which Green Fountain Grass was Found: Statewide Rate Where Locally Invasive

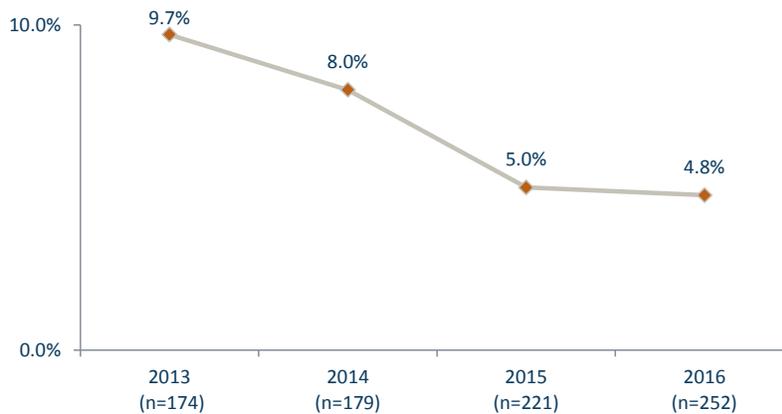
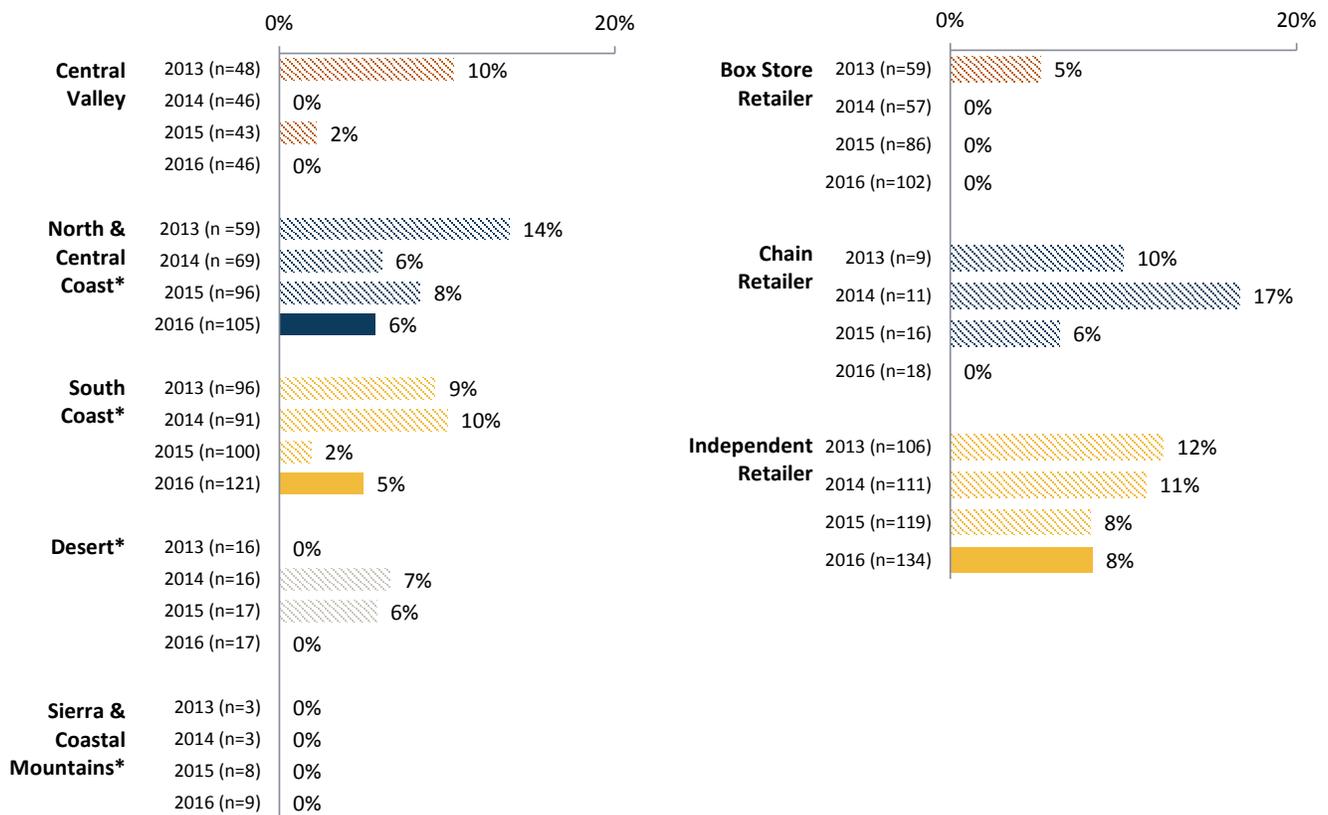


Exhibit 20. 2013-2016 Results: Percentage of Stores at Which Green Fountain Grass was Found: By Climate Zone Where Locally Invasive By Store Type Where Locally Invasive



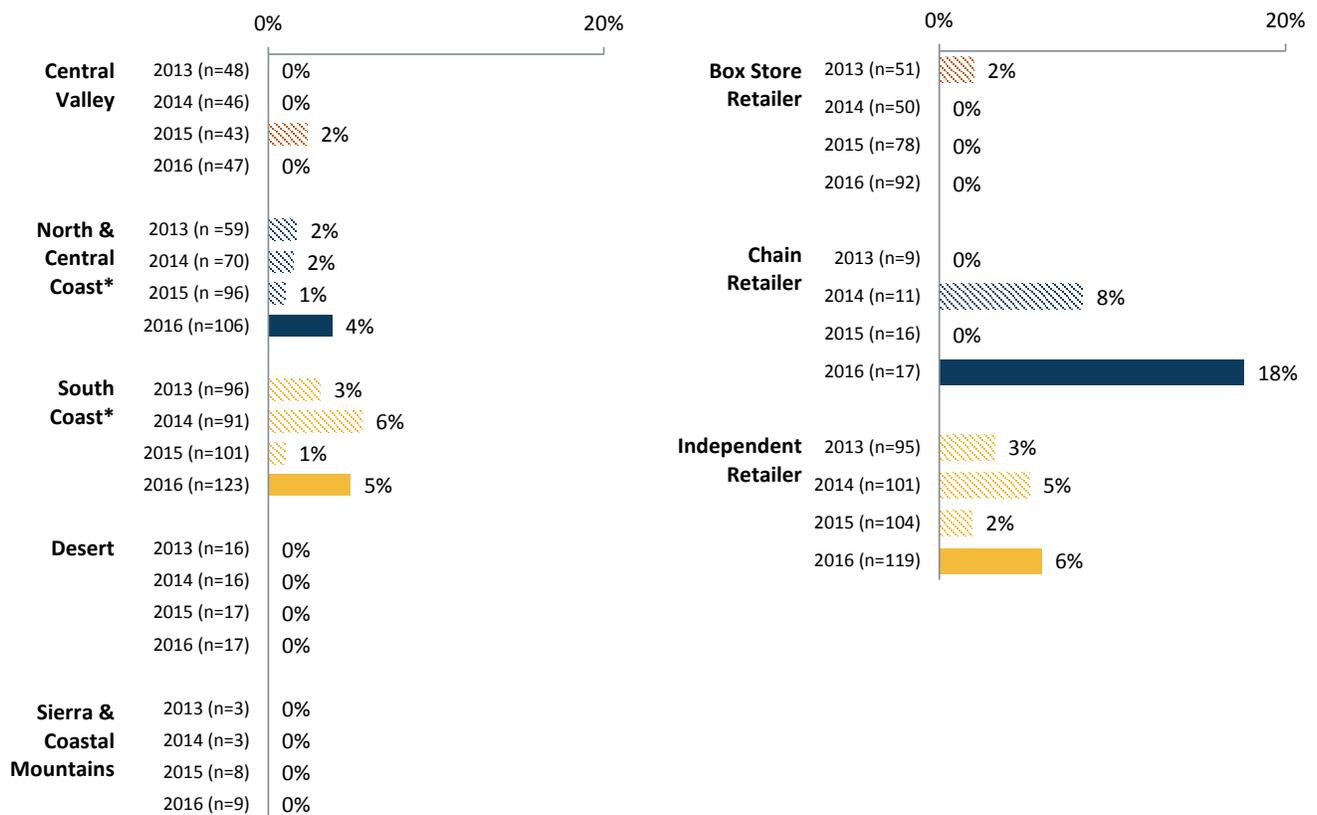
Highway Iceplant – By Climate Zone and by Store Type

Highway iceplant (Cohort 1) is locally invasive in the North & Central Coast and South Coast climate zones. In 2016, it was found for sale in both regions it is considered locally invasive.

Exhibit 21. 2013-2016 Results: Percentage of Stores at Which Highway Iceplant was Found: Statewide Rate Where Locally Invasive



Exhibit 22. 2013-2016 Results: Percentage of Stores at Which Highway Iceplant was Found: By Climate Zone Where Locally Invasive By Store Type Where Locally Invasive



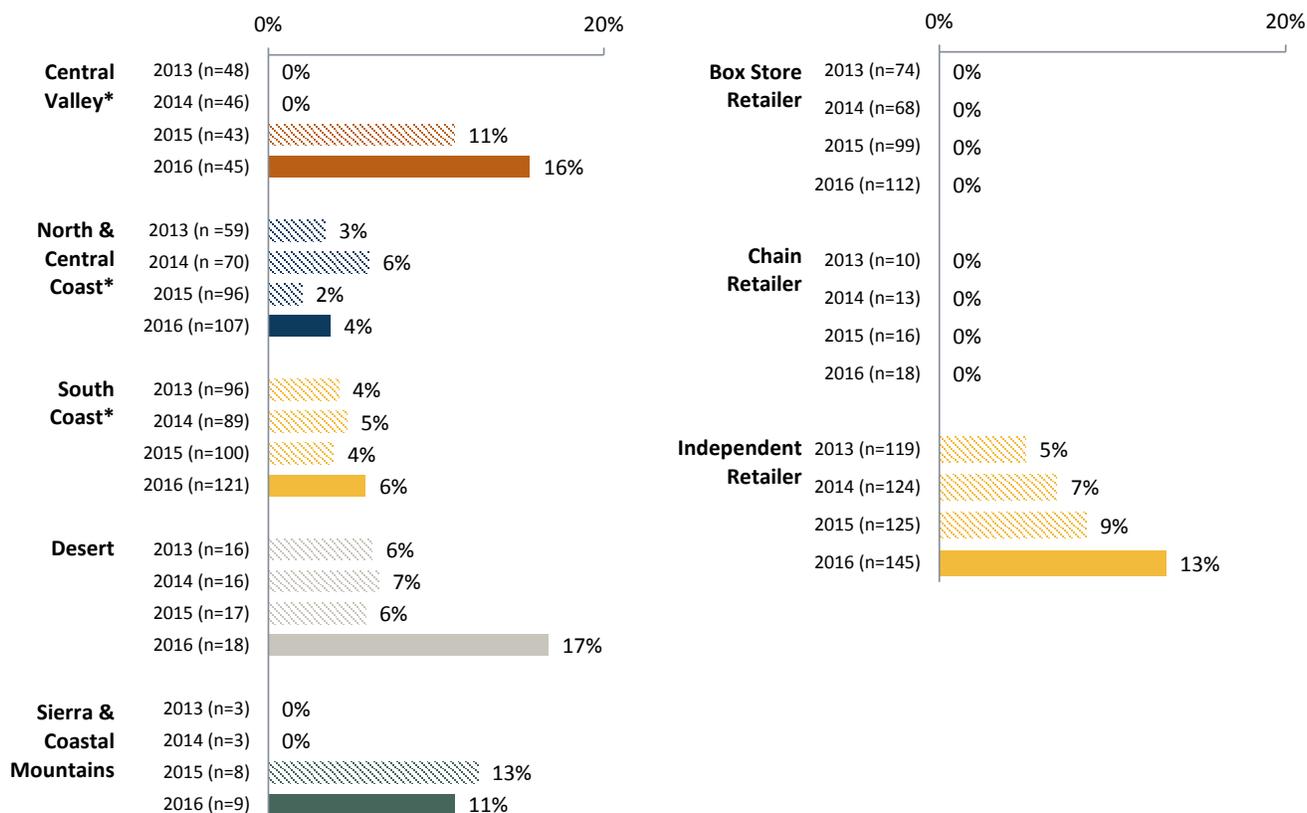
Pampas Grass – By Climate Zone and by Store Type

Pampas grass (Cohort 1) is locally invasive in the Central Valley, North & Central Coast, and South Coast climate zones. In 2016, it was found only at Independent Retailers in the climate zones where it is considered invasive.

Exhibit 23. 2013-2016 Results: Percentage of Stores at Which Pampas Grass was Found: Statewide Rate Where Locally Invasive



Exhibit 24. 2013-2016 Results: Percentage of Stores at Which Pampas Grass was Found: By Climate Zone where Locally Invasive By Store Type where Locally Invasive



Periwinkle – By Climate Zone and by Store Type

Periwinkle (Cohort 1) is locally invasive in all climate zones except for the Desert. It has been in steady decline for the past few years. In 2016, periwinkle was found only at Independent Retailers in its locally invasive regions.

Exhibit 25. 2013-2016 Results: Percentage of Stores at Which Periwinkle was Found Statewide Rate Where Locally Invasive

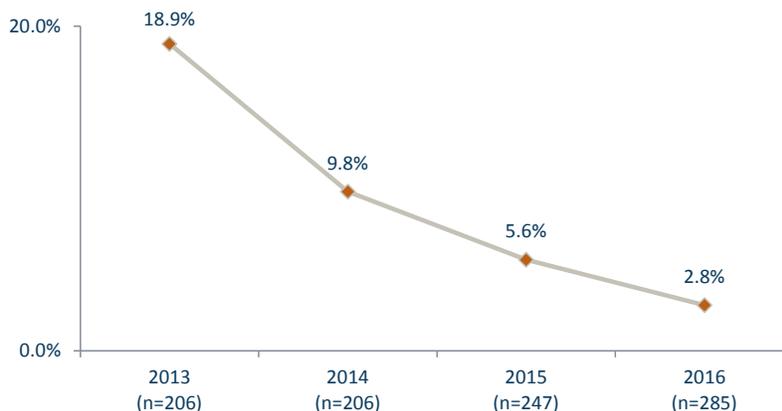
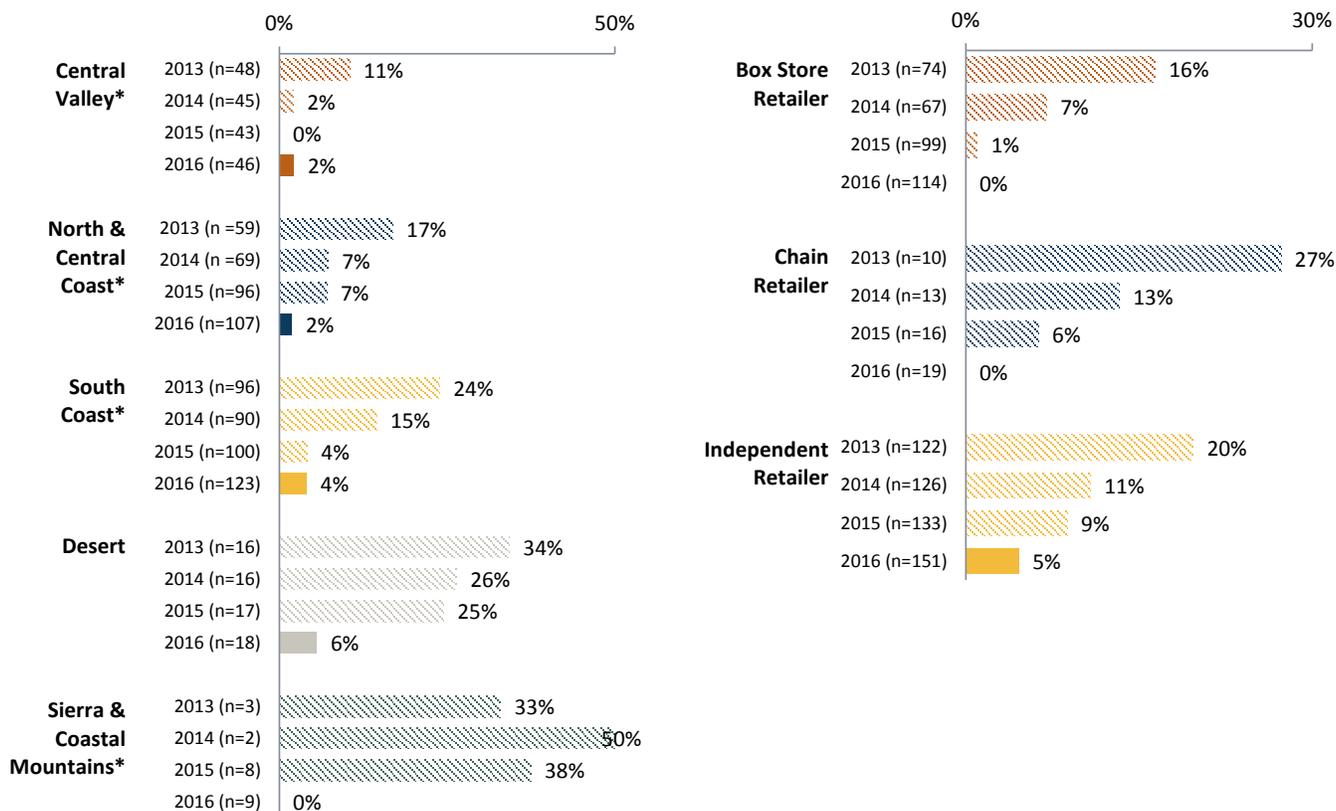


Exhibit 26. 2013-2016 Results: Percentage of Stores at Which Periwinkle was Found: By Climate Zone Where Locally Invasive By Store Type Where Locally Invasive



Mexican Feathergrass – By Climate Zone and by Store Type

Mexican feathergrass (Cohort 2) is an ornamental grass that is locally invasive in all five climate zones. In the four years it has been on PlantRight’s Survey list, it has been the most commonly found locally invasive species for sale by a large margin.

In 2014, PlantRight worked with one of the state’s largest growers of Mexican Feathergrass to accelerate their phase out from the nursery supply chain and educate the largest retailers in the country about the plant. Partnering with The Home Depot in California contributed to the drop in sales from 2014 to 2015. In 2015, stores selling Mexican feathergrass decreased dramatically, from 39% in 2014 to 25% in 2015 – a drop that is statistically significant. The rate decreased further in 2016.

Exhibit 27. 2013-2016 Results: Percentage of Stores at Which Mexican Feathergrass was Found Statewide Rate Where Locally Invasive

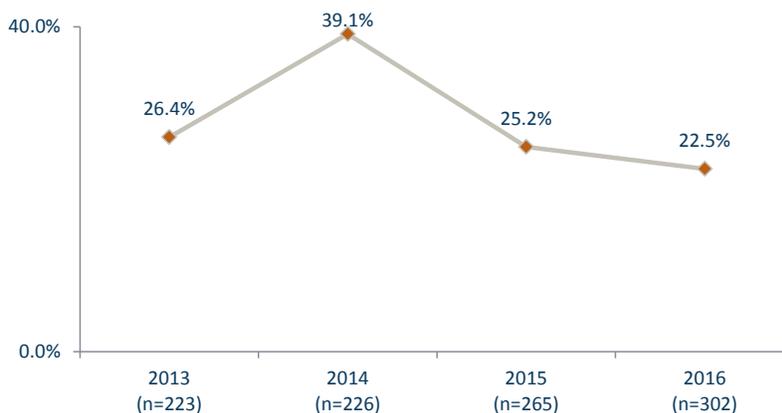
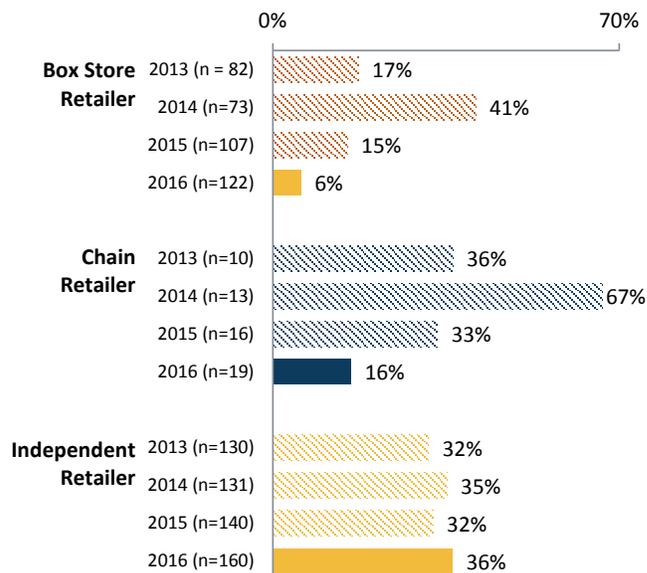
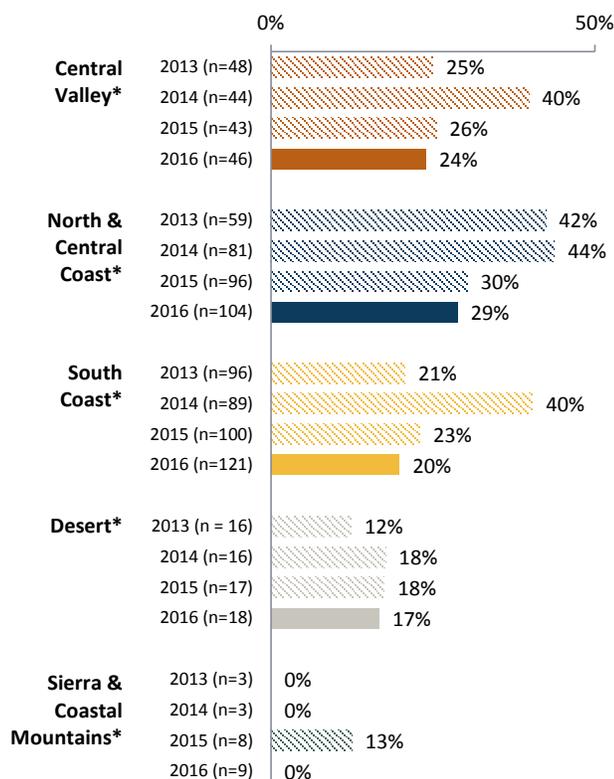


Exhibit 28. 2013-2016 Results: Percentage of Stores at Which Mexican Feathergrass was Found: By Climate Zone



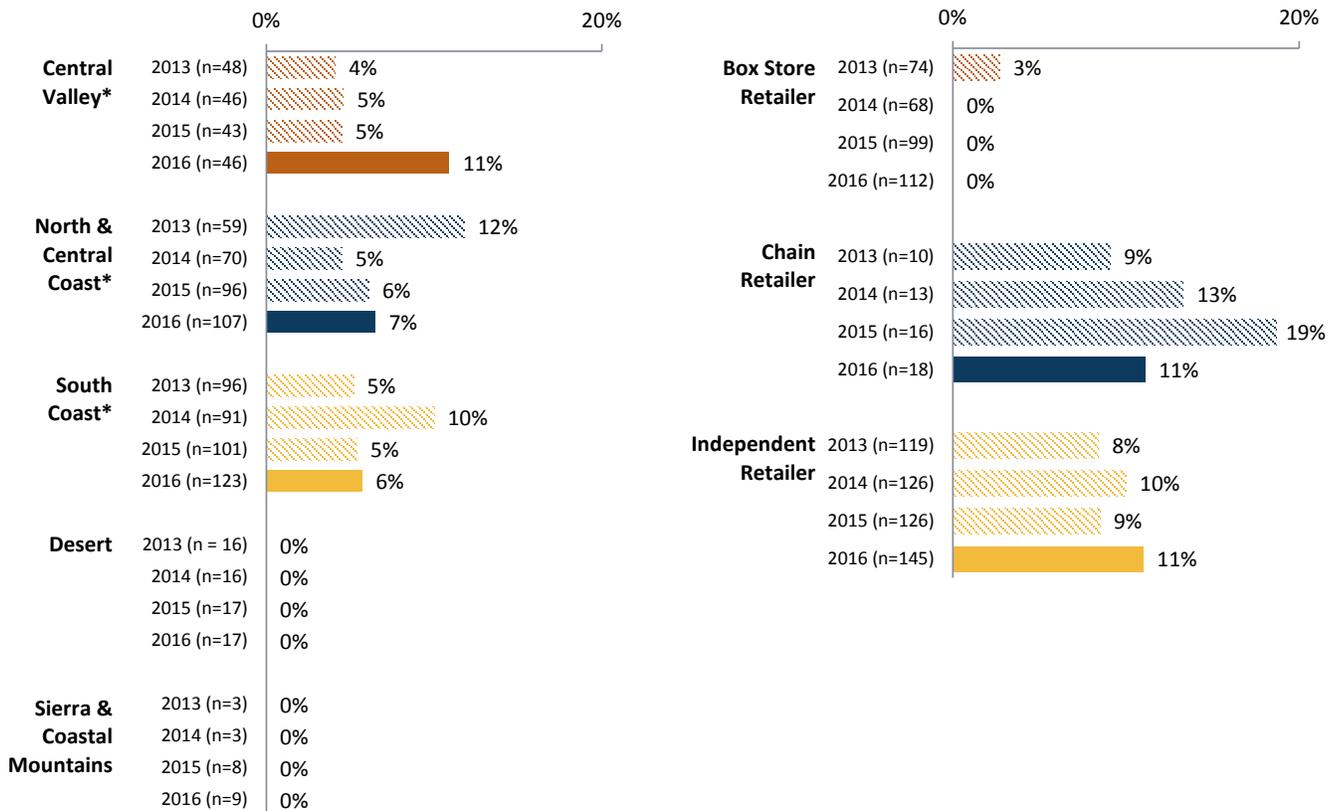
Water Hyacinth – By Climate Zone and by Store Type

Water hyacinth (Cohort 2) is locally invasive in the Central Valley, North & Central Coast, and South Coast climate zones. In 2016, it was found at the highest rate at stores in the Central Coast region.

Exhibit 29. 2013-2016 Results: Percentage of Stores at Which Water Hyacinth was Found Statewide Rate Where Locally Invasive



Exhibit 30. 2013-2016 Results: Percentage of Stores at Which Water Hyacinth Feathergrass was Found: By Climate Zone Where Locally Invasive By Store Type Where Locally Invasive



Yellow Water Iris – By Climate Zone and by Store Type

Yellow water iris (Cohort 2) is locally invasive in the Central Valley, North & Central Coast, and South Coast climate zones. In 2016, it was found only at 1% of Independent Retailers in the North & Central Coast climate zone. There is likely more yellow water iris being sold, but the plant was often found without a label and when it was not flowering. Because different water iris species look nearly identical without flowers, the exact species could not be confirmed in many cases. PlantRight was also informed by a member of its Steering Committee that water plants tend to get to stores later in the season than when the survey is conducted.

Exhibit 31. 2013-2016 Results: Percentage of Stores at Which Yellow Water Iris was Found Statewide Rate Where Locally Invasive

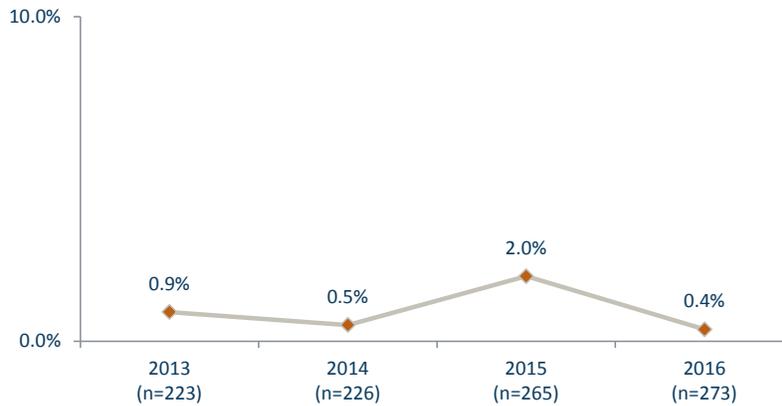
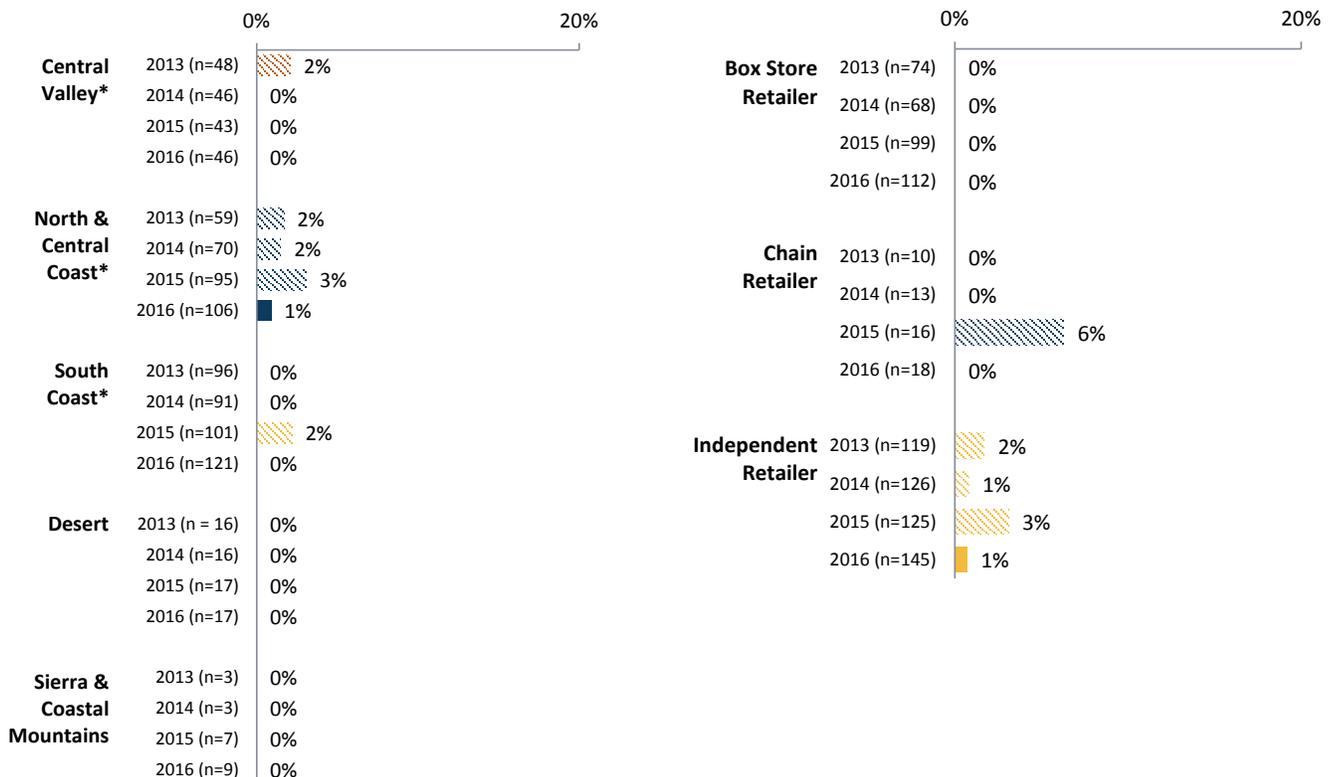


Exhibit 32. 2013-2016 Results: Percentage of Stores at Which Yellow Water Iris Feathergrass was Found: By Climate Zone Where Locally Invasive



Candidate Plant: Blackwood Acacia – By Climate Zone and by Store Type

Blackwood acacia is locally invasive in the Central Valley, North & Central Coast, and South Coast climate zones. In the regions it is considered locally invasive, it was found in 1.4% of stores (n=277).

In 2016, Blackwood Acacia was only found at Independent Retailers.

Exhibit 33. 2016 Results: Percentage of Stores at Which Blackwood Acacia was Found:
By Climate Zone Where Locally Invasive By Store Type Where Locally Invasive



Candidate Plant: Brazilian Pepper Tree – By Climate Zone and by Store Type

Brazilian pepper tree is locally invasive in the North & Central Coast and South Coast climate zones. It has been on PlantRight’s candidate plant list for two years. In 2016, it was only found at Independent Retailers.

Exhibit 34. 2015-2016 Results: Percentage of Stores at Which Brazilian Pepper Tree was Found Statewide Rate Where Locally Invasive

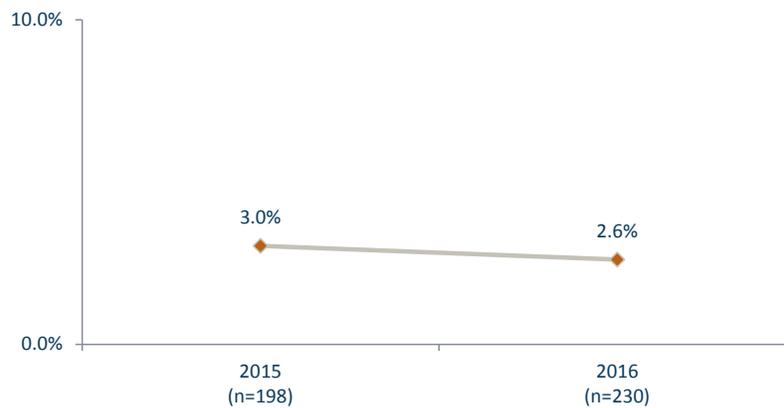
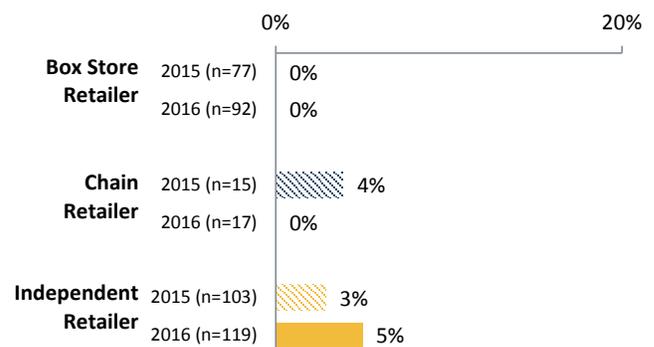
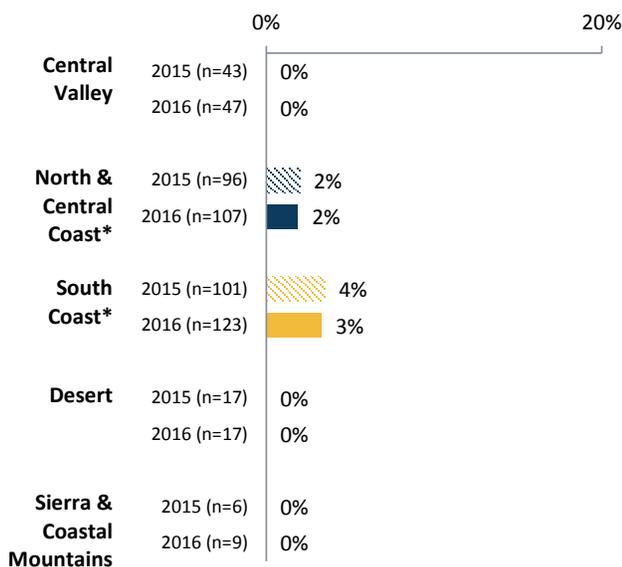


Exhibit 35. 2015-2016 Results: Percentage of Stores at Which Brazilian Pepper Tree was Found: By Climate Zone Where Locally Invasive



Candidate Plant: Evergreen (Shamel) Ash – By Climate Zone and by Store Type

Evergreen ash is locally invasive in the Central Valley, North & Central Coast, South Coast, and Desert climate zones. It has been on PlantRight’s candidate plant list for two years. In 2016, it was found at Independent Retailers in the South Coast climate zone.

Exhibit 38. 2015-2016 Results: Percentage of Stores at Which Evergreen Ash was Found Statewide Rate Where Locally Invasive

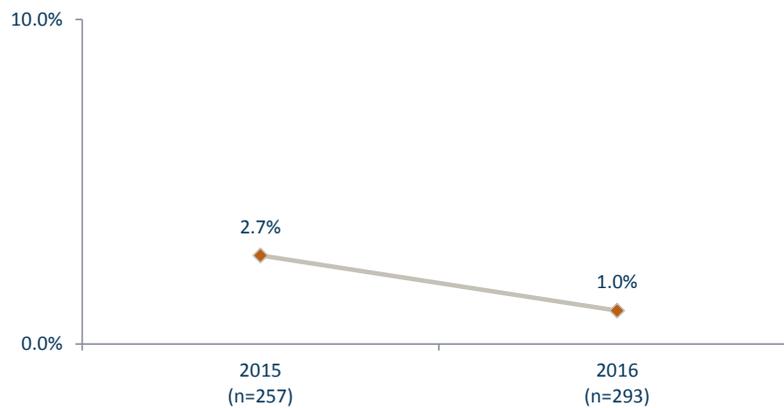
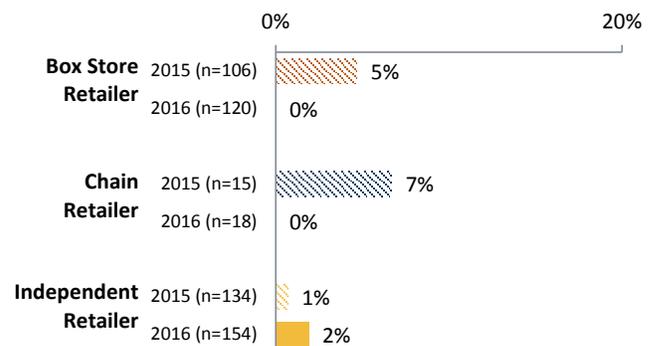
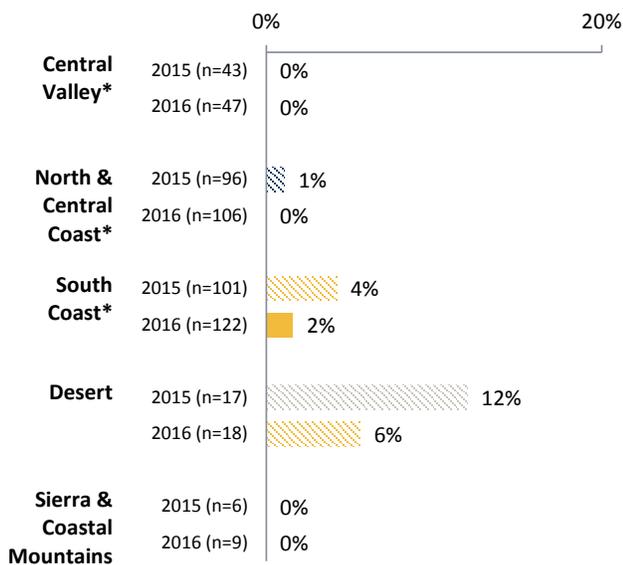


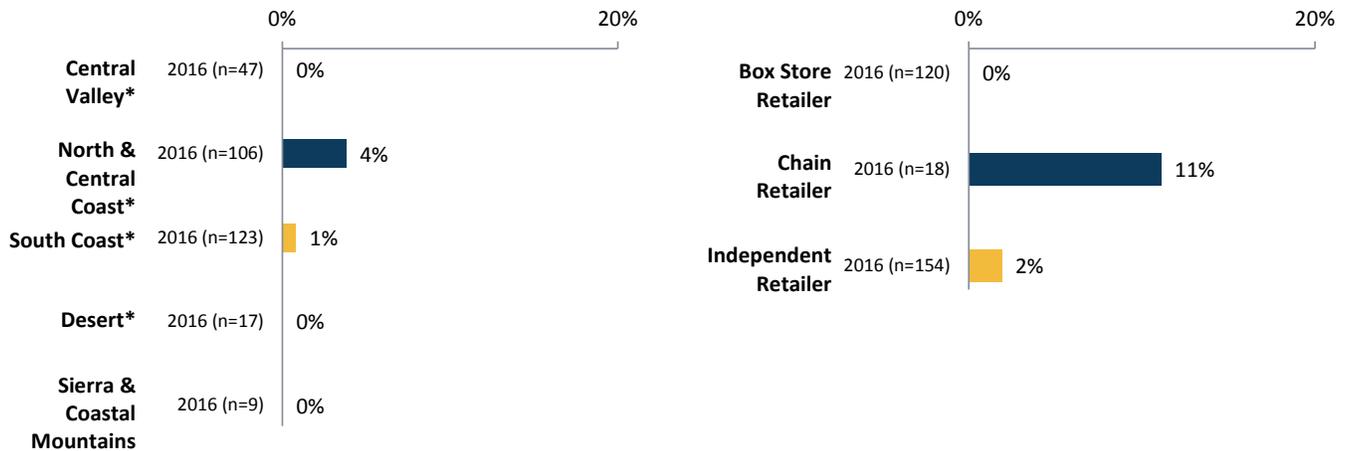
Exhibit 39. 2015-2016 Results: Percentage of Stores at Which Evergreen Ash was Found: By Climate Zone Where Locally Invasive



Candidate Plant: Italian Buckthorn – By Climate Zone and by Store Type

Italian buckthorn is locally invasive in all climate zones except for the Sierra & Coastal Mountains. It was found in 1.7% of stores in the regions it is considered locally invasive (n=293).

Exhibit 40. 2016 Results: Percentage of Stores at Which Italian Buckthorn was Found:
By Climate Zone Where Locally Invasive By Store Type Where Locally Invasive



Candidate Plant: Parney's Cotoneaster– By Climate Zone and by Store Type

Parney's cotoneaster is locally invasive in all climate zones except for the Sierra & Coastal Mountains. It was found at 1.4% of stores in the regions it is considered locally invasive (n=294) and only at Independent Retailers.

Exhibit 41. 2016 Results: Percentage of Stores at Which Italian Buckthorn was Found:
By Climate Zone Where Locally Invasive By Store Type Where Locally Invasive



Appendix C: Locally Invasive Plants by Climate Zone

California is a large and geographically diverse state. Because of the wide range in climate zones, some plants are invasive in some parts of California but not in others. Exhibit 43 summarizes which species are invasive in which climate zones – where they are locally invasive.

Exhibit 43. Climate Zones in Which Plant Species are Locally Invasive

Common Name	Central Valley	North & Central Coast	South Coast	Desert	Sierra & Coastal Mountains
Blackwood acacia	✓	✓	✓		
Brazilian pepper tree		✓	✓		
Canary Island date palm	✓	✓	✓	✓	
English holly	✓	✓			
Evergreen ash	✓	✓	✓	✓	
Green fountain grass		✓	✓	✓	✓
Highway iceplant		✓	✓		
Italian buckthorn	✓	✓	✓	✓	
Mexican feathergrass	✓	✓	✓	✓	✓
Pampas grass	✓	✓	✓		
Parney's cotoneaster	✓	✓	✓	✓	
Periwinkle	✓	✓	✓		✓
Petite licorice	✓	✓	✓		
Water hyacinth	✓	✓	✓		
Yellow water iris	✓	✓	✓		

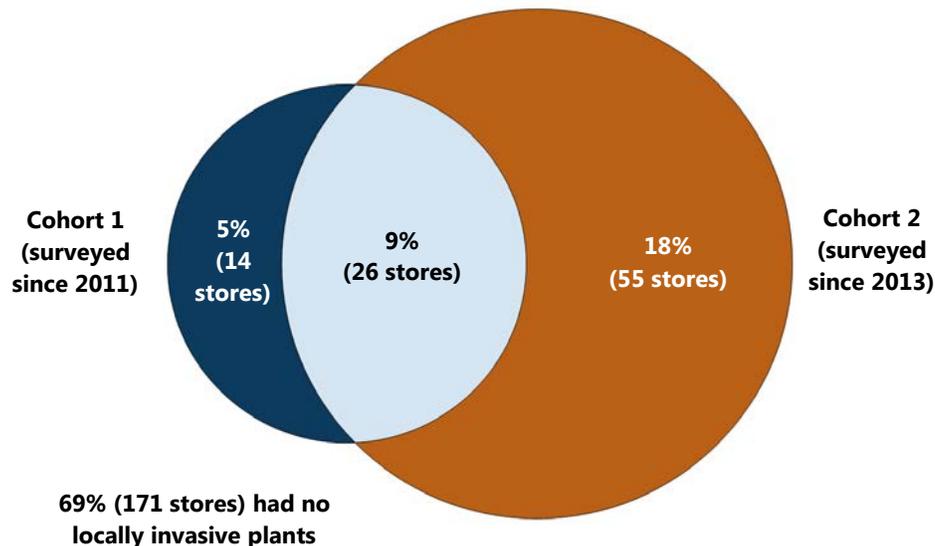
Appendix D: Cohort Overlap

The 15 species of plants on the 2016 survey were broken down into three categories:

- **Cohort 1.** This cohort includes four plants that have been on PlantRight’s list continuously since 2011: green fountain grass, highway iceplant, pampas grass, and periwinkle.
- **Cohort 2.** This cohort includes three plants that have been on PlantRight’s list since 2014 and surveyed since 2013: Mexican feathergrass, water hyacinth, and yellow water iris.
- **Candidate plants.** This group includes eight plants that are under review for PlantRight’s list: blackwood acacia, Brazilian pepper tree, Canary Island date palm, English holly, evergreen ash, Italian buckthorn, Parney’s cotoneaster, and petite licorice.

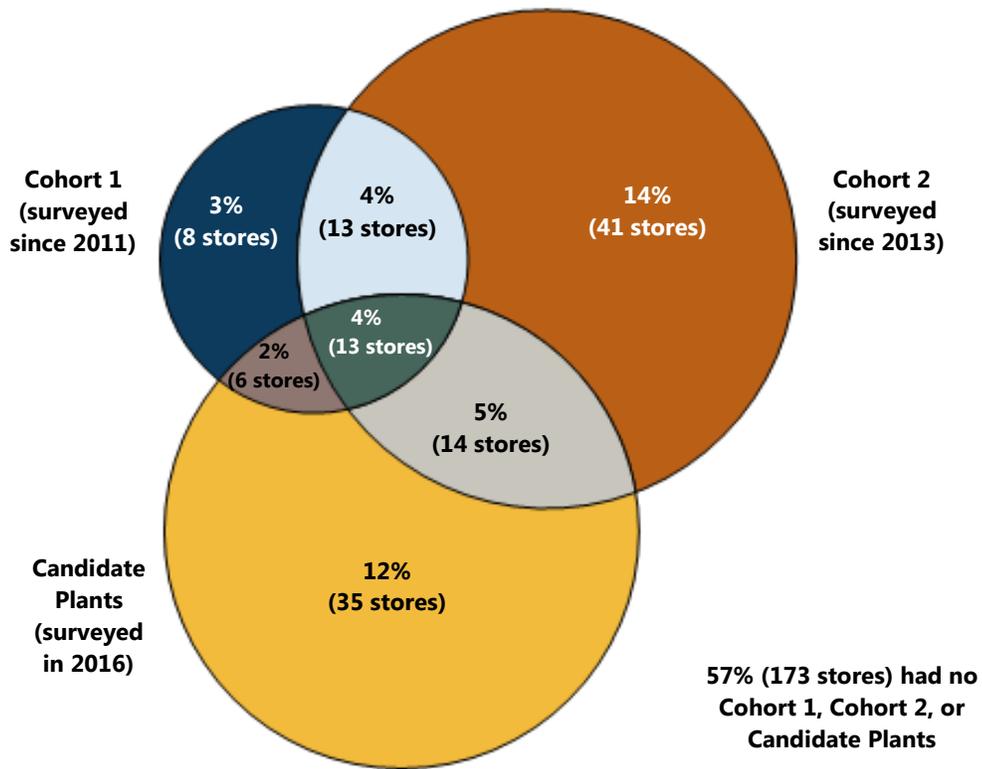
A single store could sell plants from any combination of the three categories. Exhibit 44, below, shows the overlap between stores selling Cohort 1 and Cohort 2 plants. Exhibit 45 shows the overlap among Cohort 1, Cohort 2, and Candidate Plants.

Exhibit 44. 2016 Results:
Stores Selling Locally Invasive Cohort 1 or Cohort 2 Plants (n=303)¹²



¹² n>302 for Exhibits 44 and 45 due to weighting and rounding of data.

Exhibit 45. 2016 Results:
Stores Selling Cohort 1, Cohort 2, or Candidate Plants (n=303)



Appendix E: Summary of Statistically Significant Results

This appendix provides statistically significant results at a glance.

- The first three questions below apply to *overall rates* of locally invasive species, and include Cohort 1 (included in the survey since 2011) and Cohort 2 (included in the survey since 2013) plants. For these questions, LFA conducted analyses within the 2016 data and across two years of data (2015 and 2016).
- For question four, which applies to individual locally invasive plants (including candidate plants), LFA conducted analyses on all available data.

The results are summarized below, with statistically significant findings (at $p < .05$) in **bold**.

1. How has the overall rate of locally invasives for cohort 1 plants and cohort 2 plants changed?
 - Cohort 1: No significant difference between 2015 and 2016.
 - Cohort 2: No significant difference between 2015 and 2016.
 - Cohort 1 and 2: combined: No significant difference between 2015 and 2016.
2. What percentage of stores carries one or more species of locally invasive plants?
 - 2016 data:
 - **The percentage of independent stores carrying one or more species of locally invasive plants is higher than that of box stores (51% v. 6%).**
 - **Stores in the North & Central Coast (38%), Central Valley (35%), and the South Coast (28%) are more likely to carry one or more invasive species than stores in the Sierra & Coastal Mountains (0%).**
 - Cross-year analysis:
 - **The percentage of box stores carrying one or more species of a locally invasive cohort 1 or 2 plant is lower in 2016 compared to 2015 (6% v. 16%).**
3. What's the average number of locally invasive plants carried by all stores?
 - 2016 data:
 - **The average number of locally invasive species sold in independent stores is higher than the average sold in box stores (0.7 v. 0.1).**
 - **Stores in the North & Central Coast (0.5), Central Valley (0.5), and the South Coast (0.4) carry a higher average number of locally invasive species than stores in the Sierra and Coastal Mountains (0).**
 - Cross-year analysis:
 - **Box stores had a lower average number of locally invasive cohort 1 or 2 plants for sale in 2016 compared to 2015 (0.1 v 0.2).**
4. For each species separately, what percentage of stores carries that species in the region it is locally invasive?

Cohort 1:

 - a) Green fountain grass:
 - 2016 data: **Independent stores are more likely to have green fountain grass for sale (8%) than are large stores (0%) or box stores (0%).**
 - Cross-year analysis: No significant differences across the six years.

- b) Highway ice plant:
 - 2016 data: **Independent stores are more likely to have highway ice plant for sale than are box stores (6% v. 0%).**
 - Cross-year analysis: No significant differences across the six years.
- c) Pampas grass:
 - 2016 data: **Independent stores (13%) are more likely to have pampas grass for sale than are large stores (0%) or box stores (0%).**
 - Cross-year analysis: No significant differences across the six years.
- d) Periwinkle:
 - 2016 data: **Independent stores are more likely to have periwinkle for sale than are large or box stores (5% v. 0%).**
 - Cross-year analysis: **The rate of periwinkle found for sale in regions in which it is locally invasive has been in decline since 2012 when it was found in 18% of surveyed stores. The rate went down to 17% in 2013, to 9% in 2014, to 5% in 2015, and in 2016, periwinkle was found in 2% of stores.**¹³

Cohort 2:

- e) Mexican feathergrass:
 - 2016 data:
 - **Independent stores are more likely to have Mexican feathergrass for sale than box stores (36% v. 6%).**
 - **Stores in the North & Central Coast (29%), Central Valley (24%), and South Coast (0%) are more likely to have Mexican feathergrass for sale than stores in the Sierra & Coastal Mountains (0%).**
 - Cross-year analysis: **The rate of Mexican feathergrass found for sale in regions in which it is locally invasive has been in steady decline since 2014. The rate went from 39% in 2014, to 25% in 2015, to 22% in 2016.**¹⁴
- f) Water hyacinth:
 - 2016 data: **Independent stores are more likely to have water hyacinth for sale than are box stores (11% v. 0%).**
 - Cross-year analysis: No significant differences across the four years.
- g) Yellow water iris:
 - 2016 data: No significant differences among climate regions or store types.
 - Cross-year analysis: No significant differences across the four years.

Candidate Plants¹⁵:

- h) Blackwood acacia:
 - 2016 data: No significant differences among regions or store types.
- i) Brazilian pepper tree:
 - 2016 data: **Independent stores (5%) are more likely to have Brazilian pepper tree for sale than are large (0%) or box stores (0%).**
 - Cross-year analysis: No significant difference across 2015 and 2016.
- j) Canary Island date palm:

¹³ The 2016 rate is statistically significantly different at $p < .05$ from the 2011, 2012, 2013, and 2014 rates, respectively. The differences in rates between contiguous years (i.e. 2011 v. 2012; 2012 v. 2013, etc.) are not statistically significant at $p < .05$;

¹⁴ The difference between the 2014 and 2016 rates of Mexican feathergrass found in locally invasive regions is statistically significant at $p < .05$; the difference between the 2015 and 2016 rate is not.

¹⁵ Candidate plants are species under review for PlantRight's list. Brazilian pepper tree and evergreen (shamel) ash were surveyed in 2015 and 2016; all other candidate plants only surveyed in 2016.

- 2016 data: **Box stores are more likely to have Canary Island date palm for sale than are independent stores (22% v. 11%).**
- k) English (common) holly:
 - 2016 data: **Independent stores are more likely to have English holly for sale than are box stores (15% v. 0%).**
- l) Evergreen (shamel) ash:
 - 2016 data: No significant differences among regions or store types.
 - Cross-year analysis: No significant difference across 2015 and 2016.
- m) Italian Buckthorn:
 - 2016 data: No significant differences among regions or store types.
- n) Parney's (milkflower) cotoneaster:
 - 2016 data: No significant differences among regions or store types.
- o) Petite licorice cobweb bush:
 - 2016 data: No significant differences among regions or store types.