

Results of PlantRight 2015 Spring Retail Nursery Survey

Prepared For
Sustainable Conservation

Prepared By
Learning for Action

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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, 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 towards 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 10 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 2015 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 of 73 stores in 2010, PlantRight has conducted the survey annually for the past five years: 2011 (226 stores surveyed), 2012 (238 stores surveyed), 2013 (223 stores surveyed), 2014 (226 stores surveyed), and 2015 (265 stores surveyed). The goal of the Spring Nursery Survey is to provide an annual snapshot of the statewide prevalence of invasive plants in nurseries. With this data, PlantRight can track trends in the prevalence of invasive plants over time.²

In 2010, 2011, and 2012, the PlantRight survey tracked the same nineteen plants, and the list has been revised every year since:

- In 2013, PlantRight removed seven plants from the list because they were so rarely found for sale.
- For the 2013 survey, the remaining 12 species from the original list were augmented by six additional plants.
- For the 2014 survey, this list of 18 plants was further modified: eight plants were removed and four were added.
- The 2015 survey consisted of a total of 18 plants: seven species on PlantRight's original list, surveyed since 2011; three plants added to PlantRight's list in 2014 and surveyed since 2013; five "candidate" plants currently under review for the official list, and three "retired" plants, no longer on PlantRight's official list but surveyed to make sure they stay out of the industry.

The changes to PlantRight's survey plant list from 2011-2015 are summarized in the table below.

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.

Exhibit 1. Plant Species in Each Year's Survey List

Common Name	Scientific Name	2010, 2011, and 2012	2013	2014	2015
African daisy ³	<i>Osteospermum fruticosum</i>				✓
Arundo/giant reed	<i>Arundo donax</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>	✓			
Capeweed	<i>Arctotheca calendula</i>	✓	✓		
Chinese tallow tree	<i>Sapium sebiferum</i>	✓	✓	✓	✓
Crystalline iceplant	<i>Mesembryanthemum crystallinum</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> (C. tumulicola Hort.)			✓	✓
Green fountain grass	<i>Pennisetum setaceum</i>	✓	✓	✓	✓
Highway iceplant	<i>Carpobrotus edulis</i>	✓	✓	✓	✓
Jubata grass	<i>Cortaderia jubata</i>	✓			
Mexican feathergrass	<i>Nassella tenuissima</i>		✓	✓	✓
Myoporum	<i>Myoporum laetum</i>	✓	✓		✓
Ox-eye daisy	<i>Leucanthemum vulgare</i>			✓	
Pampas grass	<i>Cortaderia selloana</i>	✓	✓	✓	✓
Periwinkle	<i>Vinca major</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>	✓	✓	✓	✓
Shamel ash	<i>Fraxinus udei</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>		✓	✓	✓

³ Recent Plant Risk Evaluation (PRE) research shows that African daisy and grassland sedge pose a low risk of becoming invasive.

Below is a list of questions addressed in the Results chapter.

This report focuses primarily on changes over time for the ten plants continuously surveyed since 2013 (Chinese tallow tree, French broom, green fountain grass, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, Scotch broom, water hyacinth, and yellow water iris):

- 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 five candidate plants that were new to this year's survey (African daisy, Brazilian pepper tree, glossy privet, grassland sedge, and shamel ash) 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?

This year, an additional section has been added to provide results for plants no longer on PlantRight's list that were re-surveyed in 2015. Starting this year, PlantRight plans to annually survey for three retired plants not surveyed in the prior year), in order to monitor them and make sure they stay out of the industry. These three plants (Myoporum, Portuguese broom, and scarlet wisteria) are the subject of two sections 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?
- When plants have been removed from the list due to a low prevalence, do they reappear over time?

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, as needed, volunteers from other gardening and conservation groups. To prepare them for this particular survey, PlantRight trained the volunteers to further hone their skills in carrying out this survey and recognizing the plants on PlantRight's survey list. In 2015, 156 volunteers participated in the survey, with each volunteer spending an average of 55 minutes surveying a nursery. A substantial portion of volunteers – 43% – surveyed more than one store.
- **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 then reviewed the pictures 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.⁴ The frequency distributions for the sample provide unbiased estimates⁵ of the frequency distributions within the population (and population subgroups).

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

2015 Focus on Locally Invasive Plants

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, unlike previous years' reports that looked at rates of invasive plants in all climate zones, this report focuses on rates of invasive species in the regions that they are considered locally invasive.

⁴ Prior to analysis, LFA weighted the data. For details on weighting, see Appendix A.

⁵ 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 2015 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?
4. When plants have been removed from the PlantRight list due to a low prevalence, do they reappear over time?

For the first through third 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 2015 survey is organized into four categories:

- **Cohort 1:** This cohort includes seven plants that have been on PlantRight's list continuously since 2011 – Chinese tallow tree, French broom, green fountain grass, highway iceplant, pampas grass, periwinkle, and Scotch broom.
- **Cohort 2:** This cohort includes three plants that have been on PlantRight's list since 2013 – Mexican feathergrass, water hyacinth, and yellow water iris.
- **Candidate plants:** This group includes five plants that are under review for PlantRight's list – African daisy, Brazilian pepper tree, glossy privet, grassland sedge, and shamel ash.
- **Retired plants:** This category includes plants that were once on PlantRight's list and have since been removed, as they have largely been phased out of California's horticultural supply chain. This year, PlantRight included Myoporum, Portuguese broom, and scarlet wisteria on the survey.

Exhibit 2 on the following page shows the breakdown of plants by category.

Exhibit 2. Breakdown of Plants into Cohorts

Common Name	Cohort 1 Plants (Surveyed Since 2011)	Cohort 2 Plants (Surveyed Since 2013)	Candidate Plants (Species Under Consideration)	Retired Plants (Re-surveyed in 2015)
Chinese tallow tree	✓			
French broom	✓			
Green fountain grass	✓			
Highway iceplant	✓			
Pampas grass	✓			
Periwinkle	✓			
Scotch broom	✓			
Mexican feathergrass		✓		
Water hyacinth		✓		
Yellow water iris		✓		
African daisy ⁶			✓	
Brazilian pepper tree			✓	
Glossy privet			✓	
Grassland sedge ⁶			✓	
Shamel Ash			✓	
Myoporum				✓
Portuguese broom				✓
Scarlet Wisteria				✓

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 2011-2014, please refer to LFA's reports from each of those years ([view on PlantRight's website](#)). 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 the 2011-2015 results.

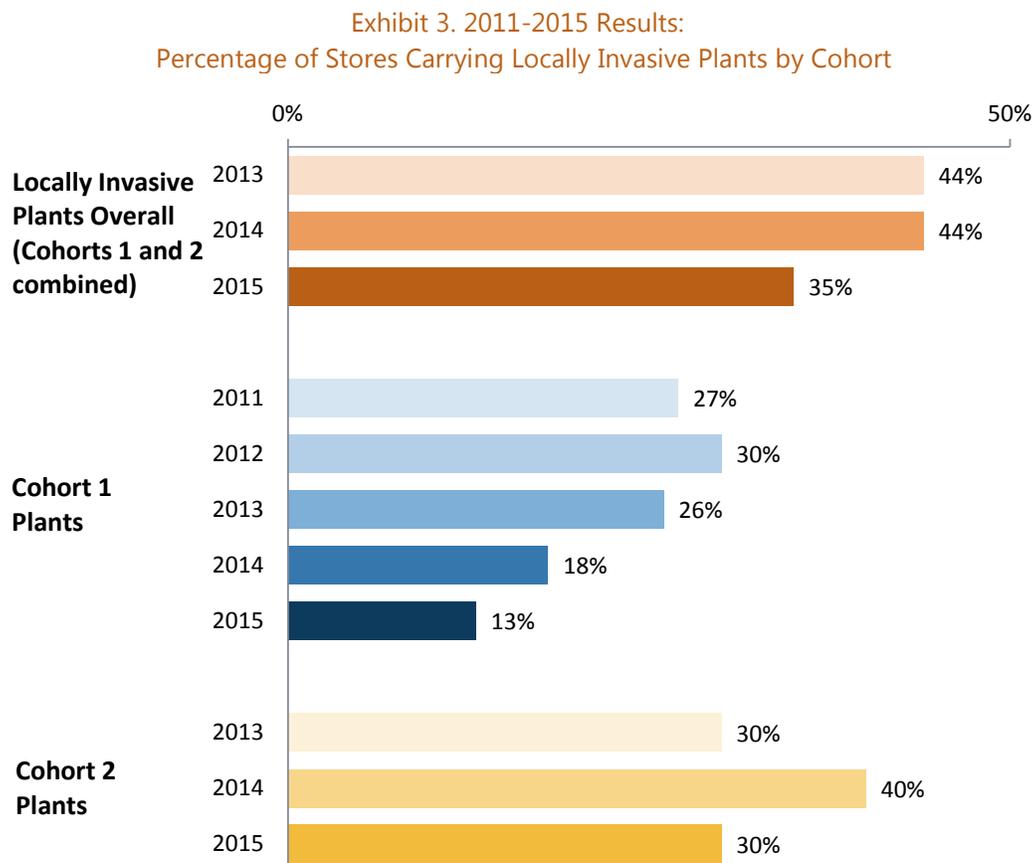
There may be discrepancies between previous years' results in this 2015 report and previous years' reports. This is due to a retroactive reclassification in 2015 of Orchard Supply Hardware from a "Chain Retailer" into a "Box Store Retailer" and Green Acres Nursery from an "Independent Retailer" to a "Chain Retailer" and the subsequent statistical implications. Statistics from past years were re-calculated for this report to reflect these changes and the new focus on locally invasive species across all results sections.

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

⁶ Recent Plant Risk Evaluation (PRE) research shows that African daisy and grassland sedge pose a low risk of becoming invasive.

1. What percentage of stores carries one or more species of locally invasive plants?⁷

Locally invasive plants on PlantRight’s list were found in 2015 at a statistically significantly lower rate than in 2014. Exhibit 3 below shows the prevalence of locally invasive plants found in each cohort for each of the years they were surveyed.



The percentage of stores selling one or more species of locally invasive plants in 2015 was 35% – considerably lower than the 44% rate in both 2013 and 2014. **This finding is a major victory for the PlantRight initiative and suggests that PlantRight’s efforts to reduce the sale of invasive species have taken hold in the horticultural industry.**

The rate of locally invasive Cohort 1 plants for sale has gone down every year since 2013, though the difference between 2014 and 2015 rates was not found to be statistically significant. And while there was an increase in locally invasive Cohort 2 plants found for sale between 2013 and 2014, the rate declined by a statistically significant amount from 40% in 2014 to 30% in 2015.

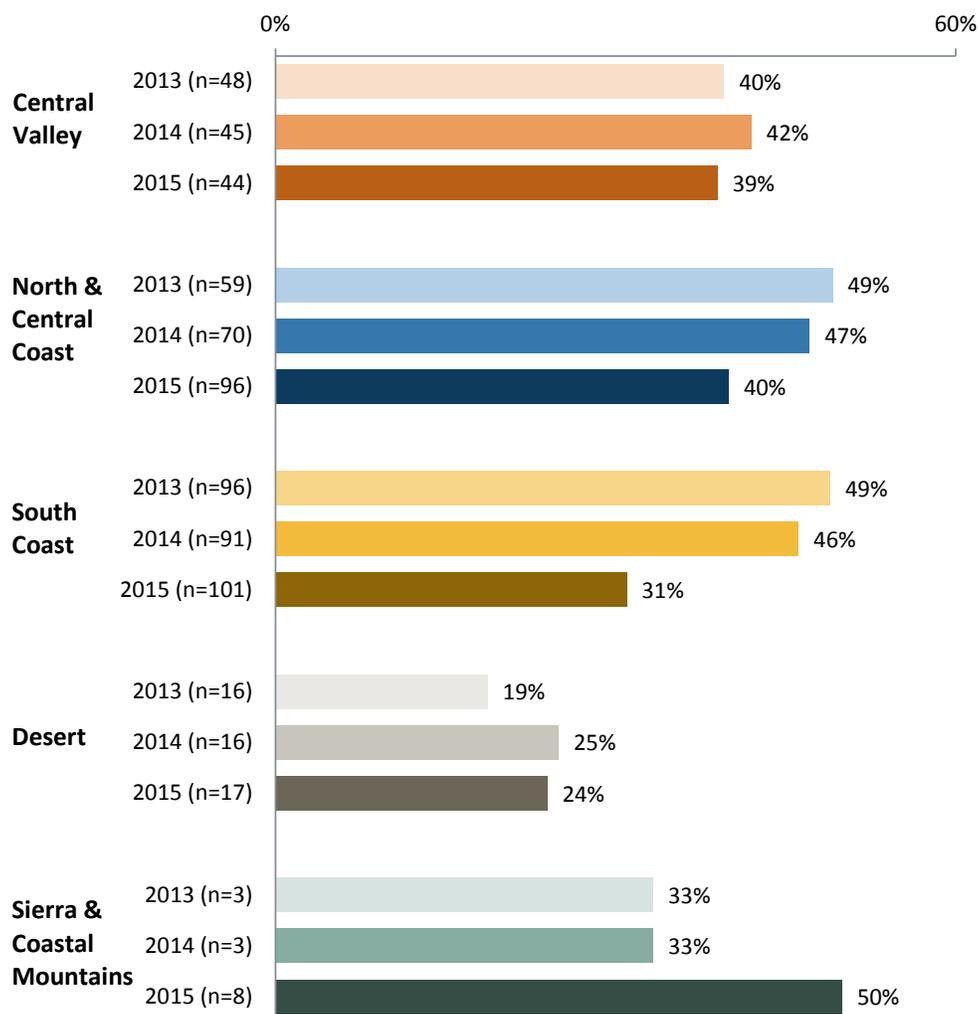
⁷ Note: as previously discussed, this section only includes Cohort 1 and 2 plants: Chinese tallow tree, French broom, green fountain grass, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, Scotch broom, water hyacinth, and yellow water iris.

By Climate Zone

The availability of locally invasive Cohort 1 and Cohort 2 plants for sale in stores varies by climate zones, as summarized in Exhibit 4.

In 2015, locally invasive plants were most often found in the Sierra & Coastal Mountains (50%), followed by the North & Central Coast (40%), Central Valley (39%), South Coast (31%), and Desert (24%) climate zones. The decrease from 46% in 2014 to 31% in 2015 of stores in the South Coast region carrying one or more species of locally invasive plants is statistically significant. And while the increase in the Sierra & Coastal Mountains between 2014 and 2015 looks substantial, a small number of stores in the region were surveyed, and the change is not statistically significant (so we cannot be confident that the increase reflects a *true* increase in the population).

Exhibit 4. 2013-2015 Results:
Percentage of Stores Selling Locally Invasive Plants by Climate Zone



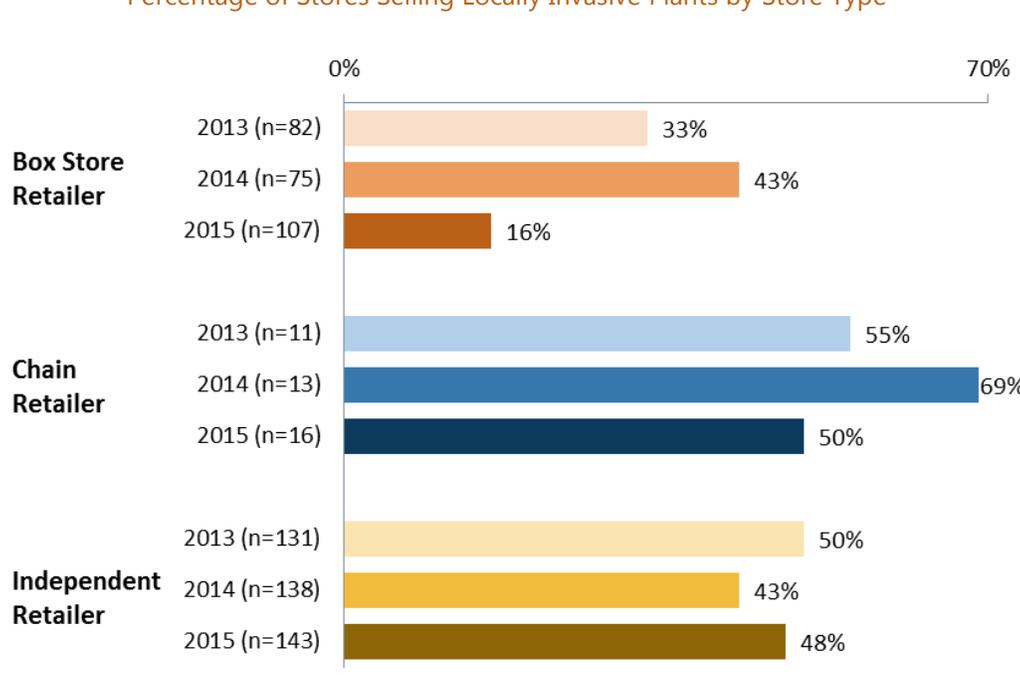
By Store Type

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).

As in previous years, Chain Retailers were the store type most likely to sell a locally invasive plant species, with 50% of surveyed stores selling at least one species of invasive plant. Independent Retailers were a close second, with 48% offering at least one locally invasive species for sale. Because there are many more Independent Retailers overall, when we look purely at the numbers and not the percentages, there are more locally invasive plants for sale at Independent Retailers.

It is a major PlantRight success that the percentage of Box Stores carrying one or more species of locally invasive plant dropped from 43% in 2014 to 16% in 2015. This statistically significant decrease can be attributed primarily to PlantRight's recent partnership with The Home Depot in California.⁸

Exhibit 5. 2013-2015 Results:
Percentage of Stores Selling Locally Invasive Plants by Store Type

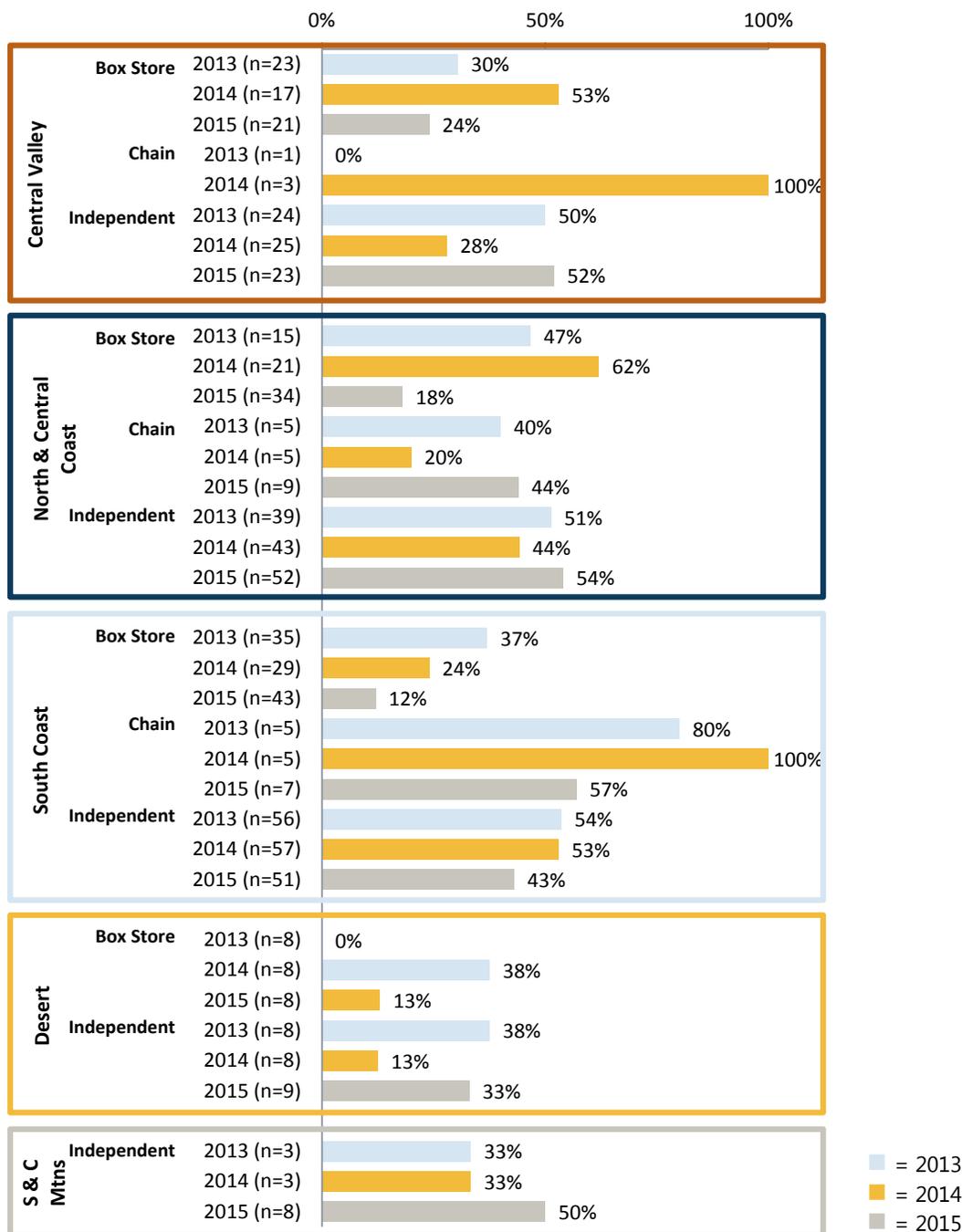


⁸ Sustainable Conservation, 2015. *Alliance to Combat Invasive Plants Grows*. <http://suscon.org/plantright/alliance.php>.

By Climate Zone and Store Type

Locally invasive plants were most likely to be found at Chain Retailers in the South Coast climate zone (57%), followed closely by Independent Retailers in the North & Central Coast (54%), Central Valley (52%), and Sierra & Coastal Mountains (50%). That said, the sample sizes for some of these categories are quite small. It is therefore difficult to draw meaningful conclusions from these patterns.

Exhibit 6. 2013-2015 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, 2013-2015; and Box Stores and Chain Retailers in the Sierra and Coastal Mountains, 2013-2015.

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

The average number of locally invasive species carried by all of the surveyed stores was 0.47 species of plants per store (n=265). This is a statistically significant decrease from 2014, in which the average number of locally invasive species carried by all of the surveyed stores was 0.68 species of plants per store (n=226).

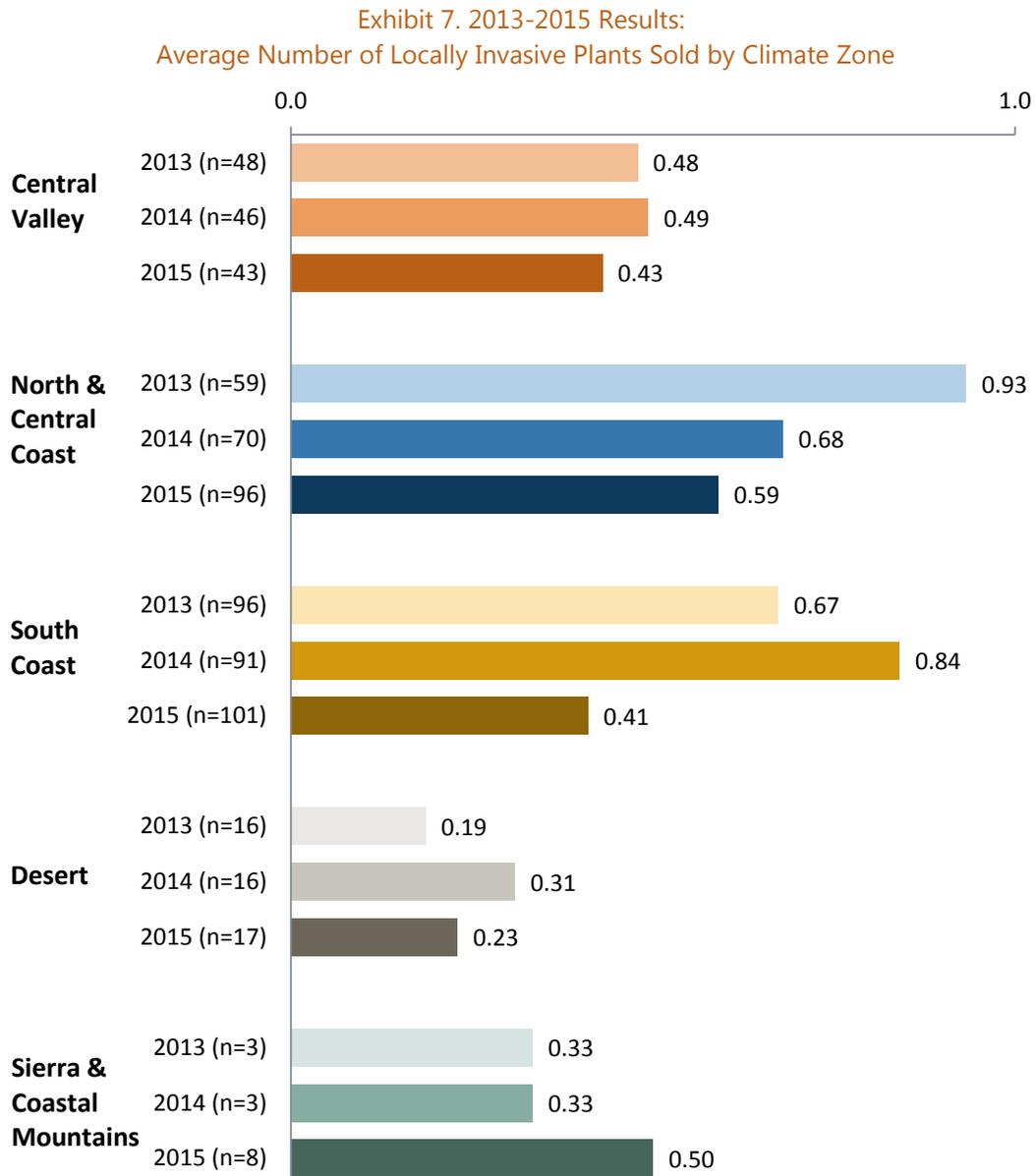
Of the 94 stores with a locally invasive species, 22% (21 stores) carried more than one locally invasive species. In 2014, this figure was 39% (39 out of 100 stores). Among those 94 stores in 2015 where *at least* one locally invasive plant was found, the average number of species present was 1.33, compared with 1.53 in 2014.

In 2015, the maximum number of locally invasive species found at any store was four. Two stores had four locally invasive species present.

¹⁰ Note: As previously discussed, this only includes Cohort 1 and 2 plants: Chinese tallow tree, French broom, green fountain grass, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, Scotch broom, water hyacinth, and yellow water iris.

By Climate Zone

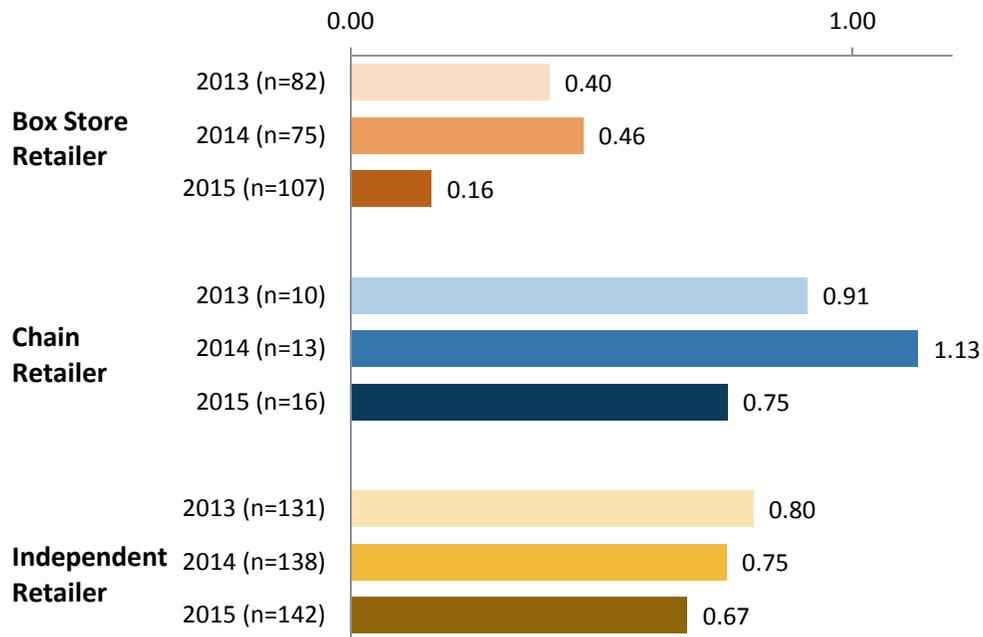
In 2015, the average number of locally invasive species sold per store was highest in the North & Central Coast climate zone, with an average of 0.59 plant species per store. The South Coast climate zone, which had the highest average number of locally invasive species for sale in 2014, experienced a statistically significant decrease in 2015, from 0.84 to 0.41 plant species per store.



By Store Type

As in 2013 and 2014, Chain Retailers had the highest average number of locally invasive species per store in 2015, at 0.75 species of plants per store. This average was higher than that of Independent Retailers (0.67 species per store) and much higher than the 0.16 species per store found in Box Stores (and these rate differences are statistically significant). The decrease in the average number of locally invasive species for sale in Box Stores from 2014 to 2015 was also statistically significant and can be linked to PlantRight's recent retail partnership with The Home Depot in California.

Exhibit 8. 2013-2015 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 ten 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 18 plants included in the 2015 Nursery Survey.

Volunteers searched for 18 different plant species, of which they found 14 in at least one store. Those 14 are: African daisy, Brazilian pepper tree, Chinese tallow tree, French broom, grassland sedge, green fountain grass, glossy privet, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, shamel ash, water hyacinth, and yellow water iris.

Results for the prevalence of the ten locally invasive Cohort 1 and 2 plant species are summarized in Exhibits 9 and 10. As the invasive ranges for each of the five candidate plants (African daisy, Brazilian pepper tree, grassland sedge, glossy privet, and shamel ash) have not yet been determined, their results reflect prevalence in all surveyed stores and are displayed separately in Exhibit 11.

The three retired plants were not found in any surveyed stores. Further discussion of the retired plants is in the next section of this chapter.

Mexican feathergrass was, by a substantial percentage, the most prevalent locally invasive species. Because it was so prevalent, this section contains an in-depth view of the climate zones and store types where Mexican feathergrass was found.

For the same level of detail about each of the other plant species, please see Appendix B.

Prevalence of Each Locally Invasive Plant Species

The most frequently found locally invasive species in 2015 were (in descending order): Mexican feathergrass, periwinkle, water hyacinth, green fountain grass, pampas grass, yellow water iris, highway iceplant, Chinese tallow tree, French broom, and Scotch broom. For ease of reading, these results are presented in two charts, each with five of the ten Cohort 1 or 2 plants found. Please note that the scales on the two charts are different in order to best reflect the differences in the prevalence of locally invasive plant species.

Exhibit 9.

Percentage of Stores Selling a Locally Invasive Plant:
Five *Most* Commonly Found Plants

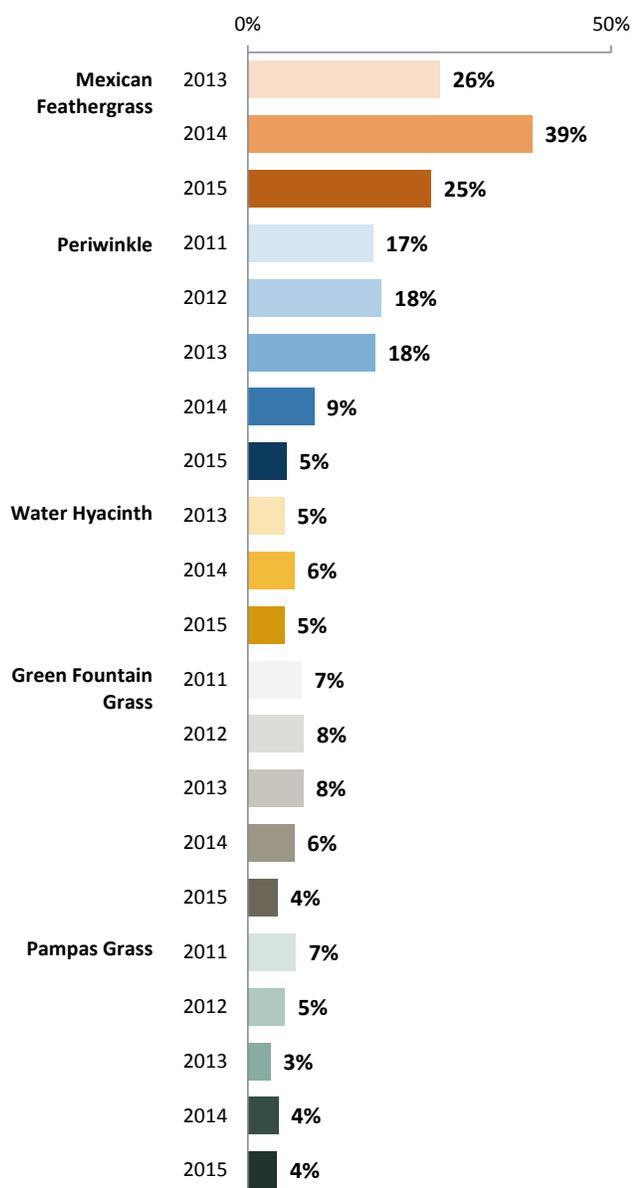
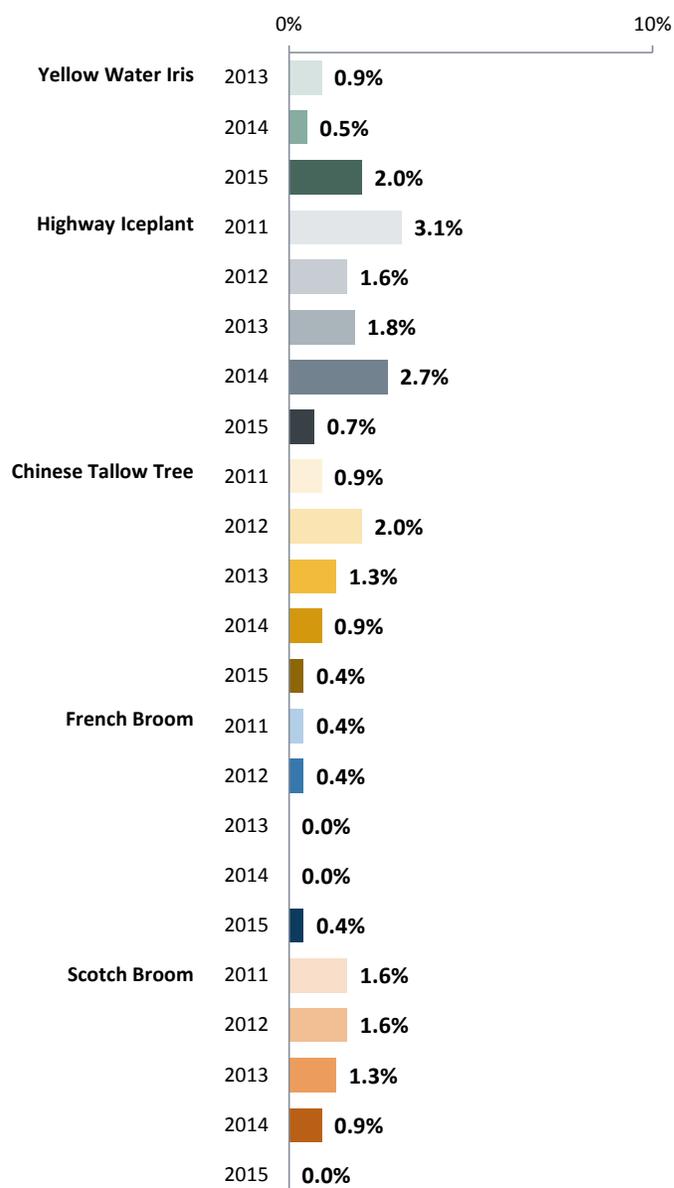


Exhibit 10.

Percentage of Stores Selling a Locally Invasive Plant:
Five *Least* Commonly Found Plants

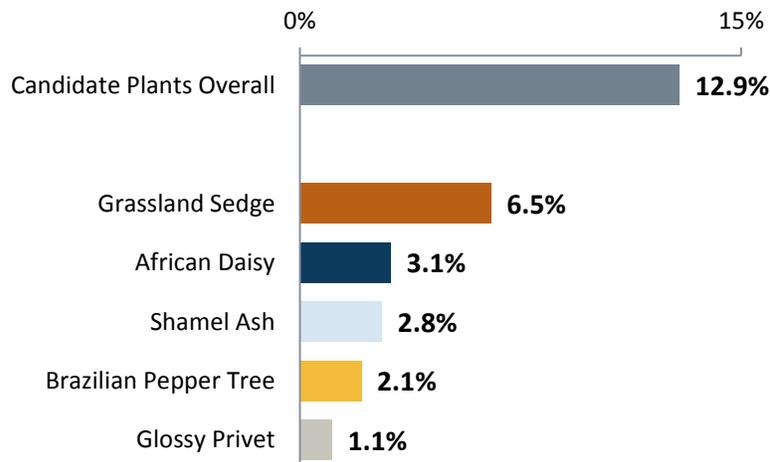


Prevalence of Candidate Species

Candidate plants are not yet considered locally invasive in any specific climate zone(s); therefore Exhibit 11 reflects their overall prevalence in all surveyed stores. Candidate plants were found in 13% of stores overall.

The most frequently found candidate species in 2015 were (in descending order): grassland sedge, African daisy, shamel ash, Brazilian pepper tree, and glossy privet. As these are 2015 candidate plants, there is no previous year comparison data.

Exhibit 11. 2015 Results:
Percentage of Stores Selling a Candidate Plant



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. Shamel ash is the only candidate plant that met all criteria for future addition (read more about these criteria on [PlantRight's website](#)).

Please note that recent Plant Risk Evaluation (PRE) research shows that African daisy and grassland sedge pose a low risk of becoming invasive.

Mexican Feathergrass – by Climate Zone and Store Type

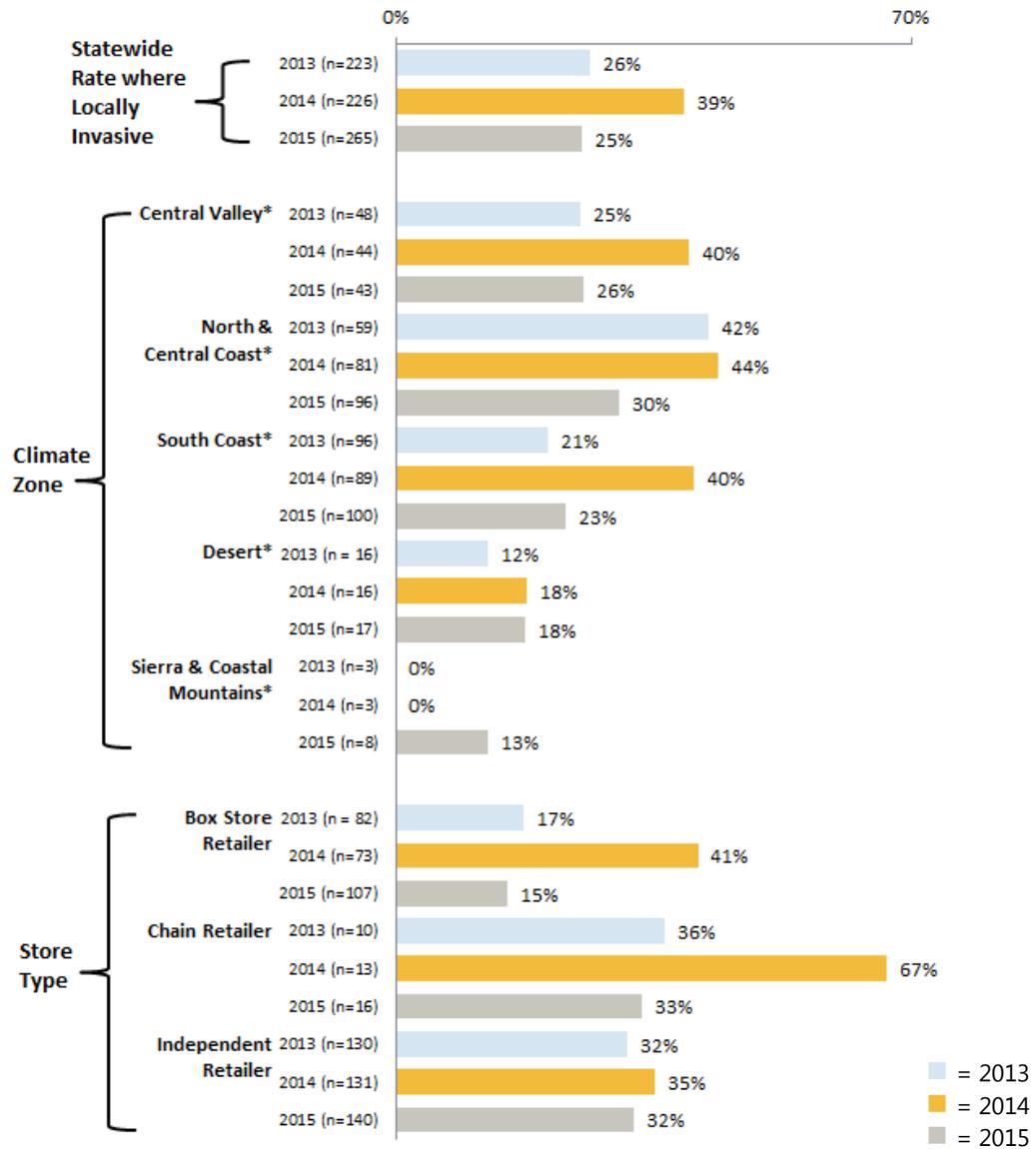
Mexican feathergrass is a popular ornamental grass that is locally invasive in all five climate zones. It is the first "emerging invasive plant" (not yet widely escaped across California wildlands) on PlantRight's list. The plant spreads rapidly and crowds out native grasses. In the three years it has been on PlantRight's Survey list – one year as a candidate plant and two years as a listed invasive – it has been the most commonly found locally invasive species for sale by a wide margin.

In 2014, PlantRight led an awareness and fundraising campaign to purchase 14,000 feathergrass plants from one of the state's largest growers to accelerate their phase out from the nursery supply chain. The grower stopped future production of the grass and worked with PlantRight to educate the largest retailers in the country about the plant.

The campaign worked. In 2015, stores selling Mexican feathergrass decreased dramatically, from 39% in 2014 to 25% in 2015 – a drop that is statistically significant. The decrease between 2014 to 2015 in South Coast region stores and Box Stores is statistically significant. Within the 2015 data, the difference between Independent Retailers and Box Stores is statistically significant.

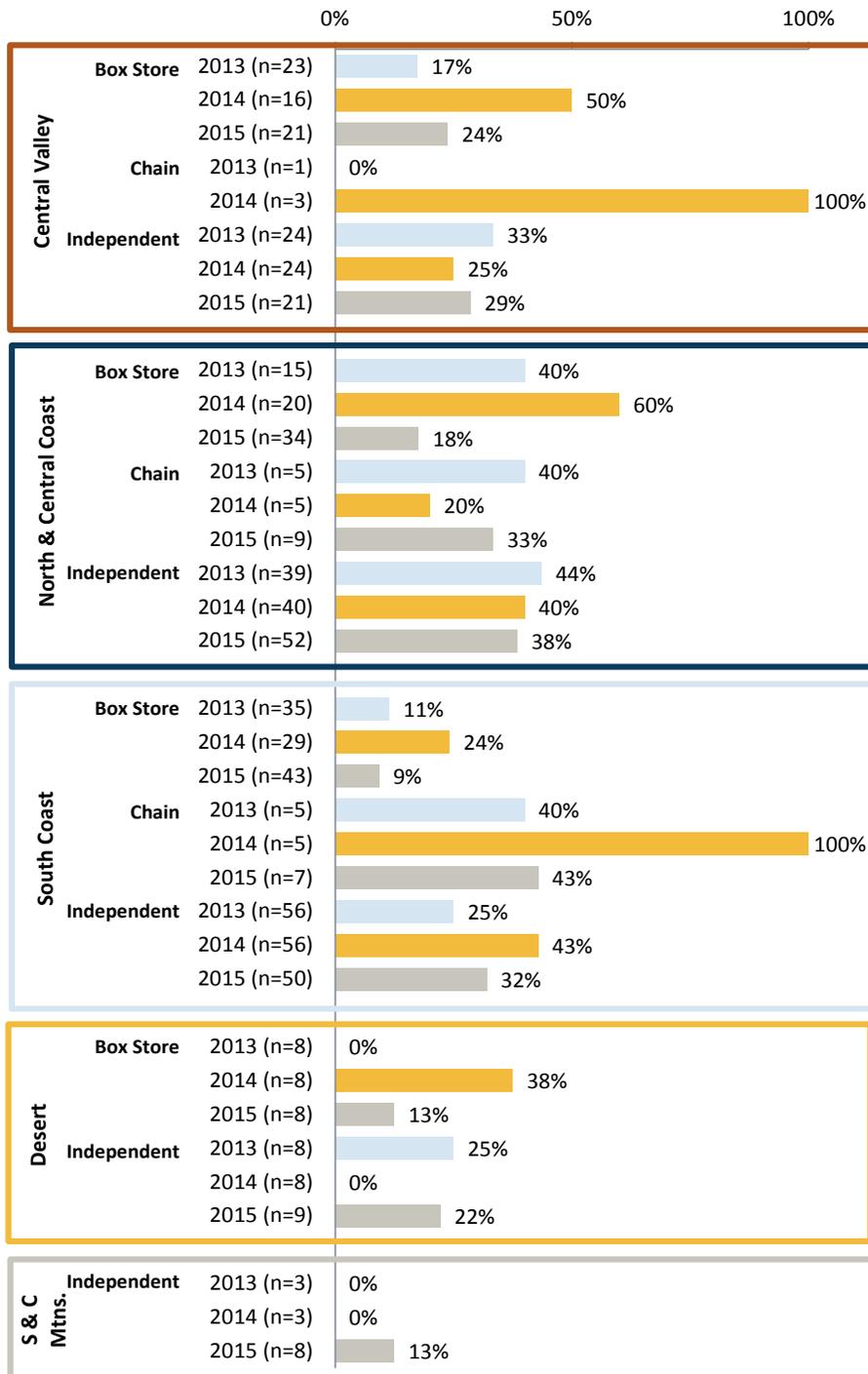
Exhibit 12 shows the PlantRight survey results over time for Mexican feathergrass. The first section, "Statewide Rate where Locally Invasive," indicates the presence of the species in all surveyed stores. The "Climate Zone" section shows prevalence by climate zone. Because Mexican feathergrass is locally invasive in all climate zones, all regions have an asterisk by their name.

Exhibit 12. 2013-2015 Results:
Mexican Feathergrass by Climate Zone and Store Type



When these results are viewed by both climate zone and store type, Mexican feathergrass is found most often at Chain Stores in the South Coast and Independent Retailers in the North & Central Coast.

Exhibit 13. 2013-2015 Results:
Mexican Feathergrass by Climate Zone and Store Type¹¹



¹¹ Stores for which there were no data points (n=0) are not included in this chart. These include: Chain Stores in the Central Valley in 2015; Chain Stores in the Desert and Sierra and Coastal Mountains. 2013-2015; and Box Stores in the Sierra and Coastal Mountains, 2013-2015.

4. When plants have been removed from the PlantRight list due to a low prevalence, do they reappear over time?

PlantRight “retires” invasive species from their list when the plants have largely been eliminated from California’s garden center supply chain and are rarely found for sale (i.e. found at less than 1% of retail nurseries for three years in a row).

PlantRight included three retired plants in their 2015 survey to see whether they have remained out of the industry. The three retired plants included in the survey this year were Myoporum, Portuguese broom, and scarlet wisteria. Myoporum was previously surveyed from 2011-2013, with no stores found carrying the species in 2012 and 2013. Portuguese broom and scarlet wisteria were found in no stores when surveyed in 2011 and 2012.

The 2015 survey results were gratifying. None of the retired plants were found in any surveyed stores. PlantRight plans to continue to include three retired plants (randomly selected from those not included in previous year’s survey) each year in the annual survey as a regular part of their monitoring process.

III. Conclusions and Recommendations

Conclusions

Locally Invasive Plants Were Found at a Lower Rate in 2015 than in Previous Years

In the aggregate, the ten locally invasive plants on PlantRight's 2015 list were found at a lower rate in 2015 than in 2014 in the climate zones where they are locally invasive. In 2013 and 2014, 44% of stores carried a locally invasive plant; in 2015, the rate dropped to 35%. Looking at the cohorts separately, both Cohort 1 and Cohort 2 plants were found at a lower rate in 2015 than 2014, with a decrease from 40% to 30% for Cohort 2 plants. These results suggest that PlantRight's efforts to curb the sale of invasive species in California are taking hold with retailers and growers.

Mexican Feathergrass Continues to be the Most Commonly Found Invasive Species

Mexican feathergrass continues to be the most widely found locally invasive species on PlantRight's list and has been for all three years it has been surveyed. In 2014, PlantRight made a concerted effort to reduce the plant's prevalence by launching a campaign to purchase 14,000 plants directly from a major grower and working with the grower to educate major retailers. Results show that their efforts made a big difference. Stores in 2015 were found to be less likely to have Mexican feathergrass for sale than in 2014, a statistically significant decrease from 39% in 2014 to 25% in 2015.

Retail Partnership Efforts Led to a Decrease in the Rate at Which Box Stores Carry Locally Invasive Species

In 2015, the percentage of box stores carrying one or more species of locally invasive plants decreased to 16%, compared to 43% in 2014. A large part of this change can be attributed to PlantRight's partnership with The Home Depot in California, a major Box Retailer with over 200 locations throughout the state. Given the large volume of plants Box Retailers sell (constituting 50% of total plant sales by volume¹², or higher according to some estimates), this drop will have a large impact on overall invasive plant sales throughout the state.

Retired Plants Have Not Made a Resurgence

The three retired plants chosen by PlantRight to be surveyed in 2015 were not found for sale in any store. Myoporum, Portuguese broom, and scarlet wisteria were rarely found for sale before being removed from the official list. These results should bolster PlantRight's confidence in their method for retiring invasive species.

¹² Carman, Hoy. 2011. *Economic Aspects of the California Nursery and Floral Industry, 2001–2009*. Davis, CA: Giannini Foundation of Agricultural Economics Information Series No. 11-1. Available at <http://giannini.ucop.edu/infoseries.htm>.

Recommendations

Continue to Build Industry Partnerships

As seen with PlantRight's success engaging with The Home Depot in California, strategic partnerships can have a significant impact on the rate of sale of locally invasive plants. PlantRight should continue their work to build strong relationships with other Box Retailers that have multiple locations, because these key partnerships will have a ripple effect throughout the state.

Focus on Reaching Independent Retailers and Chain Retailers

Chain and Independent Retailers were the store types that most commonly had locally invasive species for sale, 50% and 48% respectively – so PlantRight would do well to work with these store types to lower the rate of locally invasive plants. A challenge of working with these store types is the fact that Chain and Independent Retailers usually operate independently or have just a few locations. This means that PlantRight would need to reach each store individually, which would take a great deal of effort. To reach these stores more efficiently, PlantRight's may want to educate growers via professional trade associations, such as the California Association of Nurseries and Garden Center (CANGC) and the Nursery Growers Association (NGA). These associations could then disseminate information about invasives to the Independent and Chain Retailers in their networks.

Apply the Lessons Learned from the Continued Drop in Prevalence of Periwinkle

Periwinkle was the second most commonly found locally invasive species for sale by a wide margin in 2013. Since then, it has exhibited a steady decline. In the climate zones in which it is locally invasive, it was found in 18% of stores in 2013, 9% of stores in 2014, and 5% of stores in 2015. Unlike its efforts with Mexican feathergrass, PlantRight did not launch a periwinkle-specific initiative. It may be useful for PlantRight to reflect upon and investigate the factors that led to the periwinkle decline, through discussion with growers and store owners, to inform future campaigns that do not have the same large-scale resources as the Mexican feathergrass campaign.

Determine Locally Invasive Climate Regions for Candidate Plants Prior to Surveying

Findings are most useful for PlantRight when they focus on the rate of sale of plants only in the regions the plants are locally invasive. For example, it would not be meaningful to report the prevalence of Chinese tallow tree in the South Coast region, because the plant is not considered invasive there. Therefore, when possible, locally invasive climate zones should be determined for a candidate plant before adding it to the survey list.

Appendix A: In-depth 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 invasive plants' prevalence over time. 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:

- 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 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 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 invasive.

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 Sustainable Conservation 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 57 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 projected number of volunteers was 125, and the projected number of stores they could survey was 285.

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

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 (Master Gardener volunteers).

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 8,726 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 2015.

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 1,512.

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 2015, 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 last year’s average number of stores surveyed per volunteer: 1.9). Based on these numbers and on last year’s total stores surveyed, we estimated that these volunteers would be able to survey 285 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).** As discussed in step two, this is equal to the projected number of nurseries expected to be surveyed (285) by our projected number of volunteers (125).
- **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 these 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	611	118
Chain Retailers	89	9
Independent Retailers	812	158

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 (on the following page) 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 118 surveys of Box Stores should be surveyed, with rounding our allocation came to 115 surveys total. To compensate for these errors, surveys were added or subtracted from specific counties, as follows:

- One survey of a Box Store was added to three counties (Amador, Kern, and San Bernardino).
- One survey of an Independent Retailer was added to one county (Santa Barbara).

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	5	0	4
Amador	1		0
Butte	1		2
Calaveras			1
Colusa			0
Contra Costa	4	1	5
Del Norte	0		0
El Dorado	0		2
Fresno	4		5
Glenn	0		0
Humboldt			2
Imperial	1		1
Inyo			0
Kern	4	0	4
Kings	1		1
Lake	0		1
Lassen	0		1
Los Angeles	20	2	18
Madera	1		1
Marin	0	1	2
Mariposa			1
Mendocino	0	0	3
Merced	1		1
Modoc			0
Mono			1
Monterey	1		2
Napa	1		1
Nevada			2
Orange	9	1	11

County	Box Store	Chain Retailer	Independent Retailer
Placer	2	0	3
Plumas			1
Riverside	8	0	11
Sacramento	6	1	2
San Benito			
San Bernardino	9	0	7
San Diego	9	1	16
San Francisco	0	0	3
San Joaquin	3		4
San Luis Obispo	1	1	3
San Mateo	2		4
Santa Barbara	1	0	5
Santa Clara	7	1	3
Santa Cruz	1		4
Shasta	1		1
Sierra			
Siskiyou	0		0
Solano	2		1
Sonoma	2	0	7
Stanislaus	3		1
Sutter	1		0
Tehama	0		1
Trinity			0
Tulare	2		3
Tuolumne	1		1
Ventura	2	0	3
Yolo	1		1
Yuba	0		1
Total	118	9	158

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, 18 was the target sample size for Independent Retailers in Los Angeles. For this stratum, the 18 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:

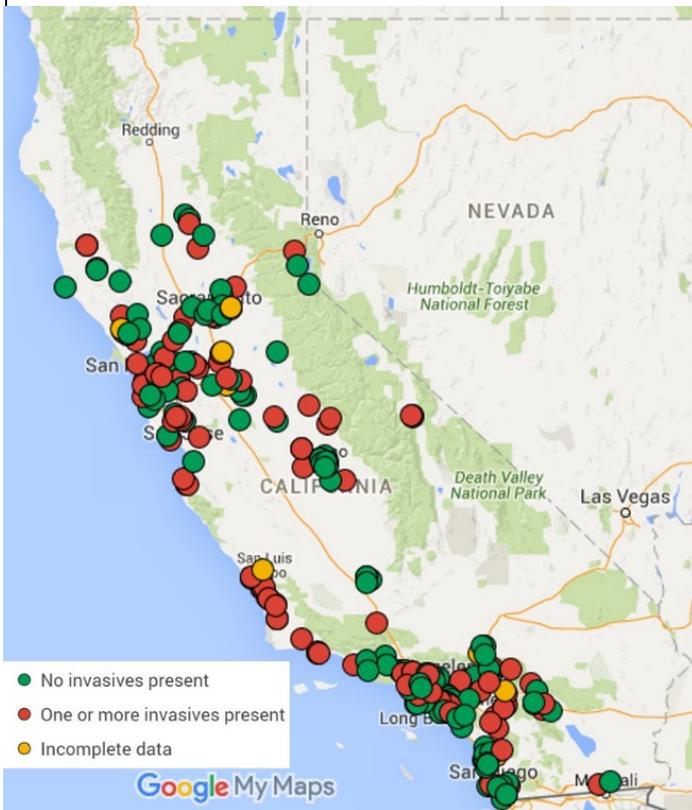
- Upon calling the store prior to administering the survey, PlantRight determined that the store did not sell plants that met its criteria (e.g. outdoor, perennial plants) or did not sell these plants at a retail level.
- The stores identified for the sample were further away from the homes of the volunteers 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



Recruiting and Training Highly-Skilled Surveyors

Participant Recruitment

Recognizing the importance of obtaining statistically significant survey data in 2015, PlantRight actively recruited participants for the survey in winter 2014-2015. Calls were made to confirm the participation of Master Gardener programs in counties across California, and 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	7 of 9
Amador	0 of 1
Butte	5 of 3
Calaveras	1 of 1
Contra Costa	10 of 10
El Dorado	1 of 2
Fresno	14 of 9
Glenn	1 of 0
Humboldt	0 of 2
Imperial	2 of 2
Inyo	3 of 0
Kern	5 of 8
Kings	0 of 2
Lake	1 of 1
Lassen	0 of 1
Los Angeles	26 of 40
Madera	4 of 2
Marin	1 of 3
Mendocino	5 of 3
Merced	2 of 2
Mono	0 of 1
Monterey	4 of 3
Napa	1 of 2
Nevada	1 of 2
Orange	26 of 21
Placer	4 of 5
Plumas	0 of 1
Riverside	18 of 19
Sacramento	11 of 9
San Bernardino	15 of 16
San Diego	24 of 26
San Francisco	6 of 3
San Joaquin	8 of 7
San Luis Obispo	11 of 5
San Mateo	5 of 6
Santa Barbara	6 of 6
Santa Clara	7 of 11
Santa Cruz	3 of 5
Shasta	0 of 3
Solano	6 of 3
Sonoma	9 of 9
Stanislaus	4 of 4
Tehama	0 of 1
Sutter	0 of 1
Tehama	0 of 1
Tulare	0 of 5
Tuolumne	0 of 2
Ventura	5 of 5
Yolo	2 of 2
Yuba	0 of 1
TOTAL¹³	265 of 285

¹³ Due to deviations from the originally selected sample, the total stores selected over the course of the survey was 342.

Survey Procedure

All participants in PlantRight's 2015 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, 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.

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 18 plants included in PlantRight's 2015 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 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 and Chain Retailers were slightly over-represented relative to their presence in the population (so they needed to be “weighted up”), while Independent Retailers were over-represented (so they needed to be “weighted down”). The weights ultimately assigned are shown in Exhibit 18.

Exhibit 18. Weights Used for Analyzing Store Types, 2015

Store Type	Weight Assigned
Box Stores	1.01
Chain Retailers	1.30
Independent Retailers	0.97

The sample sizes reported in the 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 265.

Due to the retroactive re-classifying of Orchard Supply and Green Acres stores (discussed on page 9), store type weights for previous years had to be recalculated to account for the revised number of store types in years 2011-2014. Therefore, results in this 2015 report may differ slightly from previous years’ reports. The reweighting due to re-categorization of those stores is as follows:

Exhibit 19. Weights Used for Analyzing Store Types, 2011-2014

Year	Store Type	Old Weight	Revised Weight
2011	Box Stores	0.92	0.89
	Chain Retailers	0.92	1.69
	Independent Retailers	1.06	1.01
2012	Box Stores	1.26	1.17
	Chain Retailers	0.79	0.74
	Independent Retailers	0.93	0.93
2013	Box Stores	1.03	1.02
	Chain Retailers	0.95	0.92
	Independent Retailers	0.99	1.00
2014	Box Stores	0.95	0.94
	Chain Retailers	0.99	0.89
	Independent Retailers	1.03	1.05

Appendix B: Results by Plant Species

Volunteers searched for 18 different plant species; they found 14 of the 18 in at least one store. Those 14 are: African daisy, Brazilian pepper tree, Chinese tallow tree, French Broom, grassland sedge, green fountain grass, glossy privet, highway iceplant, Mexican feathergrass, pampas grass, periwinkle, shamel ash, water hyacinth, and yellow water iris. For 13 of these 14 species, information on which climate zone and in which type of store those plants were found is summarized in the pages that follow, in Exhibits 20 through 33. A discussion of Mexican feathergrass is included in the main body of the report. Please see pages 20-21 for more information on that species.

The first section of each chart, "Statewide Rate where Locally Invasive," indicates the presence of the species in surveyed stores in the region(s) it is locally invasive. The "Climate Zone" section shows presence of the plant by climate zone, with an asterisk next the region(s) in which the plant is locally invasive. The "Store Type" section shows prevalence only the region(s) the plant is considered locally invasive.

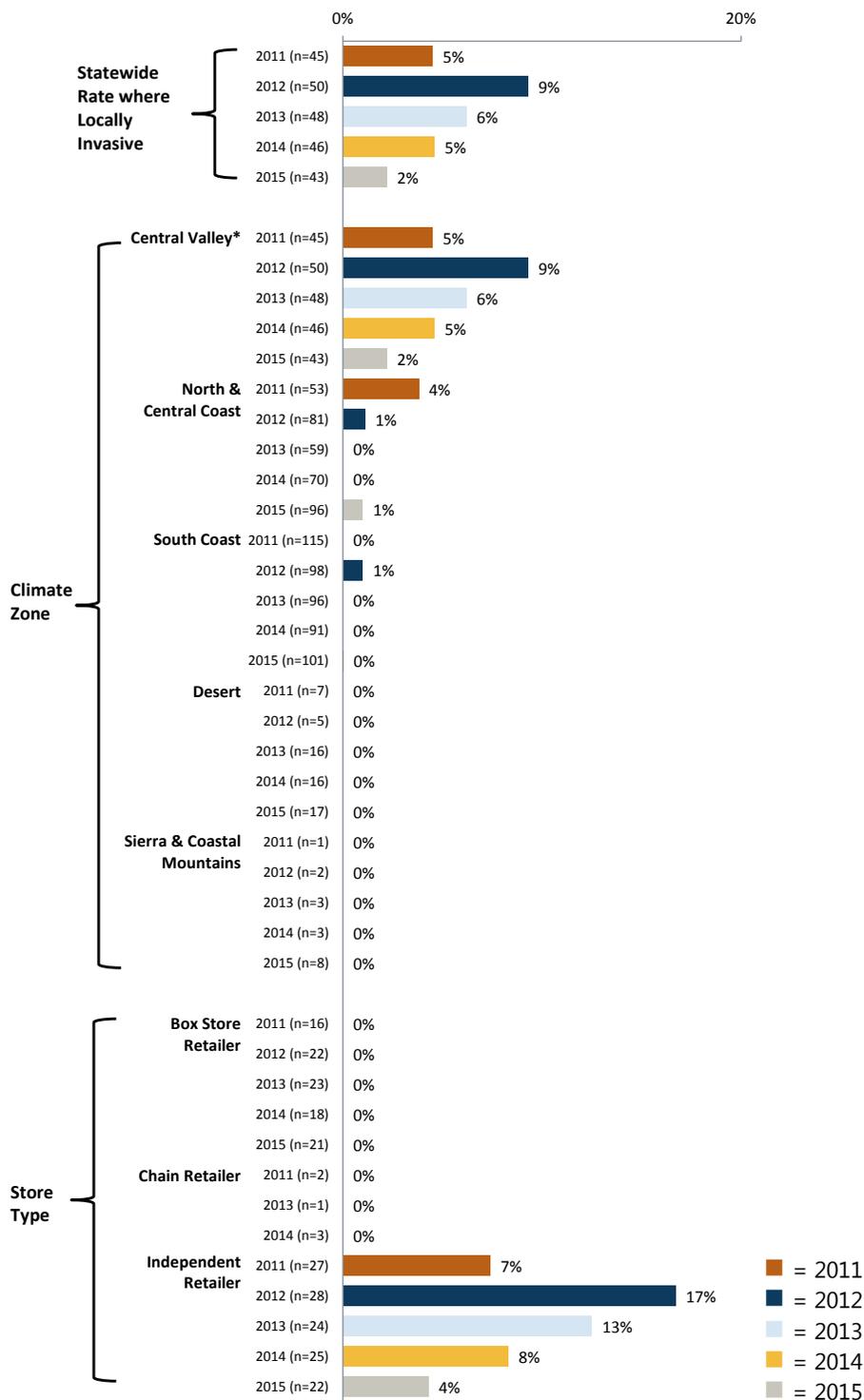
The climate zone(s) that each species of plant is considered locally invasive is included with the results (and is summarized in Appendix C). This information is available for Cohort 1 and Cohort 2 plants; however, it is not available for the five candidate plants that were included in 2015. Sustainable Conservation uses a variety of data sources and engages in extensive research to determine where specific species of plants are locally invasive. Because these plants are still under review, their invasive ranges have not yet been determined.

This section includes results for the ten locally invasive species in Cohorts 1 and 2 in alphabetical order followed by the five candidate plants. Please note that the scale for each plant varies to best display the data.

Chinese Tallow Tree – By Climate Zone and by Store Type

Chinese tallow tree (Cohort 1) is locally invasive in the Central Valley. In 2015, it was found for sale at one Independent Retailer in the Central Valley.

Exhibit 20. 2011-2015 Results: Percentage of Stores at Which Chinese Tallow Tree was Found¹⁴

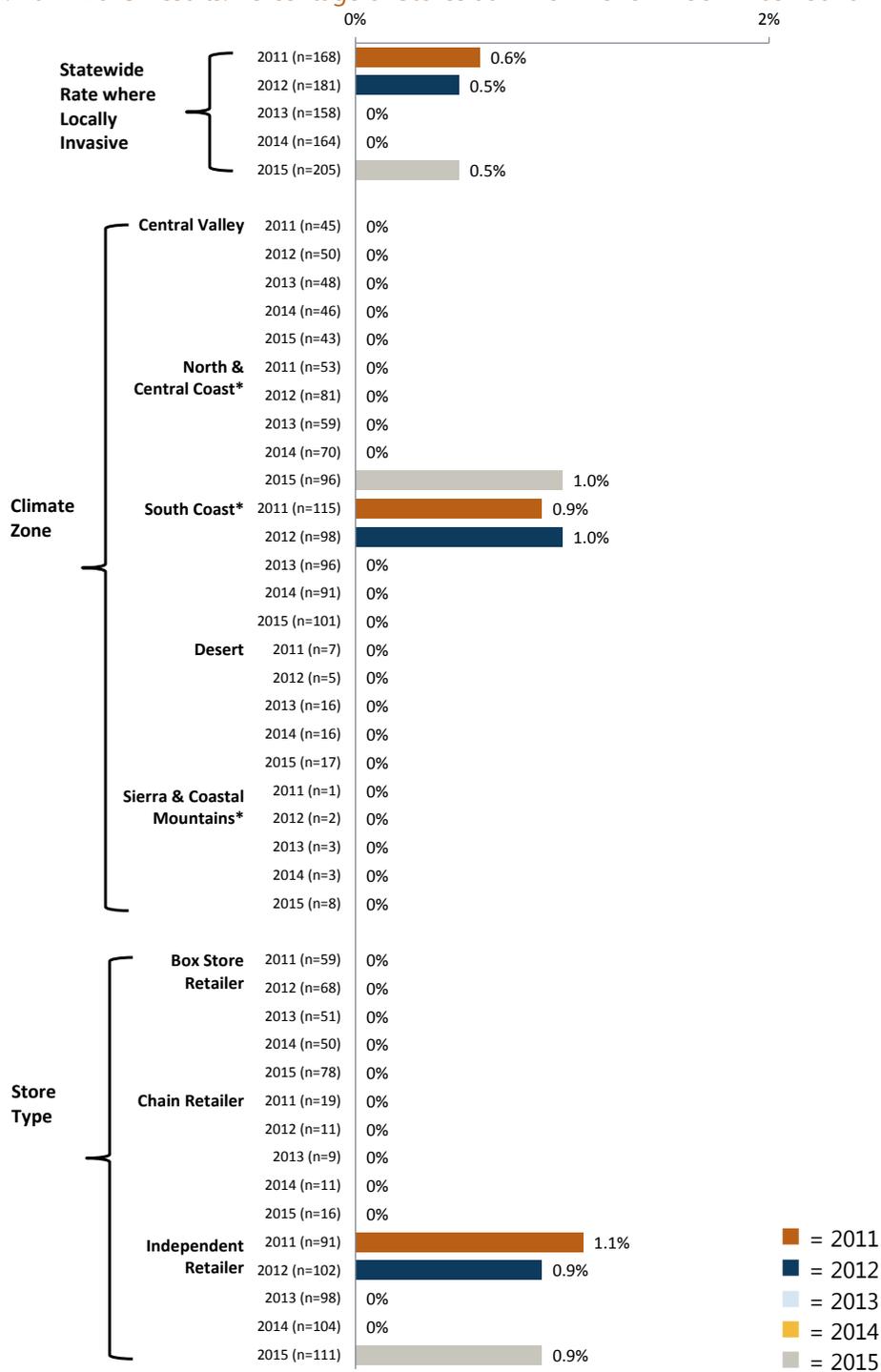


¹⁴ Stores for which there were no data points (n=0) are not included in this chart. These include Chain Retailers in the Central Valley region in 2012 and 2015.

French Broom – By Climate Zone and by Store Type

French Broom (Cohort 1) is locally invasive in the North & Central Coast, South Coast, and Sierra & Coastal Mountain climate zones. While it was not found for sale in any surveyed stores in 2013 or 2014, in 2015 it was found for sale at one Independent Retailer in the South Coast.

Exhibit 21. 2011-2015 Results: Percentage of Stores at Which French Broom was Found¹⁵

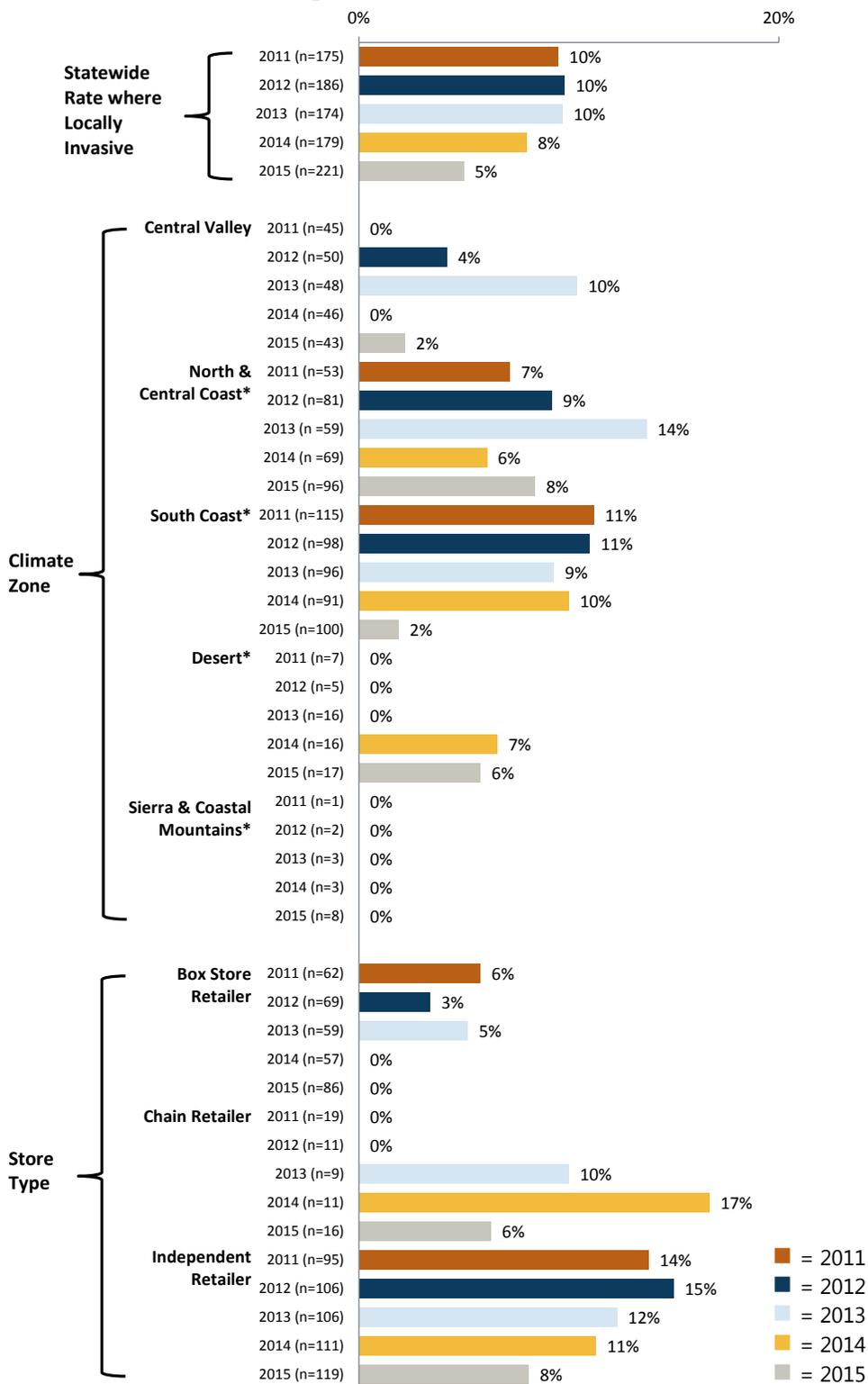


¹⁵ Stores for which there were no data points (n=0) are not included in this chart. These include Chain Retailers in 2012 and 2015.

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 2015, it was found in ten Independent Retailers and one Chain Retailer in its locally invasive regions.

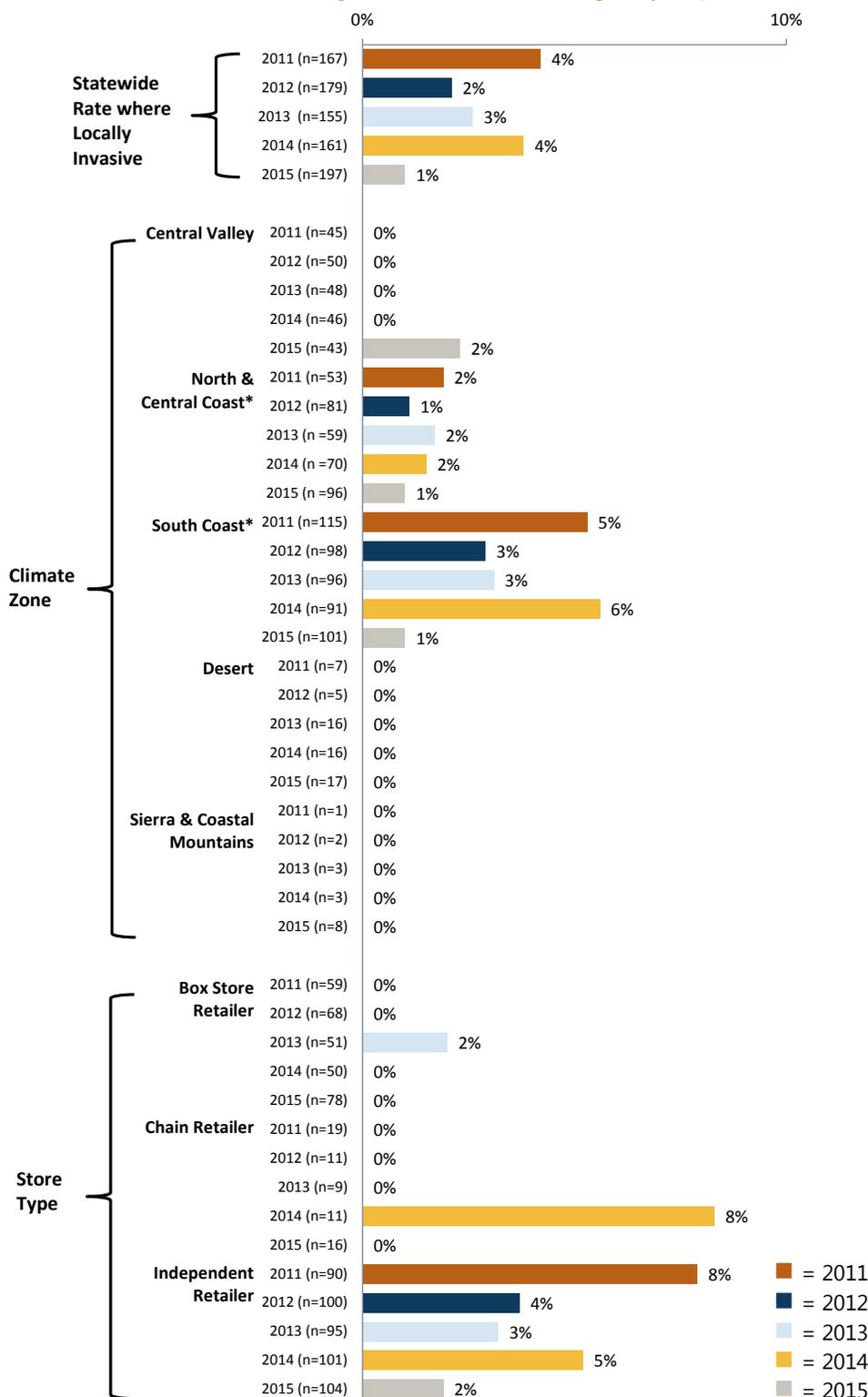
Exhibit 22. 2011-2015 Results: Percentage of Stores at Which Green Fountain Grass was Found



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 2015, it was found for sale at two Independent Retailers in those regions, one in the North & Central Coast and one in the South Coast.

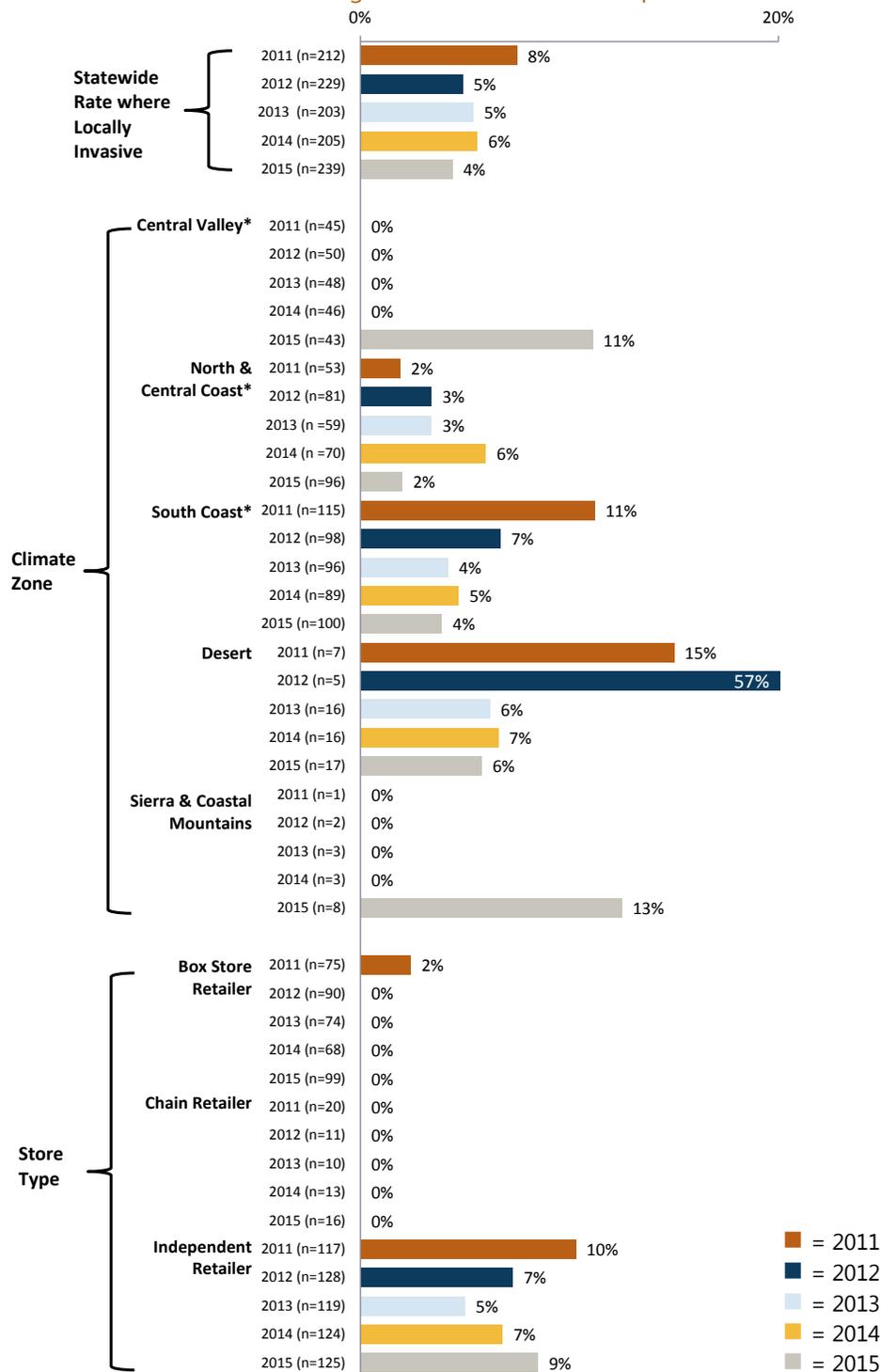
Exhibit 23. 2011-2015 Results: Percentage of Stores at Which Highway Iceplant was Found



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 2015, it was found at 11 Independent Retailers in the climate zones where it is invasive – five stores in the Central Valley, two stores in the North & Central Coast, and four stores in the South Coast region. The difference between prevalence in Independent Retailers and other store types is statistically significant.

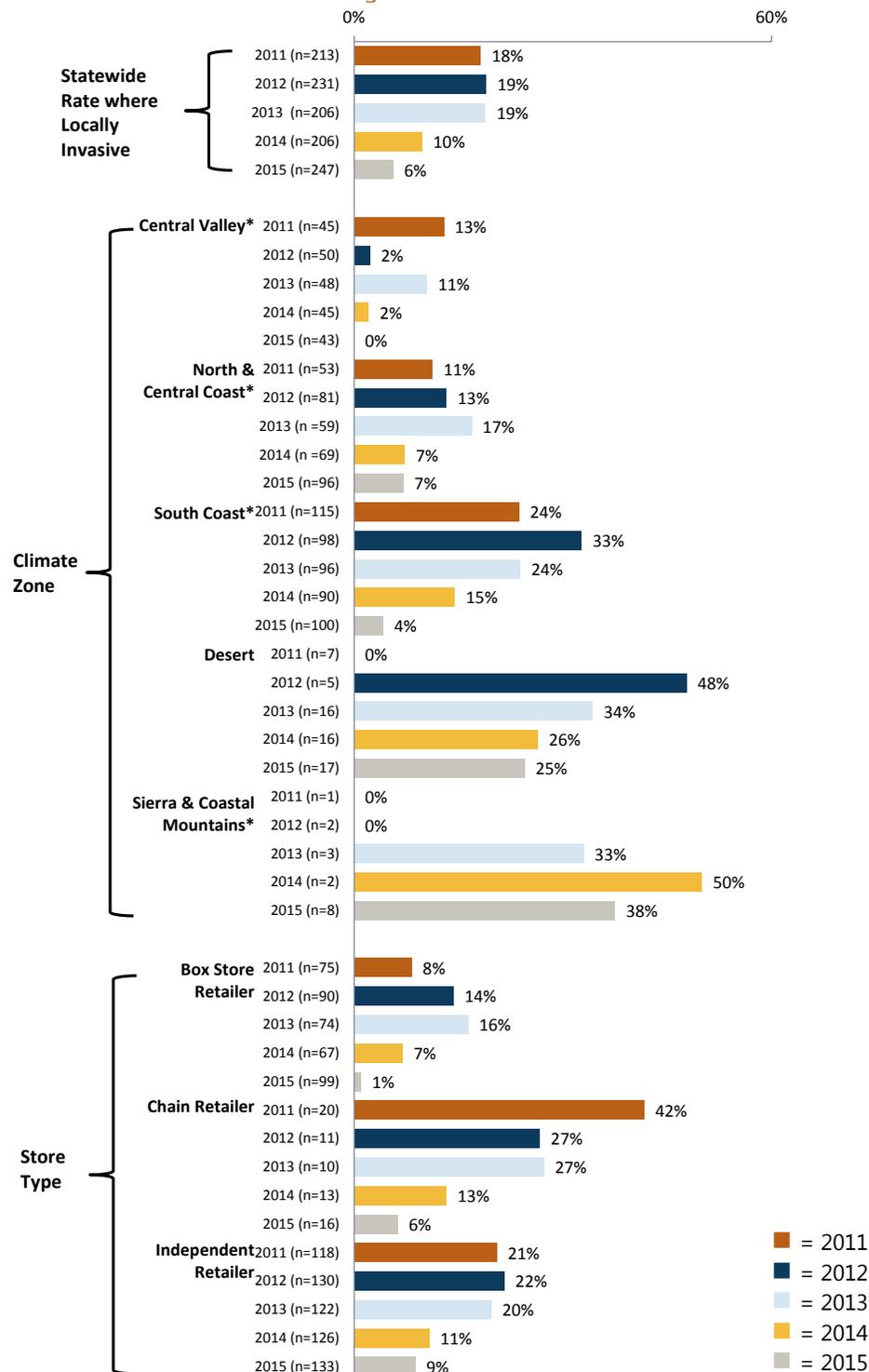
Exhibit 24. 2011-2015 Results: Percentage of Stores at Which Pampas Grass was Found



Periwinkle – By Climate Zone and by Store Type

Periwinkle (Cohort 1) is the second most frequently found invasive species for sale after Mexican feathergrass. It is locally invasive in all climate zones except for the Desert. Stores in 2015 were less likely to have periwinkle for sale than stores in any other year, except for 2014. It was found in twelve Independent Retailers, one Chain Retailer, and One Box store in its locally invasive regions. As in previous years, it was found at a higher rate in the Sierra & Coastal Mountains than in the other climate regions.

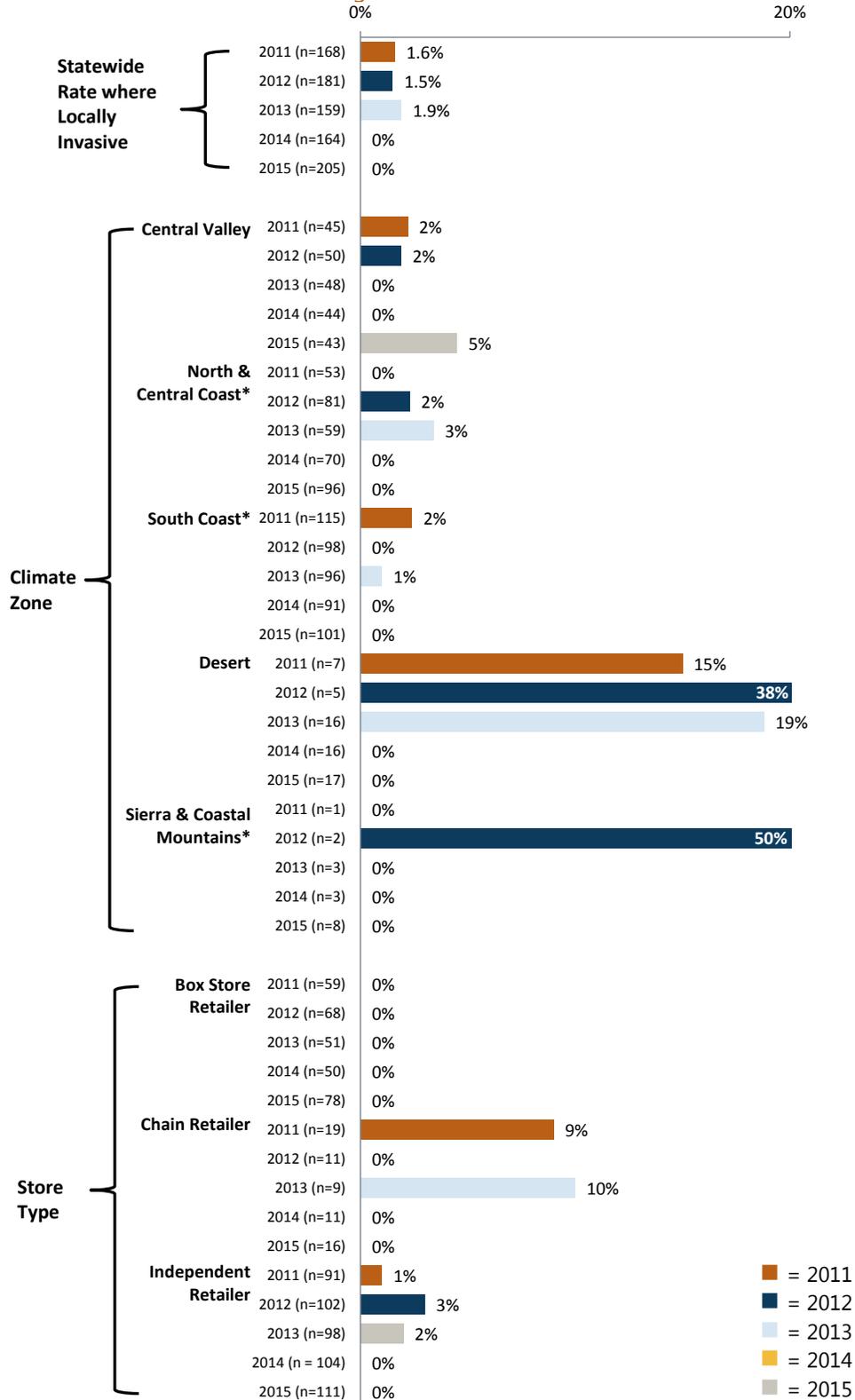
Exhibit 25. 2011-2015 Results: Percentage of Stores at Which Periwinkle was Found



Scotch Broom – By Climate Zone and by Store Type

Scotch Broom (Cohort 1) is locally invasive in three climate zones: North & Central Coast, South Coast, and the Sierra & Coastal Mountains. In 2015, it was found in zero stores in these regions.

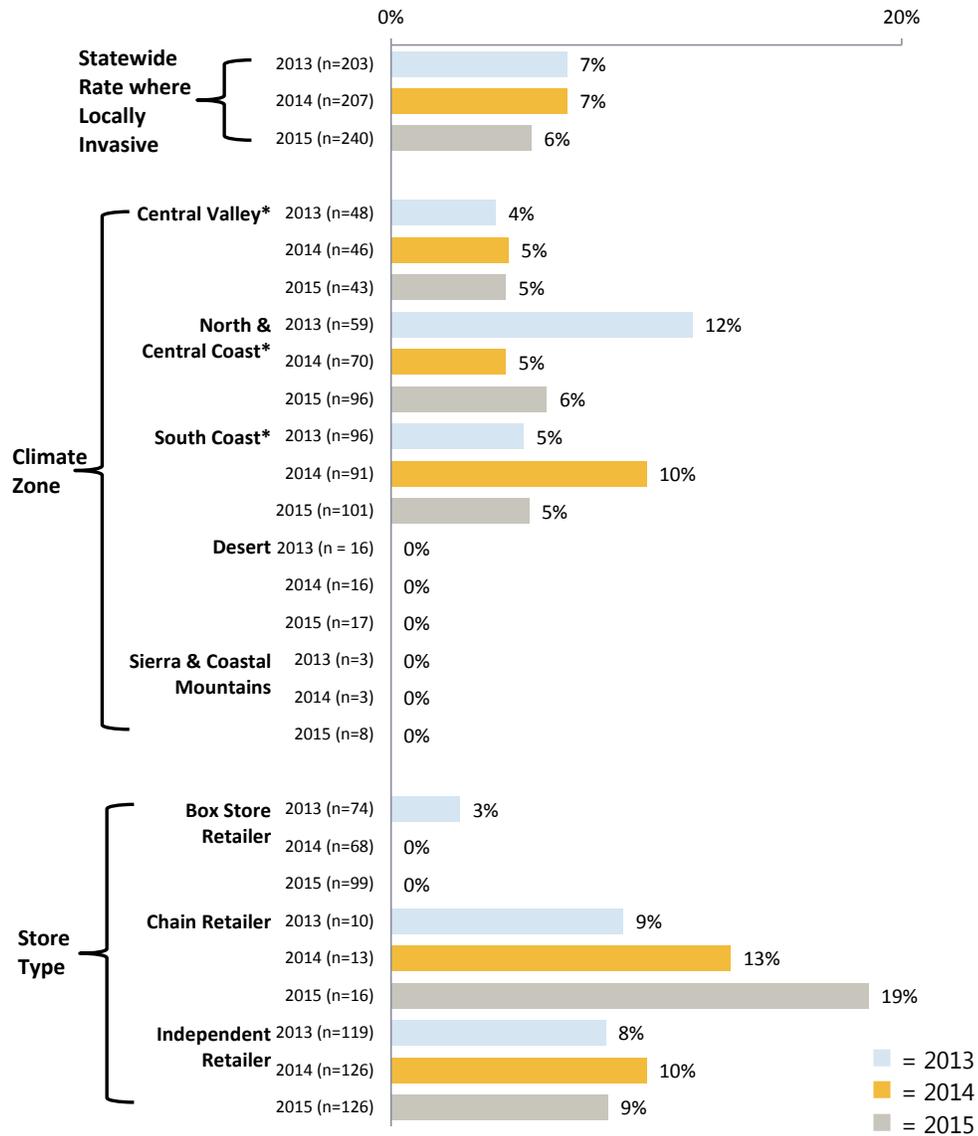
Exhibit 26. 2011-2015 Results: Percentage of Stores at Which Scotch Broom was Found



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 2015, it was found at a similar prevalence in each of those climate zones and most frequently in Chain Retailers, where it was for sale at three of 16 stores.

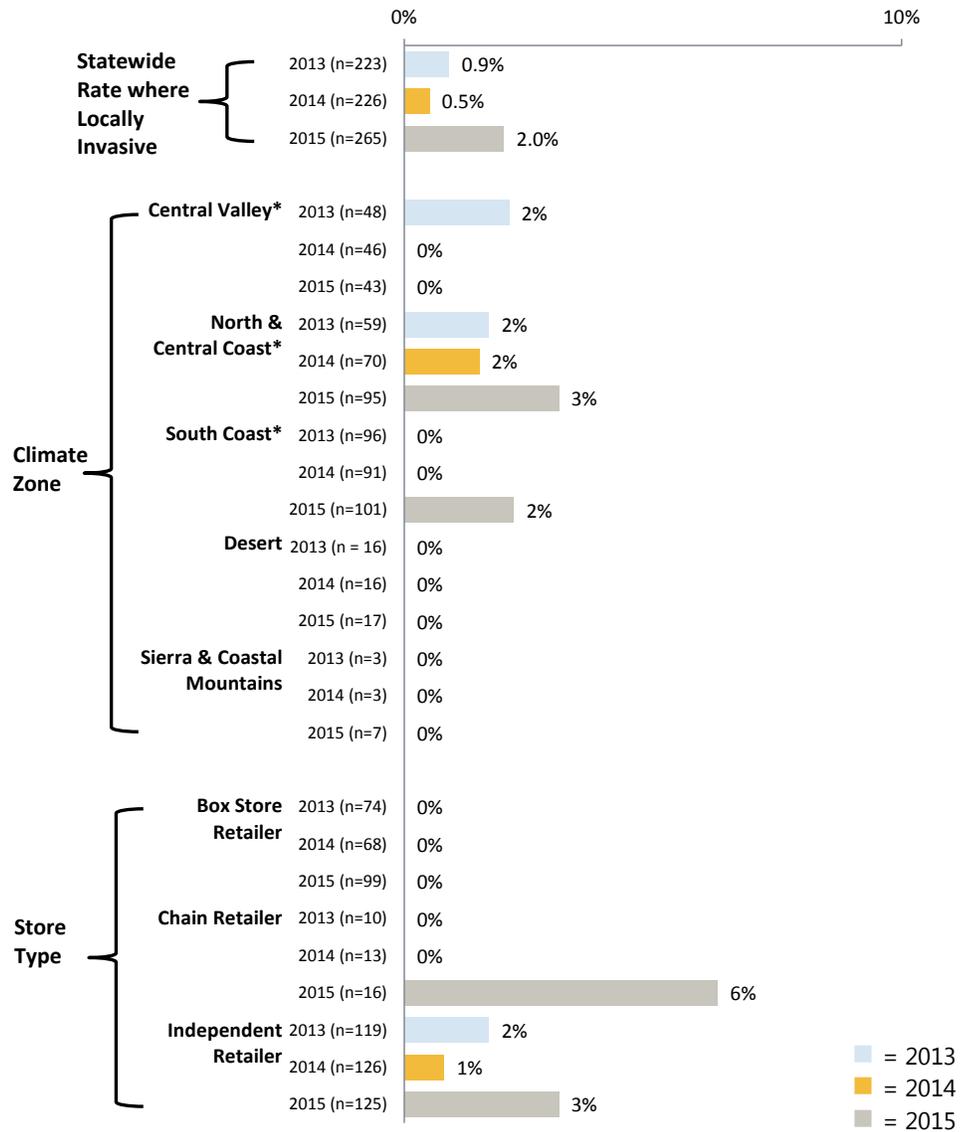
Exhibit 27. 2013-2015 Results: Percentage of Stores at Which Water Hyacinth was Found



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 2015, it was found in four Independent Retailers and one Chain Retailer in the regions it is locally invasive.

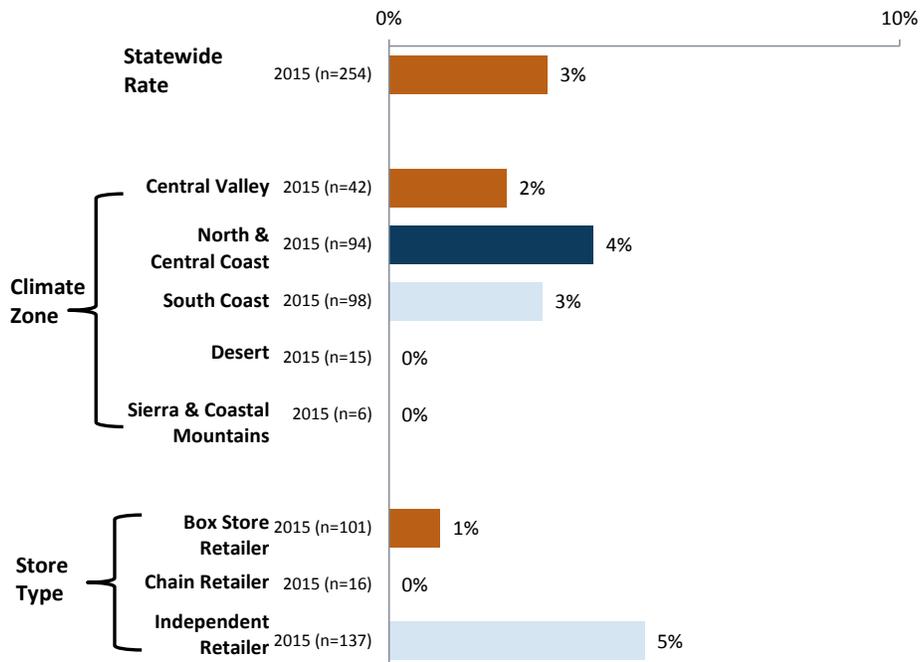
Exhibit 28. 2013-2015 Results: Percentage of Stores at Which Yellow Water Iris was Found



Candidate Plant: African Daisy – By Climate Zone and by Store Type

African daisy was found in 3% of all surveyed nurseries, most frequently at Independent Retailers. It was found in three climate zones. Recent Plant Risk Evaluation (PRE) research shows that African daisy poses a low risk of becoming invasive.

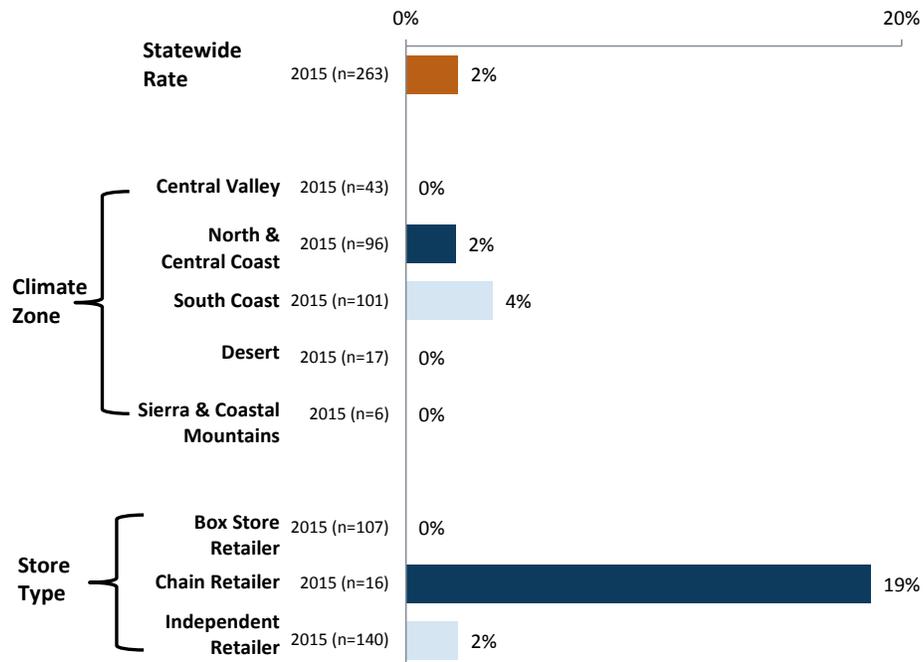
Exhibit 29. 2015 Results: Percentage of Stores at Which African Daisy was Found



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

Brazilian pepper tree was found in 2% of nurseries surveyed in 2015 and only in the North & Central Coast and South Coast climate zones. Three plants were found at both Chain Retailers and Independent Retailers.

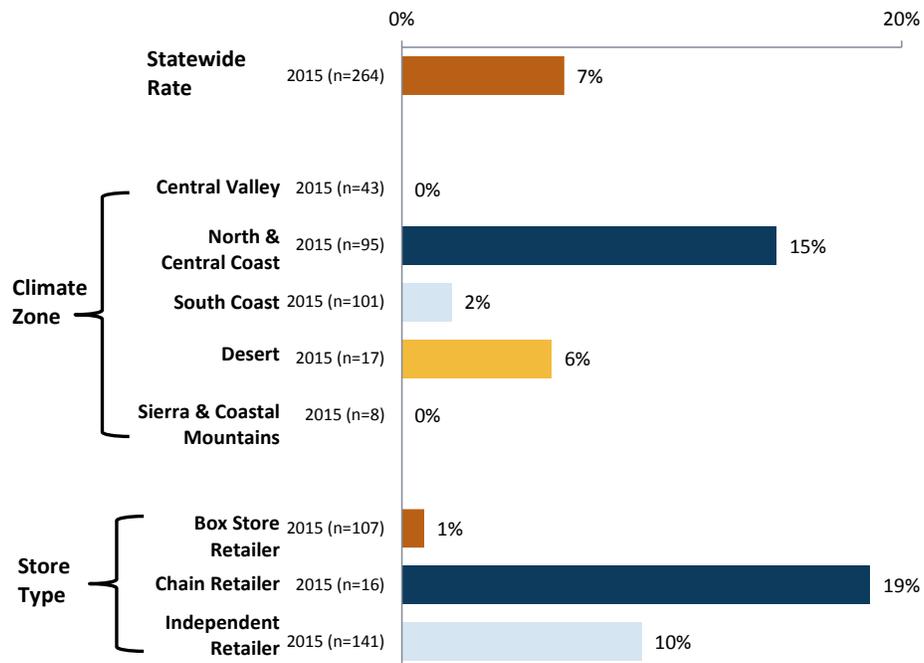
Exhibit 30. 2015 Results: Percentage of Stores at Which Brazilian Pepper Tree was Found



Candidate Plant: Grassland Sedge – By Climate Zone and by Store Type

Grassland sedge was found in 7% of surveyed nurseries and most prevalent in nurseries in the North & Central Coast. The difference between its prevalence at Independent Retailers and Box Store Retailers was found to be statistically significant. Recent Plant Risk Evaluation (PRE) research shows that grassland sedge poses a low risk of becoming invasive.

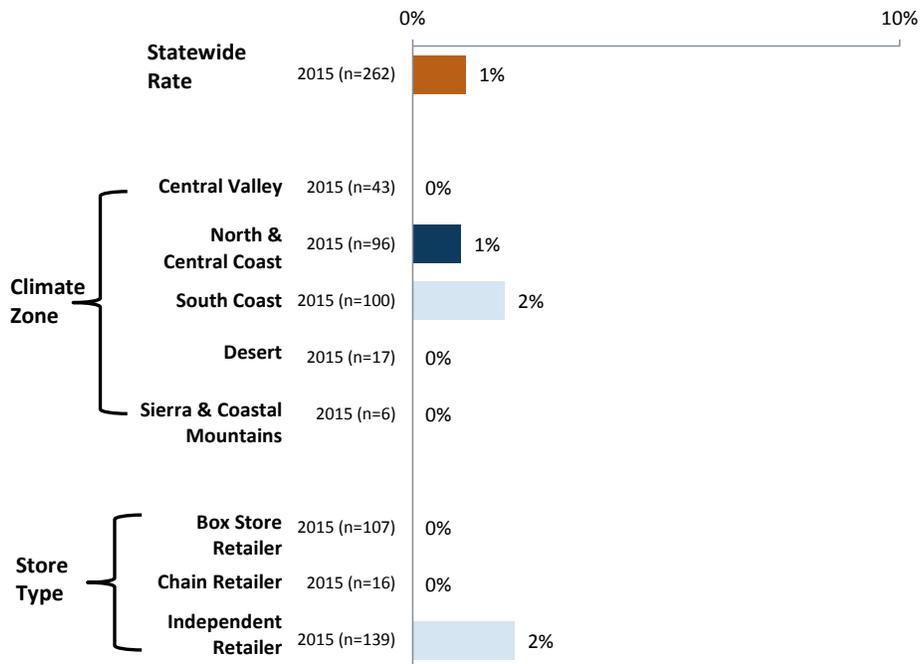
Exhibit 31. 2015 Results: Percentage of Stores at Which Grassland Sedge was Found



Candidate Plant: Glossy Privet – By Climate Zone and by Store Type

Glossy Privet was found in just 1% of surveyed nurseries and only at Independent Retailers in the North & Central Coast and South Coast climate zones.

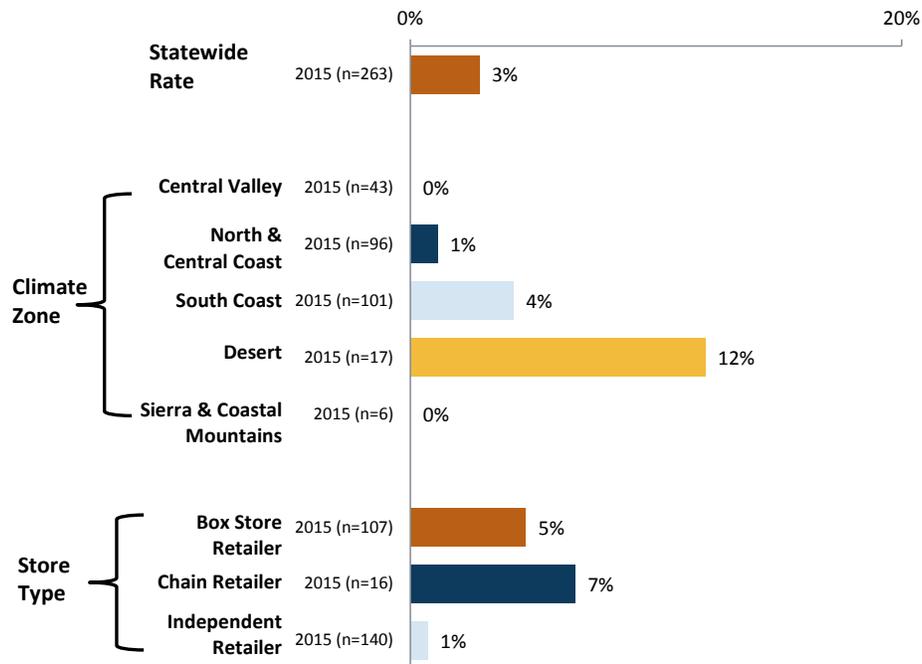
Exhibit 32. 2015 Results: Percentage of Stores at Which Glossy Privet was Found



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

Shamel Ash was found at 3% of all surveyed nurseries. It was most common in the Desert climate zone, followed by the South Coast and Desert. It was found at five Box Stores, one Chain Retailers, and One Independent Retailer.

Exhibit 33. 2015 Results: Percentage of Stores at Which Shamel Ash was Found



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 34 summarizes which species are invasive in which climate zones – where they are locally invasive.

Exhibit 34. Climate Zones in Which Plant Species are Locally Invasive

	Central Valley	Desert	North & Central Coast	Sierra & Coastal Mountains	South Coast
Chinese tallow tree	✓				
French broom	✓		✓	✓	✓
Green fountain grass		✓	✓	✓	✓
Highway iceplant			✓		✓
Mexican feathergrass	✓	✓	✓	✓	✓
Pampas grass		✓	✓		✓
Periwinkle	✓		✓	✓	✓
Scotch broom	✓		✓	✓	✓
Water hyacinth	✓		✓		✓
Yellow water iris	✓		✓		✓

Appendix D: Cohort Overlap

As explained on page 4, LFA placed the 18 species of plants on the 2015 survey into four categories:

- **Cohort 1:** This cohort includes seven plants that have continuously been on PlantRight’s list since 2011 – Chinese tallow tree, French broom, green fountain grass, highway iceplant, pampas grass, periwinkle, and Scotch broom.
- **Cohort 2:** This cohort includes three plants that have been on PlantRight’s list since 2013 – Mexican feathergrass, water hyacinth, and yellow water iris.
- **Candidate plants:** This group includes five plants that are under review for PlantRight’s list – African daisy, Brazilian pepper tree, glossy privet, grassland sedge, and shamel ash.
- **Retired plants:** This category includes plants that were once on PlantRight’s list and have since been removed, as they have largely been phased out of California’s garden center supply chain. Starting in 2015, PlantRight plans to survey three “retired” plants, in order to monitor them and make sure they stay out of the industry. This year, the three plants surveyed were Myoporum, Portuguese broom, and scarlet wisteria.

A single store could sell plants from any combination of the three cohorts. Exhibit 35, below, shows the overlap between Cohort 1 and Cohort 2. Exhibit 36 shows the overlap between Cohort 1, Cohort 2, and Candidate Plants.

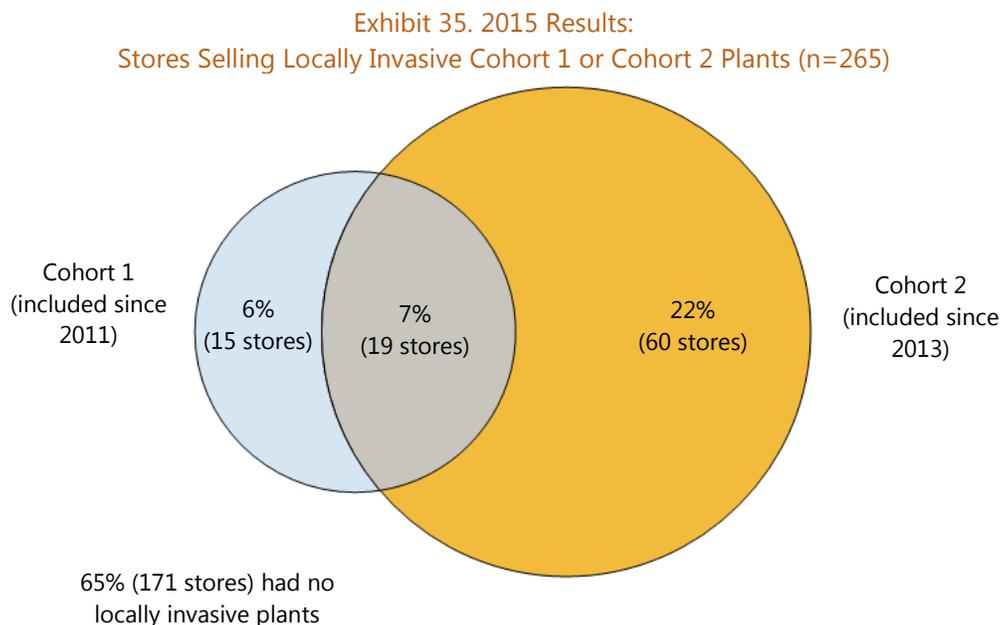
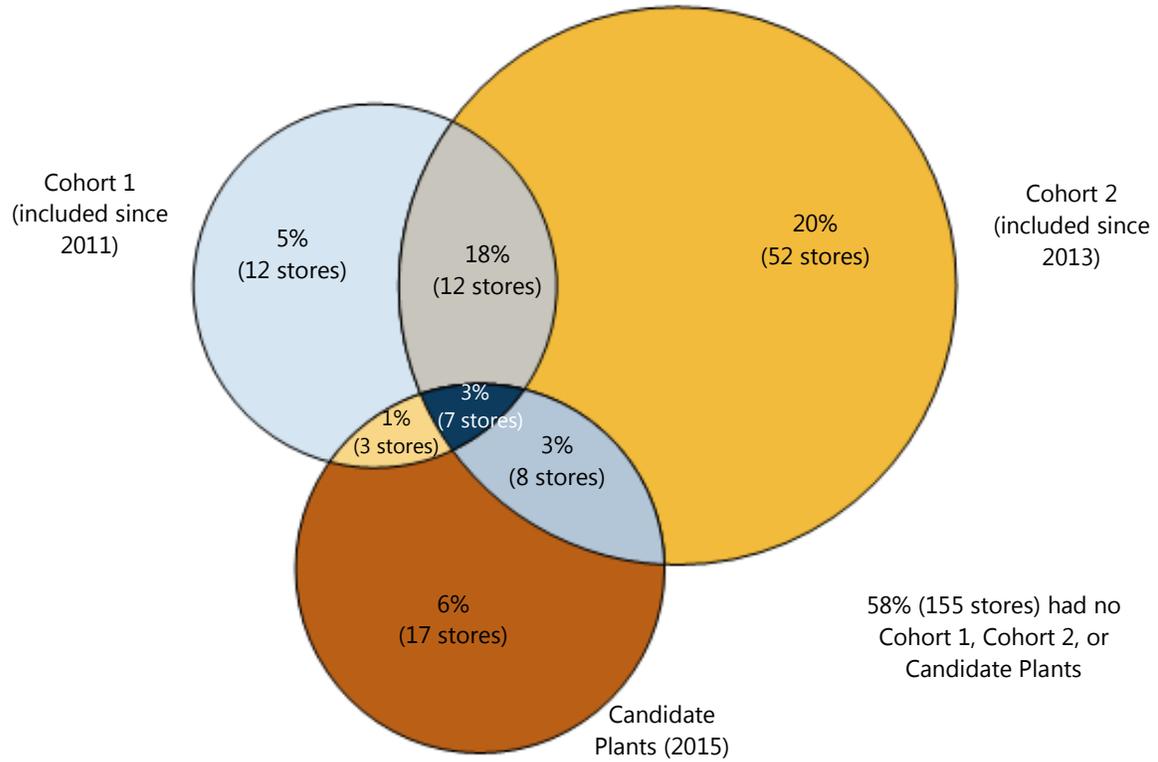


Exhibit 36. 2015 Results:
Stores Selling Cohort 1, Cohort 2, or Candidate Plants (n=266¹⁶)



¹⁶ The n's for Exhibit 35 and 36 differ due to weighting the data and rounding

Appendix E: Summary of Statistically Significant Results

For the first three questions below, LFA conducted analyses within the 2015 data and across two years of data (2014 and 2015). For question four, LFA conducted analyses on all available data. The results are summarized below, with statistically significant findings in **bold**.

- 1) How has the overall rate of locally invasives for Cohort 1 plants (included in the survey since 2011) and Cohort 2 plants (included in the survey since 2013) changed?
 - Cohort 1: No significant difference between 2014 and 2015.
 - Cohort 2: Cohort 2 plants were found in 2015 at a lower rate than 2014 (30% vs. 40%).
 - All locally invasive plants (Cohort 1 and 2 combined): Locally invasive plants were found in 2015 at a lower rate than 2014 (35% vs. 44%).

- 2) What percentage of stores carries one or more species of locally invasive plants?
 - 2015 data:
 - **The percentage of independent stores carrying one or more species of locally invasive plants is higher than that of box stores (48% vs. 16%).**
 - No significant difference between climate regions.
 - Cross-year analysis:
 - **The percentage of stores in the South Coast region carrying one or more species of locally invasive plants is lower in 2015 compared to 2014 (31% vs. 46%).**
 - **The percentage of box stores carrying one or more species of locally invasive plant is lower in 2015 compared to 2014 (16% vs. 43%).**

- 3) What's the average number of locally invasive plants carried by all stores?
 - 2015 data:
 - **The average number of locally invasive species sold in independent stores is higher than the average sold in box stores (.67 vs. .16).**
 - No significant difference between climate regions.
 - Cross-year analysis:
 - **Stores in the South Coast region had a lower average number of locally invasive plants in 2015 compared to 2014 (.41 vs. .84).**
 - **Box stores had a lower average number of locally invasive species for sale in 2015 compared to 2014 (.16 vs. .46)**

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

Cohort 1 (Surveyed since 2011):

- Chinese tallow:
 - 2015 data: No significant differences between climate regions or store types.
 - Cross-year analysis: No significant differences across the five years.
- French broom:
 - 2015 data: No significant differences between climate regions or store types.
 - Cross-year analysis: No significant differences across the five years.
- Green fountain grass:

- 2015 data:
 - Independent stores were more likely to have green fountain grass for sale than box stores (7% vs. 0%).
 - North & Central Coast stores were more likely to have green fountain grass for sale than stores in the Sierra & Coastal Mountains (8% vs. 0%).
- Cross-year analysis: No significant differences across the five years.
- Highway ice plant:
 - 2015 data: No significant differences between climate regions or store types.
 - Cross-year analysis: No significant differences across the five years.
- Pampas grass:
 - 2015 data: Independent stores were more likely go have pampas grass for sale than large stores and box stores (8% vs. 0% and 0%, respectively).
 - Cross-year analysis: No significant differences across the five years.
- Periwinkle:
 - 2015 data: Small stores were more likely to have periwinkle for sale than box stores (8% vs. 1%).
 - Cross-year analysis: Stores in 2015 were less likely to have periwinkle for sale than stores in any other year, except for 2014 (5% vs. 17% in 2013, 18% in 2012 and 17% in 2011).
- Scotch broom:
 - 2015 data: Not found in any surveyed stores in 2015.
 - Cross-year analysis: No significant differences across the five years.

Cohort 2 (Surveyed since 2013):

- Mexican feathergrass:
 - 2015 data: Independent stores were more likely to have Mexican feathergrass for sale than box stores (33% vs. 15%).
 - Cross-year analysis: Stores in 2015 were less likely to have Mexican feathergrass for sale than stores in 2014 (25% vs. 39%).
- Water hyacinth:
 - 2015 data: Independent stores were more likely to have water hyacinth for sale than box stores (8% vs. 0%).
 - Cross-year analysis: No significant differences across the three years.
- Yellow water iris:
 - 2015 data: No significant differences between climate regions or store types.
 - Cross-year analysis: No significant differences across the three years.

Candidate Plants (Only surveyed in 2015):

- African daisy:
 - 2015 data: Independent stores were more likely to have African daisy for sale than large stores (5% vs. 0%).
- Brazilian pepper tree:
 - 2015 data: No significant differences between regions or store types.
- Grassland sedge:
 - 2015 data:
 - Independent stores were more likely to have grassland sedge for sale than box stores (10% vs. 1%).
 - North & Central Coast stores were more likely to have grassland sedge for sale than stores in the Central Valley, South Coast, and Sierra & Coastal Mountains (15% vs. 0%, 2%, and 0%, respectively).
- Glossy privet:
 - 2015 data: No significant differences between regions or store types.

- Shamel ash:
 - 2015 data: No significant differences between regions or store types.

Retired Plants:

- Portuguese broom (surveyed 2011-12 and 2015):
 - 2015 data: None found in surveyed stores.
- Myoporum (surveyed 2011-13 and 2015):
 - 2015 data: None found in surveyed stores.
- Scarlet wisteria (surveyed 2011-12 and 2015):
 - 2015 data: None found in surveyed stores.