

AN ABSTRACT OF THE THESIS OF

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Abstract approved:

Paul Ries

This thesis focuses on the creation of a new collaborative website to connect key forestry topics to tourists and forest recreationists. It is divided into two main sections; the first explains the purpose and methods for creation of a new web-based educational tool called *Explore Oregon Forests*. Created through a partnership between Oregon State University and the Oregon Department of Forestry, the *Explore Oregon Forests* project features a website which allows people to virtually explore forests and forestry issues. For this thesis, a tour was created involving trail of Forest Park in Portland while providing educational messaging about invasive forest plants.

The second section focuses on a survey of state forestry agencies to learn how they are using outreach and education as part of their management of invasive plants and what outreach and education methods they find effective.

The findings indicate that there are common methods and existing conditions that contribute to the effectiveness of outreach and education regarding invasive plants in each state. They also show how web based educational projects like the *Explore Oregon Forests* website connect to many of the state forestry agencies' strategies for managing invasive plants.

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Explore Oregon Forests: A Web-Based Educational Tool for Connecting Forestry and Tourism.

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Daniel A. Gleason, Author

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Explore Oregon Forests: A Web-Based Educational Tool for Connecting Forestry and Tourism

Introduction

The desire and ability to communicate and provide up-to-date information about natural resources is important to government agencies and scientific institutions (Atkin and Rice 2013). Developing methods to communicate with and educate the general public is a part of many plans that strive to conserve and protect local, state, and federal natural resources (Schroeder et al. 2011). These efforts to communicate knowledge about natural resources and conservation take the form of different kinds of media, messages, and programs. They include informational pamphlets, interpretive kiosks at recreation areas, guided park ranger tours, informational webpages, and national campaigns with iconic characters like Smokey Bear. Using communication techniques to reach diverse forest stakeholders is part of many state forestry agencies outreach and education programs (National Association of State Foresters 2010).

Since 2010, the National Association of State Foresters (NASF), United States Forest Service, and state forestry agencies have developed forestry plans called “Forest Action Plans” for each state that list and address forest management strategies (NASF 2015). Oregon’s Forest Action Plan addresses the threats, benefits, and opportunities that exist in Oregon’s forests. The plan’s objective is to develop strategies to help protect, enhance, and conserve natural resources that are connected to forests. One of these strategies is developing new communication methods to expose the public who use Oregon forests to information regarding specific forestry topics.

This leads to the purpose of this thesis, which has two parts. The first part (chapter 1.) focuses on the development of a collaborative project between Oregon State University and the Oregon Department of Forestry (ODF) which consists of a website called *Explore Oregon*

Forests (EOF). Specifically, this thesis focuses on the creation of a section of the website which includes an interactive tour of a forest trail while providing educational information about invasive plants.

The second part of the thesis (chapter 2.) includes an exploratory study to investigate how state forestry agencies use outreach and education as a strategy to manage invasive plants in their non-federal forests.

Chapter 3 examines the EOF invasive plants tour and the findings about from the state forestry agency surveys. It highlights how different aspects of the state forestry agencies outreach and education strategies have similarities to the goals and intended outcomes of the EOF invasive plants tour. This shows some of the ways a project like *Explore Oregon Forests* could be beneficial as an outreach and education tool to other state forestry agencies other than the Oregon Department of Forestry.

Overview of Forest Action Plans

Both the *Explore Oregon Forests* website in chapter 1 and the exploratory study in chapter 2 connect to state forestry documents known as Forest Action Plans. The creation of the *Explore Oregon Forests* project stems from the national initiative to create a larger strategic plan for the nation's forests by creating statewide forest resource assessments and strategies, known as Forest Action Plans. The collection of the Forest Action Plans stemmed from the Food, Conservation and Energy Act of 2008, commonly known as the 2008 Farm Bill (United States Department of Agriculture 2008). Through the Farm Bill, the United States Congress directed each state to assess their current forests, and create strategies to address threats and improve forest health (NASF 2015).

In the creation of the Forest Action Plans, states used previous forest inventories and assessments, and gathered new information to assess current and possible threats to their public and private forests. Many state forestry agencies developed collaborative strategies involving different forest stakeholders to achieve specific goals, including strategies to effectively manage forest threats. The Forest Action Plans also identify and direct resources into existing and future programs that may help the states reach their own and national conservation goals (NASF 2105).

The State of Oregon has over 30 million acres of forested land, 40% of which is in non-federal forests (ODF 2009). Oregon's Forest Action Plan reflects the importance of its forest resources with the plans overarching goals to "conserve, protect and enhance" the state's forests.

Within Oregon's Forest Action Plan, there are many strategies that highlight state forestry programs, collaborations, and policies to help with improving forest health. Threats to the forests are highlighted in detail in the report's forests assessment. The statewide forest assessments organize the threats into how they affect the forests in three categories. These include forests facing wildfire risk, and particularly in close proximity to Oregon communities, forests vulnerable to conversion out of forest use, and forests with important fish and wildlife habitats (ODF 2010).

Oregon's Forest Action Plan includes a variety of strategies to help work towards protecting the state's forests from the identified threats, and work towards statewide forest protection. A consistent strategy for many of the forests' threats is developing better public outreach and education programs to increase public awareness of the threats. *Public outreach and education* is a common term that appears in many state forestry documents (ODF 2010; NASF 2010; Schroeder, et al 2011) and is used to describe strategies to communicate topic specific information to diverse audiences.

The purpose of the EOF project is to create an interactive on-line website that exposes tourists and forest recreationalists to specific forestry topics connected to Oregon's Forest Action Plan. In connection to the EOF project, an exploratory study was completed that investigated whether communication methods like the *Explore Oregon Forests* website are included as strategies of other states' Forest Action Plans, and if these types of methods are used by state forestry agencies.

Oregon's Forest Action Plan focuses on forestry topics designated as threats to the state's forests (ODF 2010). Such threats include wildfires, forest fragmentation, loss of biodiversity, and forest health concerns including invasive species. The Forest Action Plan has strategies for addressing each threat, all of which include increasing public awareness and literacy for each topic (ODF 2010).

Chapter 1.

Explore Oregon Forests Project

The Oregon Department of Forestry uses outreach and education strategies to create new innovative ways to connect to a range of public audiences. The *Explore Oregon Forests* (EOF) project is in the process of creating a new method of conveying forestry topics relevant to Oregon's Forest Action Plan to tourists and forest recreationalists in Oregon. A website (www.exploreoregonforests.org) has been created that can be accessed through mobile devices to provide educational information on specific forest threats tied to tour locations in the state. The goal of the EOF project is to allow users to virtually explore tours on forestry topics that connect to actual forests in Oregon that users can choose to visit to experience the topics in person.

The Explore Oregon Forests project involves researching forest threats identified through Oregon's Forest Action Plan, and constructing a mobile friendly webpage that can be used to connect to diverse groups of people interested in Oregon forests.

The EOF project involves the creation of separate website sections, called "tours", which will focus on four separate forestry topics: invasive plants, working forests, wildfire, and heritage trees. Each tour directly connects to outreach and education goals from Oregon's Forest Action Plan, and uses different mechanisms to communicate its information.

This chapter focuses primarily on the development and completion of one of the *Explore Oregon Forests* tours, the invasive plant tour at Forest Park in Portland, Oregon. It shows the process involved in developing the formatting and design of the tour and the *Explore Oregon Forests* website. It provides a detailed description of the completed invasive species tour, and

discusses the possible connections the *Explore Oregon Forests* project has to other forestry outreach and education methods.

Literature Review

A review of literature was necessary in the development of the *Explore Oregon Forests* website and specifically the invasive species virtual tour. Environmental interpretation was researched to better understand who interpretative techniques could be used to communicate information on invasive plants and other forestry topics to tourists and forest recreationalists. The review also looked at how different types of web-based and mobile technology have been used to convey educational messaging regarding natural resource conservation.

A goal of the EOF project is to communicate technical forestry information in a way that is a clear to tourists and forest recreationalists. A communication method that provides a good model for the EOF website is environmental interpretation. Many natural interpretation programs have similar goals as the EOF project and focus on communicating information about nature to make it meaningful and personal to specific audiences (Ham 1992; Stemper 2014).

Environmental interpretation has also been used in many different natural contexts to create environmental education programs (Ham 1992; Orams 1996; Benon 2009). Interpretive techniques are commonly used in developing guided tours and displays in natural areas, and help people connect on an emotional level to the place they are visiting (Ham 1992; Stewart et al. 1998).

Interpretive methods benefit the EOF project by using different communication techniques to present conservation information to different audiences. Interpretive programs often go beyond just reporting facts to engage, connect, and educate audiences in a more

personal way (Ham 1992). A successful interpretive program makes the audience want to learn and connect to the topic of the program.

Interpretation has been looked at as an important tool for communicating information about the conservation of natural areas, especially natural areas used for recreation (Orams 1996; Weaver 2006). The creation of interpretive programs has been seen as an effective way of regulating the use of natural areas for conservation as well as an important part of sustainable ecotourism (Kim et al. 2011; Weaver 2006).

Environmental interpretive programs can be designed to engage visitors and encourage learning about natural areas, including sustainable ways to interact with natural features and wildlife. These interpretive programs are also important for the management of natural areas. Visitors and tourists engage in less harmful behavior when they better understand natural areas (Kim et al. 2011). This method of protecting natural areas is preferred over restricting access to many natural areas or enforcing rules with punishments and citations (Orams 1996; Weaver 2006).

A goal of many environmental education programs is to change the behavior of program participants that reflects the programs messaging. For education programs that use interpretation to be successful in changing behaviors, the programs need to be well organized and structured (Orams 1996, 1997). Successful interpretive programs have a number of characteristics that help them stay organized and connect to audiences. These include having a theme, creating curiosity to learn more, having clear messages, being pleasurable, and being relevant (Ham 1992).

Creating engaging was to communicate interpretive messages is important because most interpretive programs are directed towards non-captive audiences who only have an intrinsic reward to pay attention (Ham and Krumpe 1996). In order to hold audiences attention and

change behaviors interpretive programs can also use educational learning strategies that help identify what motivates people to learn (Orams 1997).

An example of educational “tools” that Orams (1996) identified as important to individuals in the learning process include curiosity which makes people want to learn more, affective domain, which makes people feel that are in a relatable and enjoyable setting and motivation to act which provides clear instructions on actions people can take in the future that reflect program messaging. These tools become fine-tuned into an educational or interpretive program through participants’ feedback and evaluation.

There are many different forms of media used by interpretive programs to convey their messages to their audiences. These include guided tours, interpretive talks, posters, brochures, video media websites, and many more (Ham 1992, Stemper 2014). Computers and Internet technology have also become tools commonly used for education and interpretive learning (Kamarainen et al. 2008). Through the use of computers and hand-held mobile technology, educational and interpretive location-based information can be presented to audiences at home, on the go and in a digital format on interpretive sites. These include virtual tours that have been used to teach about a wide range of topics including forestry and natural conservation (Wiske et al. 2001, Kamareinen et al. 2008). Web-based virtual tours have been shown to communicate a variety of forestry topics as effectively as guided field trips (Easley 2002). These tours can also help enhance a user’s experience before or following a visit to the actual location featured in the virtual tour (Spicer 2001).

Along with web-based virtual tours, there have been developments in incorporating technological devices, including cell phones and PDAs, as methods for interpretive and educational learning (Naismith et al. 2004; Price & Rogers, 2004; Rutcher et al. 2010). Where

computers alone can restrict an audience to one location and can make it difficult for people to connect to the actual locations they are viewing on their screen (Price and Rogers 2004), mobile devices can aid interpretive tours because they can be designed to be very location and contextual-based (Price and Rogers, 2004; Naismith et al. 2004; Rutter et al. 2010). This allows participants the freedom to explore through self-discovery in a natural setting. Using a mobile device in this capacity can help make the information learned through interpretive programs feel very personal (Ham and Krumpe 1996).

As part of an interpretive program, virtual tours can be created to provide “real life” context to educational information provided (Naismith et al. 2004). The exploration concept connected to mobile technology can allow users to choose areas within a natural landscape that interest them, then provide information on the natural elements using text, audio and video media. Some tours allow users to connect to built-in maps and GPS settings to guide people through a tour while keeping with an interpretive theme (Rutter et al. 2010).

Using mobile technologies as interpretive media does present some challenges and areas for further research. Technical issues and the learning curve for using some mobile devices can greatly limit their effectiveness (Price and Rogers, 2004; Rutter et al. 2010). The novelty of using mobile technology and computer-based virtual tours should not exclude the elements of a traditional interpretive program. If the basic principles that are needed for an effective interpretive program are not used, it is very likely that an audience will not effectively receive the intended information and not connect to the topic. Using mobile technology for interpretive programs is still very new, and further evaluation of new mobile-based interpretive programs is important to understanding their strengths and weaknesses as an interpretive tool (Price and Rogers, 2004; Rutter et al. 2010).

A limited number of studies focus on using mobile technologies in interpretive programs. Many of the studies are exploratory because of how rapidly mobile technology changes (Easley 2002). Using different evaluation methods to try to understand the effectiveness of interpretive and educational programs can help build validity. A combination of different tools such as surveys, observations, questionnaires, and interviews can be helpful in assessing any knowledge gained and long-term behavior changes in program audiences (Orams 1997).

The design and effectiveness of a website is also a factor in how it can be used to convey educational information. Empirical evidence of what makes a website effective is lacking (Murray et al. 2000, Skadberg 2004). There are factors that are commonly associated with positive website user satisfaction that help websites convey educational messages (Skadberg et al 2004): 1) *attractiveness of the website*, which can be described as its richness and quality to users, 2) *ease of use*, which has to do with website navigation and familiarity (Beck and Cable 1998), and 3) *the previous knowledge of individual users* (Skadberg et al. 2004). When user satisfaction is higher, the time spent on the site can increase, and users can get more intrinsic benefits from the website material (Marcionini 1995, Murray et al. 2000, Skadberg et al 2004).

Methods

The *Explore Oregon Forests* project is a collaboration between the Oregon Department Forestry and Oregon State University designed to create greater public awareness about topics affecting Oregon forests, with a focus on topics identified in Oregon's Forest Action Plan. The EOF project development was conducted by a design team consisting of members of Oregon State University's College of Forestry and Department of Professional and Continuing Education (PACE).

The team members from the College of Forestry consisted of a department faculty member who provided project guidance and a masters student (myself) who researched the topics, connected with content experts, helped design content messaging and assisted in content production. I also worked intimately with all team members in the planning and development of the EOF website and tour designs.

The PACE team consisted of a project manager who oversaw the development of the tours and EOF website; a videographer who filmed and edited forestry content, a website developer who created animations and built website components and a number of designers and programmers who incorporated content into the EOF website.

Four forestry topics were selected for the EOF website by examining strategies that included outreach and education from Oregon's Forest Action Plan and discussing them with experts from Oregon Department of Forestry. These four topics selected for the EOF website were: *Working Forests*, *Invasive Species*, *Wildfire*, and *Benefits of Urban, and Community Forests*.

Each forestry topic was addressed in a "tour", or module of the EOF website designed to encapsulate some of the techniques of site or location based interpretive or guided tours. Each

tour was also tasked to highlight different geographic locations throughout Oregon. In light of the exploratory nature of the project, it was also decided that multiple innovative and compelling methods of conveying the information and connecting to audiences should be used throughout the different tours. To better understand the topics and to learn about similar existing programs in Oregon, I consulted with a number of specialist or content experts for each topic.

Pre-Test Trail: Working Forests

In order to test the development needs and technology required to create a location based virtual tour, I created a pre-test trail of a tour. The Oregon Forest Action Plan topic of *Working Forests* was selected to develop an initial trail to test the capabilities and limitations of the EOF project design. Working forests are designated as forested areas that produce timber for goods and services, but are also managed to protect and enhance forest ecosystem services (Oregon Forest Resource Institute 2008). The Working Forest pre-test focused on evaluating the strengths and weaknesses of mobile technology to communicate interpretive information to devices in a forest location.

I choose to use the Lewisburg Saddle area of the MacDonald Dunn Forest due its close proximity to the town of Corvallis. A 1.5-mile loop in the Lewisburg Saddle trail was chosen because it had some existing interpretive signs and a variety of trail features that matched with the working forest subject matter.

I gathered information on working forests by interviewing members of Oregon State University's Research Forests, reviewing a report by the Oregon Forest Resource Institute (Oregon Forest Research Institute 2008), and from the Oregon State University Starker Lecture Series on working forests (Oregon State University 2014). Using this material, and guidelines for developing and presenting interpretive programs and guided tours (Ham 1992), I created an

interpretive video script for nine stops along the trail loop. The stops had physical elements along the trail, such as bridges, preexisting signs, and large dead trees used as snags (Figure 1) that corresponded with a program trail map to indicate where people should activate the interpretive videos. I shot one to two minute videos at each location, complemented by additional narrations, text and graphics and then these edited videos were uploaded onto an Ipad Mini and Iphone 5.

The process of designing and implementing the tour revealed



Figure 1. Map of Working Forest trial tour

limitations that would affect the creation of the EOF project. These included creating contrast and clear distinction between tour-stop videos and the ability of users to locate tour-stop locations. An important discovery from the pretest design was the technical difficulty associated with displaying interpretive videos though mobile devices in forested locations. I discovered that interpretive information would most likely need to be preloaded into mobile devices before the user entered forest areas due to poor reception for content upload, and the size of files that could be used for tour content.

The completion of the initial tours at the Lewisburg Saddle led to a shift in the direction of the Explore Oregon Forest project. After evaluating technological, time and budgetary limitations, the design team decided the website and tours would be designed to focus on virtual

tours within a website. The website would still be developed to run smoothly on smartphone web browsers so mobile access was feasible.

Forest Park Invasive Species Tour

The *Invasive Species* topic from Oregon's Forest Action Plan was selected for building the first website tour. Invasive species was selected due to the availability of content experts on the subject. I conducted research to learn more about invasive species in Oregon's non-federal forests. During this process, there were a number of interviews with Wyatt Williams, Oregon's invasive specialist within the Oregon Department of Forestry (ODF). As a result of these discussions, the tour's topic focused in on invasive forest plants, which ODF identifies as a priority and negatively affect a number of park locations that are a major draw for tourists and local outdoor recreationalists. Focusing on invasive plants, from the broader area of invasive species, also allowed for a more a consistent interpretive theme.

Based on the recommendation of Wyatt Williams and ODF Urban forestry staff, Forest Park in Portland, Oregon was selected as the physical location for the invasive plant species tour. Forest Park is a heavily used urban park that consists of 52,000 acres of mostly wooded areas (Macalister et al. 2011). It is a large draw for tourists and forest recreationalists, and is also threatened by invasive plants. Managing the invasive plants within the park is an important part of the city's management plan, and is necessary for the sustainability of the park (Peterson-Morgan 2014).

Invasive plant species are a threat to many forests throughout Oregon (Oregon Forest Action Plan 2010). Forests near urban areas are susceptible to invasive plants because humans often contribute to the introduction and spread of invasive plant material. In Forest Park, the invasive plant, English ivy (*Hedera helix*), is dominant throughout many of the park's disturbed

I consulted a number of organizations to better understand the impact of invasive plants on Forest Park and learn the parks management goals. These included the Friends of Forest Park, the Forest Park Conservancy and the City of Portland Department of Parks and Recreation. In these meetings, invasive plant species, locations within the park, and invasive management techniques were discussed. During the initial planning stages and throughout the tour, the

the park, and helped provide direction and accuracy of the tour content. With her assistance, I established a trail loop consisting of the Holman Lane Trail and Wildwood Trail as a geographic location for the virtual tour (Figure 2).

The loop met many of the guidelines for creating interpretive trails including being a manageable walking length, providing numerous examples of subject matter, and allowing for a

narrative (Ham and Krumpe 1996). From the trail, it was possible to see the impact of invasive plants on a forest as well as the impact of invasive plant management on a forest. Working with the PACE team I created a content map that outlined the information desired in the tour. This identified the different virtual stops, their relevance to invasive plants and the types of media to be used.

Between the spring of 2014 and the fall of 2015, the project team and I took a series of trips to Forest Park to develop the content and collect video and photography for the virtual tour. Ms. Peterson-Morgan worked us and highlighted specific examples of how invasive plants affect Forest Park and how they are managed. Ms. Peterson-Morgan also agreed to appear on camera as a content expert. This connected the information to a reputable person with Portland Parks and Recreation that helped bring validity to the information as well as establish user trust (Shindler et al. 2007).

In her interview, Ms. Peterson-Morgan addressed overarching questions about invasive plants in Forest Park and their management. This allowed both video and audio of Ms. Peterson-Morgan to be overlaid with content filmed within the park. The scope of the project, outline of the basic content narrative, and location and set of trails within Forest Park were established to provide geographic connection for the project. Ms. Peterson-Morgan was asked questions about how invasive plants affect Forest Park and what Forest Parks invasive species management plan was. It was also discussed how Forest Park users and the general public can help reduce the spread of invasive plants. This video and audio information were incorporated into the virtual tour along with other footage and photos from Forest Park.

We also wanted to create a variety of types of media for the tour to create a sense of exploration for users. To do this we used a photography system to create “360 degree” images,

which are photos that capture 360 degree panoramic image. These are made using a special tripod setting that allows a digital SLR camera to take a series of photos that capture the surround area. Using photomerge software, the images are stitched together to create the full panoramic view. Within the EOF virtual tour, users can then scroll around the image to see 360 degree images of the Holman Trail.

The audio and video were edited by the PACE videographer and the content and links were programed into the EOF website. The design team went through two test trails and made notes on inaccuracies with the content and glitches within the website.

Website Design

The intention of the *Explore Oregon Forests* website is to create a unique environment that incorporates natural interpretation techniques to provide a place of on-line educational learning and exploration. The Forest Park module was also intended to be used to test how the website design displayed different types of media and tour content.

Working with the design team I worked to incorporate educational and engaging content about the invasive plants in Forest Park into the tour modules. We also worked to incorporate easy to access information on how users could actively get involved with the management of invasive plants. To do this we made it possible for users to link up to places they could volunteer for park conservation efforts, and information on how they could garden at home with native plants rather than use invasive plants.

We also tried to incorporated interpretive methods such as inspiring self-learning and discovery (Ham and Krumpe 1996). To do this, the forestry information within the modules was designed to stand alone as well as work within a narrative. This means users do not have to

follow a narrative within each module and have the freedom to choose what information to select and what content to access.

The *Explore Oregon Forests* website is also designed for the use of non-captive audiences. This follows similar methodology to non-guided interpretive nature tours where users choose to keep interacting with displays or not (Ham 1996). Each tour within the web site also designed to follow interpretive guidelines by creating content that is pleasurable, relevant to the individual, organized and themed (Ham 2006). Each tour's theme connects to the geographic location and forestry topic and provides simple overviews of more complex forestry topics. This is to allow users the ability to learn many different pieces of information in a quick and concise way. The intention is to have all users leave with some overarching messages about each topic and provide the ability for users to choose what aspects of the tour they want to learn more about.

The *Explore Oregon Forests* website is designed to use a variety of media and allow for different methods of learning to help drive user satisfaction. The overall goal of the project to create a website to connect to Oregon's Forest Action Plan. If the website is able to satisfy its users, they are more likely to spend more time on the website exploring other topics as well as recommending the site to others (Skadberg 2004). In doing these actions users are using the website to satisfy the outreach and educational goals established in Oregon's Forest Action Plan.

Results

The *Explore Oregon Forests* (EOF) project will cumulate in the creation of a unique forestry education website. The anticipated launch will be late December 2015 and will be located at the domain exploreoregonforests.org. When launched, the website will feature an interactive “tour” of Holman Lane located in Portland Oregon’s Forest Park. The tour is focused around the topic of invasive plants, and focuses on the ability of invasive plants to negatively affect forest health. The tour uses a number of different methods to present education about the topic and works to give the website user freedom to choose different tour elements.

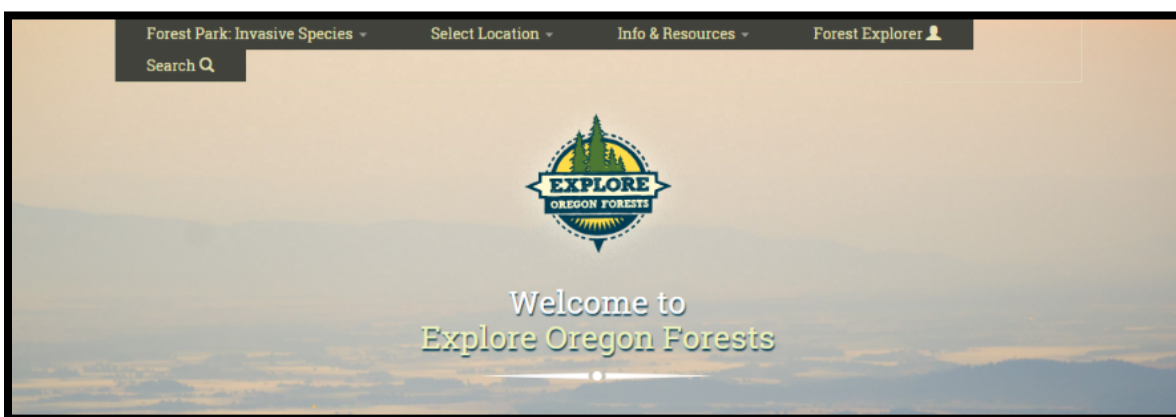


Figure 3. *Explore Oregon Forests*' homepage

The website’s homepage (**Error! Reference source not found.** presents an overview of the project and explains that Oregon’s forests are an important natural resource, but also face a number of threats. The homepage works as a launching point for the different audiences the project hopes to attract. These include website users hoping to learn about a specific place in Oregon to visit, such as Forest Park, Oregon State University, the Lewisburg Saddle or the other tour locations to be determined. Users who have come to the website are also expected to learn about a specific forest threat, such as invasive plants.

Due to the potential variety of users, the homepage has been designed to be simple and

Due to the potential variety of users, the homepage has been designed to be simple and easily allow people to locate the specific topic area they are interested in. Both locations and topics are clearly located in the website's top navigation bar, and a search feature will help provide people a way to find very specific types of information on the site. When a topic/location has been selected, the navigation bar will automatically provide an option for additional information and resources.

When the "Forest Park: Invasive species" "Park home" option is selected it brings users to the homepage for that tour. This provides a brief description of the topic of invasive plants in Forest Park and allows users to select "begin exploring". This takes users to an interactive map of Forest Park featuring the Holman Lane trail. Along the trail are icons that represent different forms of media. These include video, photographs with text and interactive "360 degree images" that allow users to view a section of the trail from 360 degrees. Although users can access any of the icons, the website encourages users to select the 360 degree icon on right side of the trail. This icon brings users into the 360-degree image with the banner "Welcome to Forest Park." Embedded within the 360 degree images are additional icons that provide further information for the users. Below the banner is a very noticeable icon, which opens a video link of Forest Park's ecologist, Kendra Peterson-Morgan. In the video she provides an overview of the benefits Forest Park provides, as well the threat it faces from invasive plants. Users can scroll around the image to find three other embedded links. These are a mix of still images with descriptive texts and links to additional webpages and videos. Each icon is designed to stand alone and provide different information on invasive plants, including the definition of what classifies a plant as "invasive," the native plants and animals negatively affected by invasive plants, and examples of the invasive plants people can see in the park.

degree image that comes from an area along the Holman Lane that has a large abundance of invasive plants present, and is used to highlight examples of features in an unhealthy forest. These include: presence of invasive plants, low light availability, lack of species diversity or “ivy desert”, and invasive vines on the trees.

The next series of tour-stops include icons that open single videos or images. These cover a number of invasive plant topics including profiles of specific plants, examples of how invasive plants out-compete native plants, animations that show how some invasive seeds are spread, and examples of how invasive plants are managed in Forest Park. There is also an animation and a video that are used to inform the user of the actions people can do to help with the threat of invasive plants. They show users how using native species rather than invasive species in their gardens and landscaping helps to reduce the amount of invasive plants escaping into forests, and how invasive seeds can be spread by pets. Lastly, a video shows how people can volunteer to help remove invasive plants in Forest Park.

Along with the map, the EOF website provides additional information on invasive plants within the “Info and Resources” section. This section provides topic-specific links to credible websites where users can choose to learn more. It also connects people to organizations and events, to provide opportunities for removing invasive plants. The website also provides additional information that can be downloaded and used in Forest Park.

The invasive species tour also includes resources for teachers within the “For K-12 Educators” section. This section provides educational materials and lesson plans involving invasive plants that connect to the State of Oregon’s learning objectives for each grade.

The site also features ways for users to show support for the website. Users can create a profile through the “*Forest Explorer*” tab to allow them to receive digital “badges” for exploring the different tours. Users can also show support through Facebook or Twitter.

The features of the EOF website are “responsive”, which means they are designed to translate and work efficiently when the website is viewed through Internet browsers on mobile phones. Website navigation and the tour content are designed to adapt to the different size and computing capabilities found on most modern smartphones.

Chapter 2.

Invasive Species Outreach Research Study

The design and goals for the EOF project come from an effort to provide an additional outreach and education tool to assist the Oregon Department of Forestry in implementing its strategies to protect, enhance, and conserve the state's non-federal forests. Creating new outreach and education programs is a goal for managing many of the forest threats recognized by the Forest Action Plan.

Every state has a Forest Action Plan, and a government agency that helps manage forest threats in its forests. Little research has been done on how state forestry agencies use outreach and education to address threats assessed in the Forest Action Plans. For this reason, an exploratory study of this area was needed to better understand how outreach and education methods like the EOF website relate to other states' forestry agency management strategies. Due to the limited time and resources available to complete this study, the topics were narrowed to a single forestry threat addressed in the EOF project, invasive plants. To help drive the study and investigate the relationship between state forestry agency outreach and education strategies and invasive plants, the following research questions are addressed:

1. Are state forestry agencies using public outreach and education as part of their management of invasive plant species in non-federal forestlands?
2. What public outreach and education methods and strategies are states' forestry agencies using in the management of invasive plant species in non-federal forestlands?
3. What are the reasons state forestry agencies are using or not using public outreach to manage invasive plant species in their state?

Literature review

In order to investigate if state forestry agencies use outreach and education in the management of invasive plants it was necessary to gain a greater understanding of how invasive plants affect forests and the responsibilities of state forestry agencies. Understanding these topics was a first step in developing the research methods and understanding how the information presented in the *Explore Oregon Forests* website could meet the needs of state forestry agencies outreach and education strategies.

A goal for the EOF project was to create a new communication “tool” or program that could be beneficial to state forestry programs. The Oregon Department of Forestry (ODF) has an ongoing goal of communicating with Oregon’s public about the threats facing the state’s forests (ODF 2015). The EOF website is a type of tool that may help connect forestry information to diverse audiences and help build support and participation for conservation strategies. One of the threats negatively affecting Oregon State Forests is non-native invasive plants.

A review of previous literature was used to help understand how invasive plants affect the nation’s forests as well as what strategies state and federal agencies use to combat their spread and effects on native forest ecosystems.

In the United States, state forestry agencies play an important role in helping to manage public forestland, and provide assistance to private forest owners. State forestry agencies directly manage 10% of the total forestland in the United States (49 million acres) (Schroeder 2011; Kilgore 2011). They also provide technical assistance and education to many private forest owners that account for 59 % of the total US forestland (Schroeder 2011). The services provided by state forestry programs are very broad, and include suppressing and preventing wildfires,

monitoring forest health, managing forest based recreation, providing timber and biomass, generating revenue from state administered forest land, and protecting wildlife (NASF 2010; NASF 2012).

Providing technical assistance and communicating with the public are also duties of state forestry agencies and an integral part of developing sustainable forest management practices in public forests. Many aspects of managing and preserving forest resources require gaining public support for policy and funding opportunities (Sharp et al. 2011). This can require the development of outreach and education programs that allow forest managers to effectively share information on forest conservation with the public. These programs can use many different methods to communicate their messages such as brochures, newspaper and magazine articles, radio and television messages, personal contacts, and neighborhood meetings (Toman et al. 2006; Shroeder et al. 2011).

Part of the responsibility of state forestry agencies is to monitor, manage and combat the invasive species that threaten their forests' health. In a nationwide survey of state foresters, invasive species were seen as having a major impact on state forestry agencies and among the top issues requiring state foresters' attention (NASF 2010). State agencies are responsible for expanding management strategies to deal with invasive species in state forests, and assisting private forest owners and communities. One method used by state forestry programs includes creating ways of educating people about their role as vectors for spreading invasive plant species and how they can assist in their management (Prinbeck et al. 2010).

Invasive species are non-native plants and animals that have been introduced to local ecosystems and can cause harm. They are widely seen as one of the greatest threats to biodiversity and ecosystem stability worldwide (Aukemia et al. 2011). The federal government

defines invasive species under Executive Order 13112 as “*An alien species whose introduction will likely cause economic harm, environmental harm or harm to humans*” (Thompson et al. 2014). There are many different invasive species that threaten forests in the United States and worldwide. They can be plants, animals, or pathogens that have the ability to outcompete or kill native forest species, and alter forest composition. The effect of invasive species on the natural environment can also negatively affect human industry. It has been estimated that the economic cost of invasive species is over 137 billion dollars annually (Pimentel 2000; Schroeder 2001).

Humans play a pivotal role in the spread and relocation of plants and animals that can become invasive. The increase in global trade markets and the ease in which goods and people can travel has helped species quickly relocate from one side of the globe to the other. Most invasive plants have been introduced to the United States for food, fiber or ornamental purposes (Pimentel 2000). Once established, invasive plants can be transported locally and spread very quickly, compromising many different areas. It is estimated the United States has 700 invasive plant species which have invaded 100,000,000 acres and continue to invade 3,000,000 acres a year (Thompson 2014).

Many invasive species negatively affect forests in the United States. Along with federal agencies, state forestry agencies have been tasked with creating programs to help reduce the negative impact of invasive species on state forestland (NASF 2015). Some state forestry agencies view the management of invasive species as one of its most crucial tasks. Creating initiatives for combating invasive species is also limited by budgetary restraints (NASF 2010). Assistance from an informed public can help government agencies identify the spread of invasive species in new areas (Prinbeck et al. 2010). Government agencies also desire help from the public to stop the introduction of new invasive species. (Gallo and Waitt 2001).

Invasive plants have been identified as a threat to Oregon's forests specifically (ODF 2010). They threaten many forests' health by outcompeting native plants for forest resources and interfering with natural forest regeneration (McAllister 2011). Human behavior, specifically outdoor recreation, has been identified as a likely vector for the spread of invasive species in Oregon (Prinbeck 2010; NASF 2010; ODF 2010). Creating greater awareness about invasive species for the people who use the forests is a strategy for reducing the impact of invasive plants in Oregon forests (ODF 2010).

Methods

The Oregon Forest Action Plan (2010) identifies invasive plant species as a threat to forest health. Using public education and outreach is noted as a strategy to expand awareness both for the general public and specific forest stakeholders. This threat and the strategy to manage it creates opportunities for outreach and education projects such as *Explore Oregon Forests* (EOF). The EOF project provides a new educational outreach tool that corresponds to Oregon's Forest Action Plan strategy for creating and raising public awareness about invasive plants.

This research study aims to generate information as to whether projects similar to the EOF would fit into strategies for managing invasive plants of other state forestry agencies.

Two methods were used in stages to gain information and insight that could be used to credibly outline the potential need for additional invasive plant outreach and education in the context of other state forestry plans. The first method involved a systematic review of each state's Forest Action Plan according to pre-developed criteria developed around key indicators related to: a) the presence of the topic of invasive plants as a threat to forests, and b) whether outreach and education regarding invasive species was included as elements of a strategy to manage invasive species in the Forest Action Plans.

This systematic review fed into the design of a questionnaire that was used to reach out to state forestry agency representatives across the country. Its objectives were to gain a better understanding of how outreach and education are connected to the management of invasive species, the range of outreach and education approaches and technologies being used and also better understanding of the overall commitment to management of invasive species and these types of approaches.

Forest Action Plans content analysis

Each state has a Forest Action Plan, available to the public through the National Association of State Foresters (NASF) website (<http://stateforesters.org/regional-state>). This website has links to the forestry agency website of each state, which, in turn have links to the respective Forest Action Plan documents.

Most Forest Action Plans were published in 2010, although a number have been updated since. They are still used by state forestry agencies to express the current assessment of the state's forests and provide strategies for addressing management concerns. The layout of the various state Forest Action Plans are presented in various ways. Most states have their plan organized into two separate documents: one includes an "assessment" and features state forest resources and threats facing those forests, and the second document focuses on strategies and through varied arrangements of the information, share content that outlines current and future strategies for protecting, enhancing and conserving state forest resources. Some states include both major types of information in one document with different sections for the assessment and strategies. Although many of the states' overall Forest Action Plan documentation share fundamental formatting and content, states structured and presented their information in various ways.

To systematically review and draw relevant information for comparison from each state's Forest Action Plans, a reliable coding system was needed. The coding system allowed for consistent answers to the following questions across all Forest Action Plans.

1. Does this Forest Action Plan describe invasive plants as a threat to the forests within the state?
2. Is outreach and/or education used or desired as a strategy for addressing the threat of invasive plants?
3. Is outreach and/or education used or desired as a strategy for addressing forest health which more generally may include invasive plants?

In order to test the reliability of the coding scheme to answer these questions, different persons with similar forestry knowledge and background provided consistent interpretations of the various forestry plans and demonstrate consistency in how the questions in interest are answered.

The research plan included a quantitative preliminary examination of each Forest Action Plan. This was based on a simple set of terms related to invasive species and strategies that were drawn from the formatting of Oregon's Forest Action Plan. For example, the presence or absence of the term "invasive plants" in the threats section of a plan resulted in a "Yes" or "No" for the corresponding question.

The terms "outreach" and or "education" were treated similarly with "Yes" or "No" in each plan's strategy section that connected with invasive plant threats. After reviewing of all plans, the "Yes" and "No" answers were to be tallied for the questions "Are invasive plants listed as a top of concern for the forests?" and "Is outreach and education a part of the strategy to addressing this threat".

However, it was found that the plans had considerable differences in their formatting and structures, section headings and subheadings were not as consistent as anticipated and a range language choices for similar topics were used. This made the desired questions difficult to answer reliably with the "Yes" or "No" coding system based off the initial wording choices.

Many coding issues came from differences in the formatting of the documents with some reports clearly identifying undesirable forest conditions including invasive plants under the sub-heading or connected to the wording "threat". The desired information often did not appear as manifest content allowing for a counting of words (Potter and Levine-Donnerstein 1999).

However, the information did exist in the latent content in the reports, which took a more detailed interpretation to ascertain.

Although the presence or absence of particular words or small set of words would not be able to capture the differences within the reports, easily recognizable patterns or wording combinations were found that could be used to compare the key questions across documents. Some Forest Action Plans did not have a section or sub-section titled “Forest Threats.” For example, the 2010 Arizona Forest Action Plan used the heading “Critical Issues” for the section that included what other plans included under “Threats.”

It was also difficult to accurately judge in some plans if “outreach” and “education” were strategies to address invasive plants if a search was made for those specific words. Because the state’s Forest Action Plans have several ways of describing outreach and education programs, identifying such programs required looking for themes that implied outreach and education rather than for the specific terminology. For example, connected to strategies for addressing invasive plant species, plans or goals included phrases like “expand programs to create greater awareness about invasive plants with the public”. This shows a clear connection between using some type of outreach or education without using the wording “outreach” or “education”.

To address the differences in and constraints in coding, Oregon’s Forest Action Plan along with ten other plans were re-examined in detail regarding structure and language. Using notes and patterns from the initial 11 plan examinations, a simple coding system was created to examine all the state Forest Action Plans and create some guiding rules to answer the questions of interest. The coding scheme was further refined during the first examination of all 50 of the Forest Action Plans (Appendixi).

The coding scheme for the outreach and education sought additional wording, phrasing, and formatting that identified if and how outreach and education strategies were used or desired in relation to invasive species.

The initial in-depth review of state plans also helped clarify how to determine if a term like “awareness” was linked with outreach and education. Different plans used various combinations of wording like “outreach,” “public education,” “educate” and “awareness” to describe communication strategies such as distributing pamphlets, creating educational programs and using radio ads. This helped validate that that such activities could be included within the definition of “outreach and education.”

Coding criteria developed around education and outreach strategies required that they be directly linked to the topic of invasive plants. This meant that a strategy section of a plan needed to either include specific wording about invasive plants in its description, or refer back to the section of the “Threats” section that dealt with invasive species. For example, the strategy of a plan section might say, “Create outreach and education material regarding invasive plant species.” It might also might simply say, “improve outreach and education” under a subheading that linked to a section of the threat assessment that was in fact focused on invasive plants. Unless there was a clear connection between the threat and the strategy, the plan was not considered to be using outreach and education as a strategy for addressing invasive plants.

In addition, a distinction had to be made for the cases where invasive plants were listed as threat but strategies using outreach and education addressed forest health issues in general and not specifically invasive plants. In these cases there was a possibility that the forest health issue where outreach and education was desired included invasive plants, but it could not be

confirmed. This resulted in the creation of the third question on the coding scheme, and these occurrences were treated as separate from outreach and education regarding invasive species.

Using the coding scheme as developed through the interactive process described above, Forest Action Plans from all 50 states were analyzed. Once all of the documents were examined the coding scheme was finalized and the Forest Action Plans were examined a final time to ensure consistency with the new coding. To further ensure reliability of the coding scheme and data, two research assistants used the code to analyze three randomly selected Forest Action Plans. The results for each question of interest were highly consistent with the original coding.

The coding scheme, though carefully developed, remained simple and was developed mainly from document examination rather than from outside theory for concept analysis. The relatively simple objective of the analysis of the contents of 50 plans was to learn if invasive plants were among the forest conditions that concern state forestry agencies, and if outreach and education was a common method to address this concern. The simplicity of these concepts also helped reduce subjective interpretation that could have lower coding validity (Potter and Levine-Donnerstein 1999).

State Forestry Agencies Survey

After reviewing the all of the Forest Action Plans for whether (1) invasive species were identified as a topic of concern in state forests and (2) whether the states' plan included the use of use outreach and education as part of a management strategy to address those concerns regarding education, this study then proceeded to investigate these topics in greater detail.

In order to learn more about the strategies state forestry agencies used to manage invasive plants, survey data were collected from a census of the 50 state forestry agencies. Contacting a

subject matter expert from each state's forestry agency to represent their agency was used to collect data from this specific and small population (Dillman 2011).

The systematic examination of State Forest Action Plans provided information as to whether invasive species were a concern, whether outreach and education were a strategy to deal with this problem, and some initial insight into the methods and strategies being used. However, the reviews of the plans did not provide the level of detail required to fully answer the research questions. A survey allowed for further exploration of the topic than what can be ascertained from an examination of the Forest Action Plans alone (Vaske 2008). Therefore, survey research was selected as an appropriate method to gather more detailed information. Development of an appropriate survey required some additional subject matter investigation.

An initial interview, conducted with the Oregon Department of Forestry's Invasive Species Specialist, Wyatt Williams, provided insight. He explained current methods and use of outreach and education addressing invasive plants in Oregon's Forestry agency. Williams provided information on the limitations affecting their use and the types of audiences targeted by the messages. Williams also provided information on methods and resources commonly used by forestry agencies to create and distribute outreach and education.

The interview with Wyatt Williams and a review of past literature on invasive plants and on state forestry agencies helped provide additional relevant information on managing forests, with outreach and education programs. State forestry documents and previous studies did show that state forestry agencies had budgeted for and incorporated an overarching concept titled "outreach and education" into management strategies (NASF 2012). This was reinforced by references to these terms found in the majority of State Forest Action Plans. However, these

same sources confirmed a lack of previous research on the topic. The lack of specific research necessitated a survey design that was exploratory rather than one based on previous surveys.

Information from the Forest Action Plans, the review of past literature, and interviews with Oregon's forestry agency representative were used to develop a detailed questionnaire. The questionnaire targeted a knowledgeable representative from each state's forestry program.

The questionnaire was drafted and included an introductory overview of the study and defined key, including possibly ambiguous terms such as "management". The questionnaire included twenty separate questions, the majority of which had multiple sections. The questions were designed to obtain information on the major research questions along with details related to the *Explore Oregon Forests* project. Questions sought information that would further illuminate specific study areas including the following:

- 1) Confirmation if outreach and education were used by the majority of state forestry agencies for the management of invasive plants;
- 2) Identification of the types of audiences targeted by their outreach and education;
- 3) Identification of the goals of these outreach and education program, and
- 4) Information on limitations in creating effective outreach and education strategies.

Following initial development of the questionnaire, the draft was examined by group of experts made up of Oregon State University professors. Each of the group's three members had experience in public outreach and education in forestry at a state level. The group reviewed the survey questions and variables and provided comments that proposed changes aimed at covering common outreach topics, preventing bias and increasing question clarity.

The revised questionnaire draft was then pre-tested with state forestry agency employees who focus on invasive species or forest health in the states of Oregon, Washington, and Idaho. These employees agreed to complete an on-line version of the questionnaire and provide

feedback on content and clarity. Input from the first review group and the comments from those who did the on-line questionnaire draft were incorporated into the final survey design and its content. The survey pre-testing helped bring validity to the survey tool, and help shape the research design.

The survey was developed on and distributed using the *Qualtrics* (Qualtrics, Provo, UT) on-line survey program. The importance of obtaining responses from people knowledgeable about the study's subjects in each state required specific person-targeting rather than random selection of respondents. The targeted respondents were employees who worked in the management of forest health or invasive species for state forestry agencies.

The initial list of survey participants was developed using The 2014 Forest Health Protection, National Staff Directory (United States Forest Service 2014). Because of differences in how states organize their forestry programs, these individuals held a variety of titles and worked in different agencies. For example, in Oregon the targeted representative worked for the Oregon Department of Forestry and held the title of Invasive Species Specialist. In other states, the targeted respondent came from, for example, the Department of Natural Resources which manages state forests and held the title Forest Health Manager rather than Invasive Species Specialist. Regardless of the title, the survey recipient was the subject matter expert for invasive species, and therefore the person requested to complete the survey (appendix ii).

In the spring of 2015, a digital request for participation in the survey was sent out. This email included a request for participation, an overview of the study and a link to the questionnaire. The request also provided the description of those from whom the information was sought after, and pointed out that those who provided survey answers were doing so as representatives of their agencies.

Following standard survey methodology (Dillman 2011), a reminder was sent a month later to those who had not completed the survey. This was further followed up with phone calls in the fall of 2015 to again notify representatives about the study and verbally ask for their participation.

Follow-up activities resulted in learning that many contacts obtained from the *2014 Forest Health Protection National Staff Directory* were no longer employed in their position, or could not be reached by phone or email. In order to reach the target population, a search was done of on-line directories of state forestry agencies that had not responded, to help identify current forest health / invasive species specialists. Phone calls were used to confirm if the listed employee was able to represent their agency for the study, and to ask for their participation. The phone calls were followed up with a digital survey request along with the link to the questionnaire.

The survey was closed on October 31, 2015. This combination of methods, including the follow-up activities, resulted in returned questionnaires from 46 states. The great majority of these were fully completed. The overall response rate was 92% (46 out of 50 states), which has been found to be acceptable for research-based on targeting specific populations (Vaske 2008). Because all methods for contacting the missing state representatives had been exhausted, a non-response bias test was not possible. All of the respondents represented state forestry agencies with one exception. The State of New Jersey's respondent listed "New Jersey Invasive Species Strike Force" as the agency they were representing. Upon further investigation it was discovered the respondent is an employee of New Jersey's State Forest Service, and the NJ State Forest, uses the Strike Force for to make invasive management decisions for the agency.

Data from the survey were entered into the SPSS (IMB Corp, Armonk, NY) program for analysis. The small population of interest for the study and the use of non-random sampling did not allow for use of inferential statistical tests (Vaske 2008). The information obtained through the survey is representative of the state forestry agencies. The information can be examined with frequencies and descriptive statistics, and provide valid evidence towards the research questions.

The survey responses were examined in a number of ways. Many questions were analyzed examining the frequency of state's responses. Many questions also allowed respondents to add additional variables and explain their responses in open-ended questions. These were examined as part of the analyses and helped provide further exploration into the differences between state forestry agencies and create more reliability for the survey tool.

Many questions respondents provide information on different variables on scales. For example, respondents were asked to rate the importance of reaching different types of audiences regarding invasive plants. For each audience, they selected: *not at all important*, *slightly important*, *moderately important* or *extremely important*.

Ranking questions were also used to determine specific information about the variables. Respondents were asked to rank the top three variables for different questions. This allowed the frequency of the top ranking variables to be compared, as well as the frequency of variables that appeared in the top three rankings for the states. This created more specific detail for the relationship between the variables and the state forestry agencies.

For some questions the number of respondents was not consistent for each variable examined. All responses provided were included in the analyses, and counts of the state answers were an accurate way to distinguish pattern in the data. Percentages were also included in the analyses but were affected by the difference in the number of states who participated.

The results from the questionnaire along with the data from the state forestry agencies was used to answer the research questions. The analyses provided evidence that helped support answers for some of the research questions. The analyses also helped provide information to further the discussion of how the *Explore Oregon Forests* project, and fit into the outreach and education strategies of state forestry agencies.

Results

Findings from this study provide information about how state forestry agencies are using outreach and education in the management of invasive plants. The results may be beneficial to state forestry agencies who wish to compare their strategies with those of other state agencies. The findings from the study also help to understand potential applications for projects like *Explore Oregon Forests* that can be used as outreach and education methods for state agencies.

The invasive species tour on the exploreoregonforests.org website helps the Oregon Department of Forestry meet its goals of developing new methods for outreach and education about invasive species. The development process of the invasive species tour on the *Explore Oregon Forests* website provides a template that will be used to design future tours for the website and provide a tool for outreach and education on other forest conservation topics.

The analysis of the state Forest Action Plans' contents verified that 47 of the 50 states include *invasive plants* as a subject that threatens their forests or in an issue they are concerned about (Table.1) (Appendix iii). This shows that invasive plants are an issue or threat that state forestry agencies currently, or will likely in the future have to face.

Table 1. Status of the 50 Forest Action Plans

States	(n)	(%)
Invasive plants are a topic of concern	47	94
Outreach and education in strategies for addressing invasive plants	38	76
Outreach and education in strategies for forest health, which may include invasive plants	47	94

The Forest Action Plans show 38 states currently use or desire some kind of outreach and education as part of their strategy of addressing invasive plants.

Outreach and education might be a strategy for addressing invasive plants for an even greater number of states. All of the 47 states that include invasive plants as a topic of concern include outreach and education for addressing the topic of forest health.

The analyses of the Forest Action Plans provide some evidence that outreach and education is directly connected to the majority of state strategies for addressing the threat of invasive plants. It also provides justification for a more detailed examination of how state forestry agencies use outreach and education to address invasive species. By gaining a greater understanding of the details and limitations for state forestry agencies to develop outreach and education in regards to invasive plants, light is shed on the type of tools, like the *Explore Oregon Forests* project, that may assist states in their efforts.

Both the analyses of the Forest Action Plans and the survey responses can be used to answer the study's research questions. After reviewing data from the Forest Action Plans' survey, data from the survey were used to help answer the first question: *Are state forestry agencies using public outreach and education as part of their management of invasive plant species in their forestlands?*

To answer this question, responses from various survey questions were examined. State Forestry Agencies were asked if they manage invasive species in their state and if they currently use, or plan to use in the future, outreach and education as part of their management plan. The states were also asked how they prioritize the management of invasive plant species within their state.

Survey responses indicate that 42 of the 46 states (91%) manage invasive plants in their forests. The analyses of the Forest Action Plans indicate that all of the states that responded "no"

to whether they manage invasive plants have invasive plants listed as a threat to their state's forests.

Forest Action Plans show many states are concerned with different types of invasive species. The surveys show that 25 of the states rank invasive insects as the highest management concern amongst invasive plants, insects, and pathogens. Fifteen states rank invasive plants as the highest management concern and four states rank invasive pathogens as the highest management concern.

The survey also examined how important management of each of these three categories of invasive species is to each state. Importance of management was evaluated by having respondents rank each category on the following scale: *not important, slightly important, moderately important, or extremely important*. On this scale, 25 out of 46 states (54%) rank the management of invasive plants as highly important for their agency, and 14 out of 46 states (30%) find it moderately important. Thirty-six out of 46 states (78%) find the management of invasive insects extremely important, and 10 states (21%) find it moderately important. This provides evidence that there is a greater consensus amongst the responding states for the importance of managing invasive insects than invasive plants.

State's forestry agencies use different strategies to manage the invasive plants in their forests. The survey results find that 39 of 46 (85%) state forestry agencies are currently using outreach and education in the management of invasive plants, and 42 of the 46 (93%) states plan to use outreach and education as part of their management of invasive plants in the future. Only four of the 46 responding states reported "unsure" with regard to the question of whether they were currently using outreach and education for the management of invasive plants; only three responded "unsure" regarding future plans. In the descriptive explanation of why they were

unsure if they were using outreach and education for invasive species management, most state representatives explained that their “division” or “department” was not using outreach and education as part of their invasive plant management, but were uncertain about this issue in terms of the agency as a whole. This shows that the majority of responding states (46) and total possible states (50) are currently using outreach and education in some capacity, as part of their management of invasive plants. The data also show that more states think they will do so in the future.

The survey also provided information used to answer the research question: *What public outreach and education methods and strategies are state’s forestry agencies using in the management of invasive plant species in forestlands?*

The survey requested information on the frequency of use of 11 common outreach and education methods and strategies (Figure 5) developed through interviews with Oregon Department of Forestry staff.

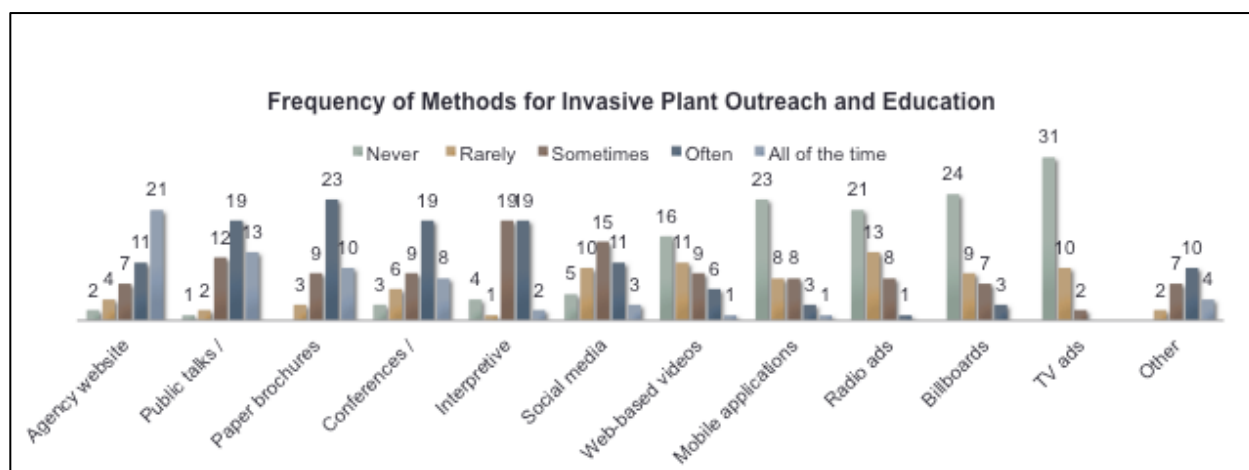


Figure 5. Frequency of outreach and education methods for invasive plants

Based on the responses across the 11 variables, the most frequently used method for outreach and education by the responding states is their agency websites with 21 states. The

second and third most common methods reported by the states are public talks / meetings (13) and paper brochures (10).

The lowest least used method of outreach and education reported by the states involve types of advertising. These include TV ads, which are never used by 31 states, billboards (24) and radio ads (21). The methods that have some other similarities to the *Explore Oregon Forests* project include, web-based video and mobile applications, and are not used very frequently over by state forestry agencies.

Some state agencies included additional methods by selecting “Other”. Eleven states added outreach and education methods that they reported using either “Sometimes” “Often” or “All of the Time”. These additional methods included the following:

- *Meetings with private landowners (n=3)*
- *Other agency/collaborative websites or online education services (n=3)*
- *Community events or training programs (n=3)*
- *Other mediums of advertising (n=2)*

State forestry agencies also responded with information ranking how effective each of the different methods is for outreach and education about invasive species. They selected and ranked the first, second, and third method in terms of which were most effective.

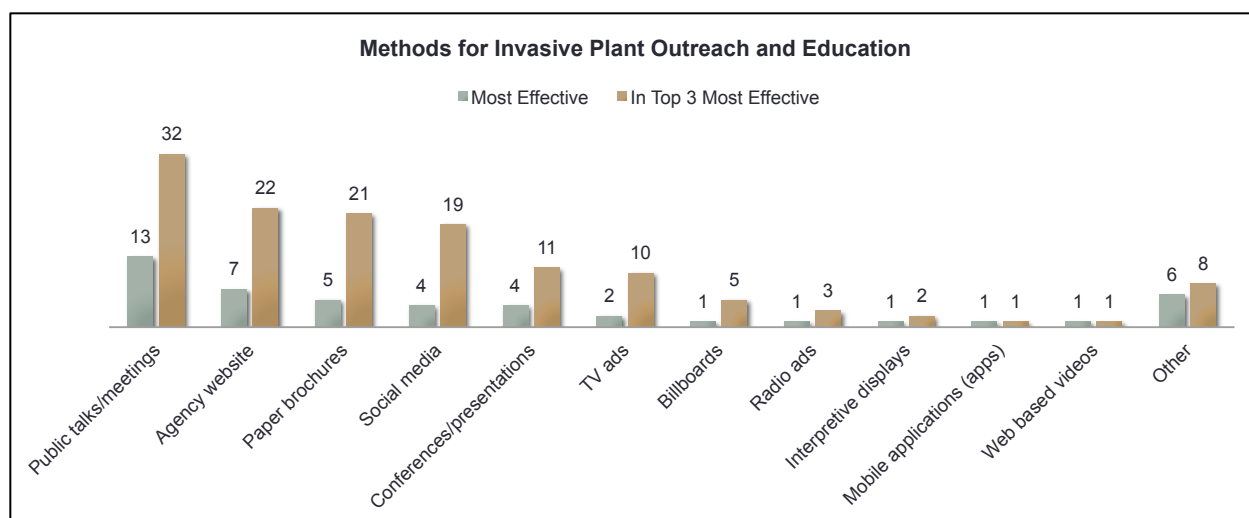


Figure 6. Frequency of most effective outreach and education methods

The survey results on this question show a wide range of response as to what methods are viewed by state forestry agencies as the most effective, and in the top three most effective for outreach and education about invasive plants in their state (Figure 6). Each method listed was ranked first as the most effective method by at least one of the state forestry agencies.

Public talks/meetings is ranked first as the most effective method in 13 and in the top three for 32 states. The *agency website* is ranked the most effective for seven and in the top three for 22 states and *paper brochures* are the most effective method in five states and in the top three for 21 states. Six states also selected and described "other" methods as most effective. These include the following:

- *One-on-one or personal contact,*
- *Other agency websites/social media*
- *Newspapers*
- *Direct mailing*
- *Work projects*

These show that meeting with the public is seen as the most effective by the largest number of responding states, followed by the agency website. The results also show that a wide range of outreach and education methods are viewed as the most effective by different state agencies.

Working with other organizations or agencies to form collaborations is another way for incorporating outreach and education into the management of invasive species that was explored in the survey. Forty-three states of the 46 (94%) states confirm that, *“They currently collaborate with other groups/agencies for the management of invasive plants using outreach and education”*. This provides evidence that almost all the agencies have systems in place to allow for collaborative projects or the sharing of information about invasive plants.

The 43 states signified the importance of different aspects of collaborations for outreach and education about invasive species. Thirty-seven states report that they work with or directly rely on collaborators in the creation of content about invasive species management. States also indicate how important different aspects collaborations are. States signified this by indicating the level of importance as, “Not at all important,” “Slightly important,” “Moderately important” and “Extremely important”. Twenty-eight of the 43 states forestry agencies indicate that collaborations are “Extremely important” for content delivery. Twenty-five states report that collaborations are extremely important for reaching target audiences. Nine states report collaborations are “Extremely important” for content creation. This shows that similar numbers of state forestry agencies feel collaborative groups can help with content delivery and reach specific audiences, while creating content is something much fewer states feel collaborations are important for.

The survey also provides data to answer the third research question: *What are the reasons State Forestry Agencies are using, or not using public outreach to manage invasive plant species in their state?* To answer this question, the importance of outreach and education to invasive species management; the goals of the agencies; outreach and education strategies; the audiences they want to reach and the limitations that effect how they can use outreach and education are examined.

Regarding how important the use of outreach and education is compared to other types of invasive plant management in their state forest, 61% of the 46 participating states responded that outreach and education is “Extremely important,” 14 indicated it is “Moderately important,” and 4% indicated outreach and education is “Slightly important.” There are no states that responded that outreach and education was “Not at all important” (Table 3). This shows evidence that the majority of state forestry agencies feel outreach and education are very important to the management of invasive plants, and no states think it is not at all important.

Table 2. Importance of Outreach and Education Compared to Other Invasive Species Mgmt.

Level	(n)	(%)
Extremely important	28	61
Moderately important	14	30
Slightly important	4	9
Not at all important	0	0

1. Based on responses of 46 states.
2. Units may not add to 100% due to rounding error

The state agency goals for outreach and education are an indicator of how outreach and education fit into larger invasive plant management programs. These goals help explain some of the reason states would want to have outreach and education regarding invasive plants. States selected the importance of each goal for their outreach and education regarding invasive plants

(Figure 7).

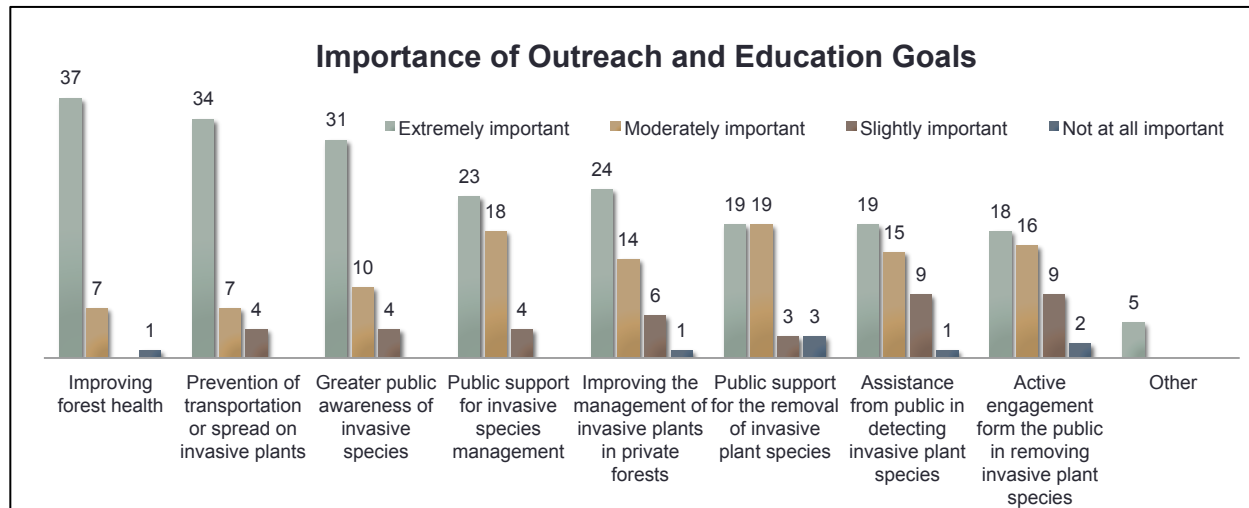


Figure 7. Importance of state outreach and education goals

The goal of “improving forest health” is seen as “extremely important” by the most number of states, followed by “prevention of transportations of invasive plants” and “greater public awareness of invasive plants”. The goals that were the least important to states over all involved active engagement from the public in detecting invasive plants and removing them.

States were provided with the option to provide additional goals by selecting “other” and writing in a description and importance level for their goals. Five states included additional “extremely important” goals for their public outreach and education about invasive plants. These goals are:

- *Getting adjacent landowners to manage invasive plants*
- *Improving public support for biological controls*
- *Maintaining forest health*
- *Creating politician awareness about invasive plants*
- *Encourage and inform private landowners to manage invasive plants*

The outreach and education goals like “*Improving public support for biological controls,*” show that states many specific topics within the larger category of invasive plants that they want to communicate.

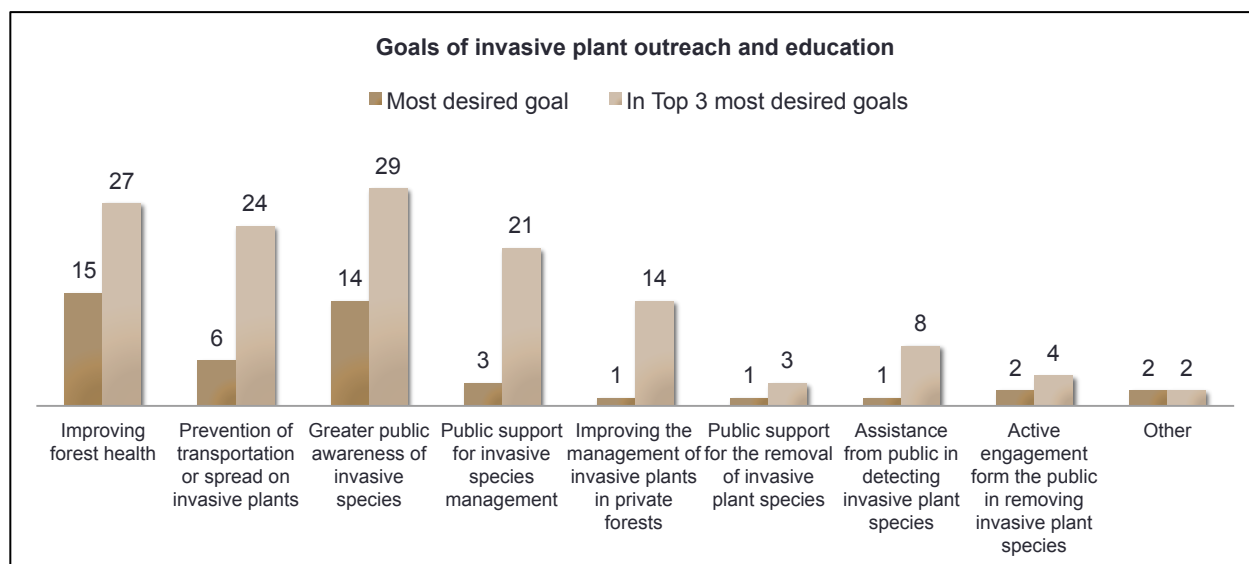


Figure 8. Most desired goals for state outreach and education

The agency goals were further explored by comparing the frequencies of what states list as the top desired outcomes for outreach and education regarding invasive plants, as well as the frequencies of most desired outcomes that are ranked in the top three most outcomes from outreach and education about invasive plants (Figure 8). “Improving forest health” is ranked as the most desired outcome by 15 states and “greater public awareness of invasive species” is ranked as the most desired outcome of 14 states. No other outcome had more than 10 states select it as their most desired outcome. There is great variability in the responses and each listed outcome appears as a states most desired outcome.

Four goals are listed the most in the top three *desired outcomes* from outreach and education about invasive plants for over 20 states. The outcome “Greater public awareness of invasive species” appears in the top three goals in the responses of 29 state forestry agencies. “Improving forest health” appears in 27, “Prevention of the transportation or spread of invasive

plants appears in 24 and “Public support for invasive species management” appears in 21 (Figure 8). The most desired outcomes from the least states are “Assistance from public in detecting invasive plant species,” “Active engagement from the public in removing invasive plant species” and “Public support for the removal of invasive plant species”.

When looking at the top three desired goals for outreach and education, it is possible that many states share similar goals. This makes sense because the goals help achieve similar overarching goals. Greater public awareness about invasive species can lead to improved forest health and the prevention of transporting of invasive species.

Three states provided additional desired outcomes under the “other” category. These listed outcomes include “maintaining forest health” and “raising cooperative engagement amongst various agencies involved with invasive species.”

The audience for outreach and education messages is an important part of using a specific strategy for invasive plant management. Results from the survey provided data on the desired audiences for state agencies’ outreach and education messages. The level of importance was reported by the states using the scale: “Not at all important”, “Slightly important”, “Moderately important” and “Extremely important”.

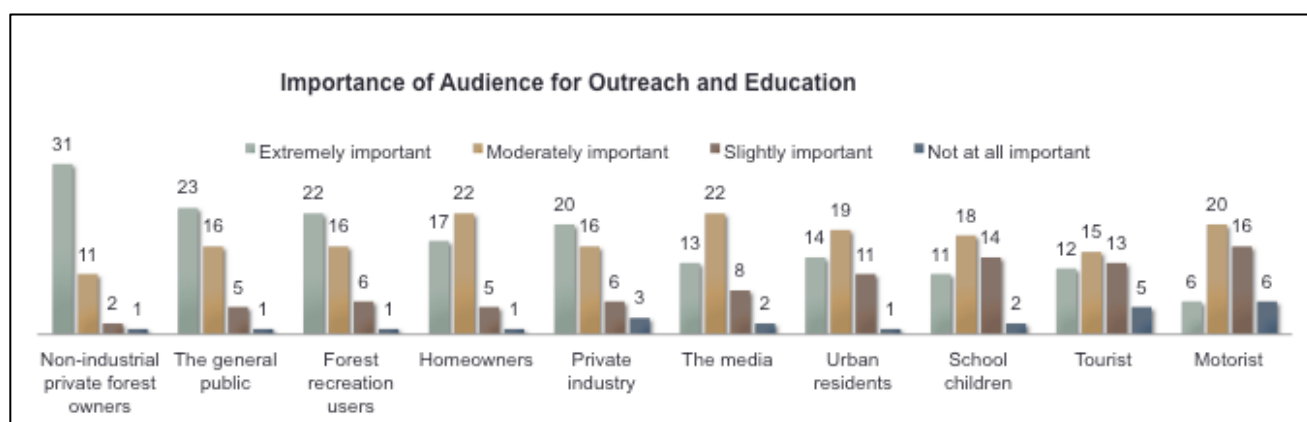


Figure 9. Importance of audiences for invasive plant outreach and education

The “non-industrial private forest owners” audience is seen as the most “extremely important” for outreach and education messages by the most states. “The general public” is the second and “Forest recreation users” is the third highest. “School children,” “Tourist,” and “Motorist” had a range of importance rankings but had the least number of states feel they are “Extremely important” audiences.

The counts for the top ranked audiences and those included in the top three audiences for outreach and education messages for the responding states are also examined. Twenty-one state agencies responded that “Non-industrial private forest owners” are the most desired audience to reach about invasive plants. This is also the audience that had the greatest frequency among the top three most desired audiences to reach. “The general public” and “Forest recreation users” are the other audiences among the top three most desired audiences for state forestry agencies to reach about invasive plants (Figure 9). Agencies also included additional audiences under the “other” category. Three audiences that were added by agencies as among the top three important audiences were “Public officials”, “Members of other state agencies” and “Other land management groups.”

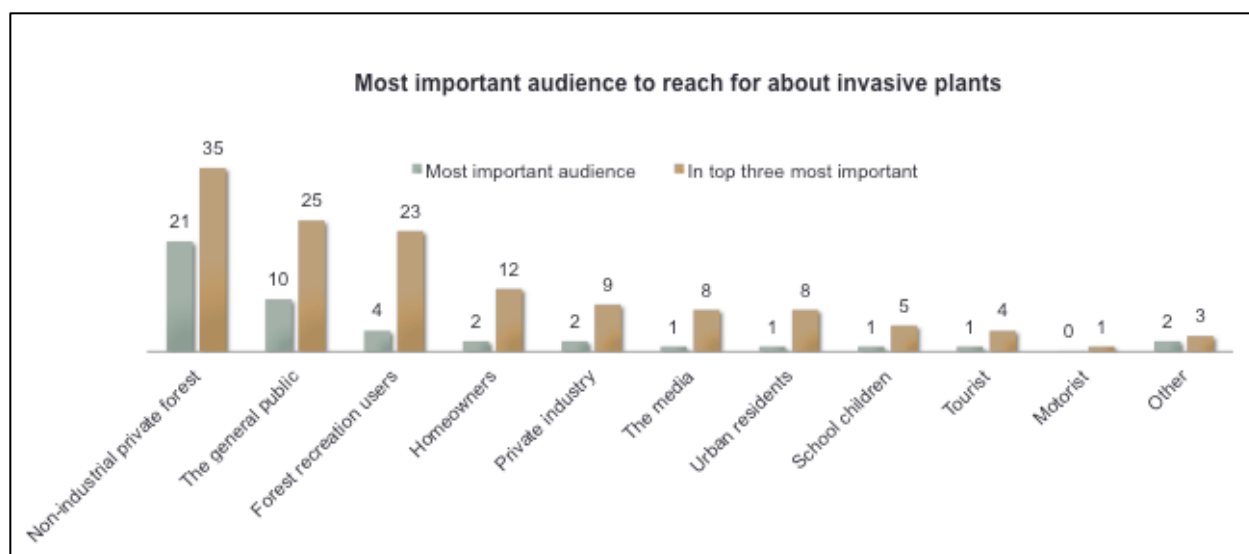


Figure 10. Top ranked audiences to reach for invasive plant outreach and education

These results show that non-industrial private forest owners are considered the most desired audience to reach for the most states, and almost half the states that responded. They are also an audience that over 75% of the states ranked in the top three. The second and third highest desired audiences ranked in the top three only had around 50% of the states. The results also show that there are differences between the states in who they see as their most important audiences to reach.

While survey results show that many state forestry agencies find outreach and education is an important strategy for managing invasive forest plants, the study also explored whether agencies have all the resources they need to create effective outreach and education programs or tools, and what elements within agencies may contribute to a lack of resources.

Responses from 28 of the 46 (61%) state forestry agencies indicated their agency does not have the resources needed for effective outreach and education about invasive plants. The state forestry agencies indicated that different factors contribute to these resource limitations. The survey provided a scale to allow all responses to be compared in terms of reported

importance: “Does not influence”, “Slightly influences”, “Moderately influences” and “Greatly influences” (Figure 11).

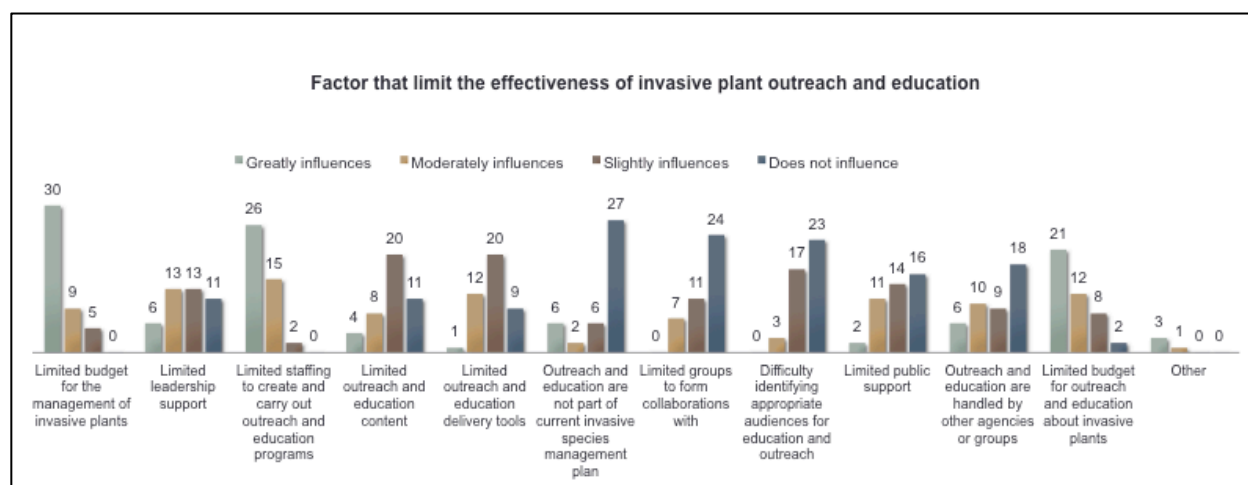


Figure 11. Factors that influence the effectiveness of state outreach and education

The limiting factor for effective outreach and education regarding invasive plants with the great influence for the most states is, “Limited budget for the management of invasive plants” with 30 states stating it “greatly influences” their outreach and education. This was followed by “Limited staffing to create and carry out outreach and education programs”, which greatly influences 26 states and “Limited budget for outreach and education about invasive plants” which greatly 21 states. This data shows that across all responding state forestry agencies, budget and staffing are the two biggest restraints

Four state agency representatives provided other limitations that affect effective use of education and outreach in the management of invasive species. These include:

- *Reluctance of leadership to face invasive plant issues*
- *Budget options that create cost share incentives for private landowners*
- *Limited economic impact of invasive plants*
- *Ensuring consistent messaging*

The top factors that limit the use of outreach and education were also examined. “Limited budget for the management of invasive plants” was also ranked as the primary factor that influences how effectively outreach and education is used in the management of invasive plants by 24 states. Eight states reported, “Limited staffing for outreach and education” was the primary limitation. Only between one and four states report any of the other factors as the primary limiting factor.

The results show evidence that for many states, their budget for invasive species management is the limiting factor for implementing effective outreach and education regarding invasive plants.

State agencies were also asked a number of questions in order to help understand how an outreach and education project like *Explore Oregon Forests* could be used for invasive plant management.

Out of 44 responding states, three “Strongly agree” and 22 “agree” that educating tourists is an important part of their agency’s strategy to manage invasive plants in their forests. This shows evidence that educating tourists about invasive plants is important for the majority of state forestry agencies, although tourists may not be in the top audiences most states want to reach.

Chapter 3.

Discussion

In this section, the *Explore Oregon Forests* website and tour are examined in relation to the methods used to create an effective strategy for outreach and education. The results from the Forest Action Plans and state agency surveys also were used to investigate the research questions and discuss if similar outreach projects with similar characteristics to the EOF would apply to other forestry agencies.

The results may be beneficial to state forestry agencies that wish to compare their strategies with those of other state agencies. The overall investigation's results provide useful information on the states' priorities regarding invasive species and how they use outreach and education. The results can also be linked with characteristics of the EOF project and illustrate its potential as an outreach and education method model for other states' agencies.

Outreach and Education in Forest Action Plans of State Forestry Agencies

The key findings from this study show that the 47 of the 50 state forestry agencies report invasive plants are a threat to forests in their states and are issue that requires active management. These results match the findings of other research that show invasive species are a growing concern amongst state forestry agencies (NASF 2015).

This study shows that outreach and education are widely accepted among the state forestry agencies as an important strategy for managing invasive plants. There are similarities between the state forestry agencies in their most common methods for outreach and education. These include the agency websites, public talks/meetings and paper brochures. However, there also appears to be considerable differences among many of the state's outreach and education programs. At least 16 states provided different methods that they reported to be most effective.

Among the many similarities in the most frequent outcomes for state forestry agencies' outreach and education about invasive species most have overarching goals such as improving/maintaining forest health and creating greater public awareness of invasive species. Responses suggest that many fewer states desire assistance or engagement from the public in the actual management.

It is interesting that the findings include both a method for reaching a larger audience and more a personalized method that appears to target a smaller audience. The more generalized audience is described as the general public or forest recreation users. The more specific audience is that of private forest owners. This is interesting because the size and diversity of these two audiences are very different and most likely require different methods of outreach. This need for tailored approaches may explain why different methods like the agency websites and personal meetings are both common and considered effective methods overall. This suggests that tailoring the methods of outreach for the audience may help create more effective messaging.

Although most state forestry agencies responded that the management of invasive plants is important and that outreach and education are used as part of this management, more than half the responding agencies stated that they did not view the resources available as adequate to achieve effective outreach and education regarding invasive plants. Budget and staffing limitations within the agencies affect outreach and education programs more than other factors. This suggests that many state forestry agencies would be interested in new methods for outreach and education that would involve lower costs and require less staff involvement.

The results of the content analysis and survey as well as from previous literature on creating effective education programs lead to some recommendations for state forestry agencies:

- 1) States that do not already have invasive plant outreach and education messages on their state agency's website should develop and include such information.

- 2) State forestry agencies should try to find ways to expand budgets and resources to add or enhance outreach and education programs addressing invasive species. Using education and outreach as a preventative strategy to help reduce the spread and impact of invasive species may be more cost-effective and practical than working mainly on invasive plant containment and eradication.
- 3) Setting additional or stronger goals that involve active engagement from the public could be beneficial in educating the public about invasive plants. Research has shown that providing hands on experience with a natural conservation topics can help create greater awareness on the issue.

Oregon Department of Forestry, *Explore Oregon Forests* Website

Based on the results of the study, the *Explore Oregon Forests* invasive plant virtual tour is highly relevant to understanding how an agency views the importance of the public's awareness and education in the overall management of invasive species. The invasive species tour on the exploreoregonforests.org website helps the Oregon Department of Forestry meet the goals of developing new methods for the outreach and education about invasive plant species. The development process of the invasive species tour on the *Explore Oregon Forests* website provides a template that will be used to design future tours for the website and provide a tool for outreach and education on other forest conservation topics.

The study results strongly imply that outreach and education projects like *Explore Oregon's Forests* could be used by state forestry agencies. The study showed that outreach and education projects about invasive plants are desirable by far more states than only Oregon. Therefore, the EOF invasive species tour, which shares this objective, may be an effective and helpful model for many states. The EOF project also shows why active management and public involvement are important in reducing the impact of invasive plants on forest ecosystems, and

this may be helpful to other states in generating resources for this area and for similar strategies to support forest management.

The characteristics and objectives of the EOF project match up well with the most commonly desired outcomes for outreach and education projects for state forestry agencies, including creating greater public awareness about invasive plants and improving forest health. The EOF invasive plants tour also demonstrates it can communicate multiple messages and types of information can be communicated within the tour. Similar projects by other states forestry agencies would benefit from this type of flexibility. States could easily tailor their content and messaging in ways that would help meet somewhat different state forestry agencies outreach and education goals.

The invasive species tour of Forest Park is tailored to forest recreation users and tourists. The study found that, overall, state forestry agencies view state forest recreation users as an important audience. Some state agencies also find tourists to be an important audience for outreach and education about invasive plants, but tourists are not an audience prioritized by most states. The EOF project hopes to reach tourists as a main audience, and doing so could help develop new strategies to reach this type of audience. Projects similar to EOF could help state forestry agencies better reach these audiences.

There are similarities and differences in the methods state forestry agencies use and view as most effective regarding invasive plant outreach and education. States report that their forest agency websites are a common and effective way of communicating information on invasive plants. This provides evidence that the agencies believe the audiences they want to reach are using computers to access their site. This could mean that the same audiences would use a website like *Explore Oregon Forests*. However, using web-based videos and connecting through

mobile applications are not seen as effective methods by states. This input could mean future tour development could rely on more printable information closer to what state forestry agencies produce with their paper brochures.

An area where further investigation would be useful is that of whether the development and upkeep of a website like EOF is more cost-effective than other outreach and education programs and methods currently used by state forestry agencies. This is important because of the findings that state forestry agencies have limited budgets to manage invasive species. The EOF project may provide a model on how to develop similar projects for invasive plant management. This would be helpful as state agencies attempt to increase their outreach and education about invasive species with the limited resources available. Future research also could explore how outreach and education programs are used in a more general sense by state forestry agencies, and for what forestry topics. Exploring how education and outreach are used to convey information on the EOF project's other intended tour would also be beneficial for the development of the *Explore Oregon Forests*.

Explore Oregon Forest Project

These exploratory investigations through content analysis and survey were also closely linked to the specific *Explore Oregon Forests* website. As noted in earlier sections, EOF is the first attempt to develop a new innovative tool for outreach and education about invasive plants in Oregon. The research reported in many ways reflects characteristics and decisions that were part of EOF development. The findings are also relevant to future work in expanding EOF projects into other topics.

The EOF project reflects what is viewed as a successful first step towards creating greater awareness among the general public of forestry topics in Oregon. The invasive species tour

implements many interpretive concepts for communicating natural conservation to online audiences, and audiences accessing the website through mobile devices. The exploratory study confirmed that, like the Oregon Department of Forestry, many other state forestry agencies incorporate methods of reaching diverse audiences into their management of invasive species.

Although the EOF project underwent many changes in its development, the work was fully consistent with the objective to help meet state forestry management goals to engage the public through outreach and education about invasive plant species.

Similar to other states, as found through the survey, Oregon also has resource constraints that, in the case of the EOF, resulted in having to change the original project design. The original project's goal was to create an interactive, educational, mobile website that could be accessed by the public while they were in forest locations. However, the initial testing of this project model found that it could not be successfully accomplished with the existing budget and timeframe. The initial testing did prove useful, however and provided a template of how the "exploration" of a forested area with the use of interpretive concepts could be used to communicate forestry ideas through a website.

The resulting website incorporates many techniques that have been found effective in other websites and interpretive programs that aim to connect to non-captive audiences and create intrinsic value. The interpretive concepts of self-learning and discovery are a central theme used in the EOF website and invasive species tour. The website attempts to provide users with choices regarding tour elements and the depth of information they will receive on each topic within each tour they access. These choices include which icons and links they can access as they proceed along the tour map. This approach is designed to be able to reach out to a large general audience, and allow curiosity and personal decision-making. Working to connect to a wide

audience shows that the EOF website may be useful to other states who desire to reach “the general public” or “forest recreation users”.

For the website and virtual tours to connect effectively with audiences, the EOF attempts to provide a user-friendly and engaging an online learning environment.

The simplicity of the website layout and tour components allows for easy viewing and use on computer web browsers and through browsers on mobile phones. This allows people to use a computer to access the website to learn more about Forest Park or invasive species both in their homes and also during an actual visit to the park. This may attract the audience of “tourist” who use their mobile devices to learn about areas they are visiting.

The anticipated audience for the tour is “non-captive” (Ham and Krumpe 1996). The website does provide initial direction as to where users can start, and gives them the overarching concepts of the tour and overview of the concept. However, nothing is mandatory. Each user is free to select what elements they experience. The design includes internal and external links that allow users to choose both the information they want to investigate in detail and other information where they are only seeking a quick overview. The concept of choice is used to provide users with a sense of control and individualism in how the site is used. The website uses main concept repetition to enhance learning and retention. For example, information on the types of invasive plants and how those types of plants affect the forest is repeated during each stage of the tour. If this method is successful in raising public awareness about invasive species it could be a useful method for other state forestry agencies who strive for this goal.

The invasive species tour is just a first step in the completion of the *Explore Oregon Forests* project. Many lessons were learned in the development of the initial pre-test “*working forests tour*” and final “*invasive species tour.*” As a result of this work a system has been created

that should facilitate future development of additional themed tours including “*working forests*,” “*wildfire*” and “*benefits of urban/community forests*.” Lessons in how to connect with and interview content experts, how to capture and display media content, and on how to display the information within virtual tours will make future work more efficient and continue to build the effectiveness of this strategy for outreach and education of state forests systems. It is a goal of the EOF project to create a system to efficiently and cost effectively create the themed virtual tours. If the website and tour creation can be done cost efficiently, similar projects to communicate about invasive plants could be more likely used by other state forestry agencies with limited budgets for outreach and education.

Going forward, a full evaluation of the EOF website should take place once the website has been made available to the public. Future research could help to evaluate the invasive species tour and the EOF website. Previous research has established that evaluation is a key component in creating educational programs (Orams 1996). Through project evaluation, feedback can be incorporated in future project design. Feedback could be used to change elements of the invasive species tour to help assure it reaches the project goals, and be incorporated into the other topic tours.

Evaluation of the EOF website is needed to test if the design and tour elements are successful in effectively communicating forestry topics. It could also shed additional light on the types of audiences that will use the website. Feedback from audiences will also help provide evidence the EOF project could be used by other state forestry agencies to assist in their outreach and education goals.

Project and Study Limitations

Of necessity, the study and virtual invasive plant tour were undertaken and completed over a short time-frame with a limited budget. This created challenges in both the research study and the EOF project design.

The short time to complete the study limited the scope of the research design to be largely exploratory and only a single respondent was targeted for participation from each state forestry agency. Although a systematic approach was used to reach the population of interest, it was difficult to eliminate potential response biases due to the differences in position titles and responsibilities between all the state agencies and the lack of an up-to-date directory of agency personnel who manage invasive plants. A larger set of respondents would have allowed cross checking of responses within each states better assuring the validity of the survey in terms of how each respondent represented their state agency section or department dealing with this specific issue.

The timeframe available to design and build the EOF project website and tours also presented many challenges. Elements of the tour had to be created without a finalized platform for their display on the finished website. This made it difficult for the EOF design team to conceptualize and test different types of content throughout the process. Testing different elements of the EOF project through focus groups could have helped ensure the most effective methods for conveying information on invasive species were used.

Conclusion

Invasive plants have been assessed as a major threat to the forest ecosystems within the State of Oregon. Educating the public and raising awareness on the topic of invasive plants is part of Oregon Department of Forestry's strategy of managing this threat. The *Explore Oregon Forests* project is part of this strategy and has been designed to be an outreach and education method that features on-line virtual tours of forest areas. This approach is a new method for Oregon's state forestry agency and benefits from the research on how other state forestry agencies use outreach and education in their management of invasive species.

This research reinforces the importance of the EOF project, showing that invasive plants are a threat to forests throughout the United States and that most state forestry agencies use the strategy of outreach and education in the management of invasive plant species. This strategy involves connecting mostly to the generalized public and to private forest owners to help educate them on the negative effects of invasive plants.

States have identified and use many different methods of outreach and education they consider to be effective. Many states rely a considerable extent on their forest agency's website, and personal interactions and meetings to convey information on invasive plants. In addition, many states are limited to how effective their outreach and education can be based on the costs of programs and staffing. Numerous states also work with partners to help create and deliver the invasive plant content.

Methods of outreach and education similar to those incorporated in the *Explore Oregon Forests* website have the potential of being used by other state forestry agencies. The EOF

project uses interpretive concepts to provide a greater public understanding and awareness of invasive plants. This type of outcome is desired by many of the state forestry agencies surveyed, and could work well for state agencies trying to reach forest recreation users.

The *Explore Oregon Forests* project approach of trying to use tourism to educate about invasive plants appears to be unique for most state forestry agencies. If future evaluations of the EOF project show it can raise awareness of invasive plants amongst tourists, it could guide the creation of similar projects for other state forestry agencies.

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Appendix

Appendix i: Coding Scheme used for Content Analysis

Question one: **Forest action plans list invasive plants as a topic of concern?**

To answer *yes* the following conditions must be met:

1. Any section within the document contains the discussion of invasive species as a subject of concern within that Forest Action Plan.
(Sections for information on invasive species are often included in section headings and sub-headings of Forest Action Plans (i.e. *Threats*, *Areas of Concern*, *Criterion*, *Issues*)
2. Topic matter qualifies as discussing invasive species when it meets the following conditions:
 - The wording combination “invasive plants” is stated.
 - The concept of invasive plants is derived or inferred contextually. For example, “concern over invasive species, including plants, insects and pathogens”.
 - The term “invasive” must be included as a descriptive element to any concept connected.
 - Acceptable synonyms for plants include: “vegetation” and “weeds”; weeds are considered invasive plants when connected to the term “invasive”.
 - Any additional state documents that include “invasive plants” are considered a part of a Forest Action Plan when complete sections of the plan are included in the Forest Action Plan.

Question Two: **Forest action plans include outreach and education as a strategy to address invasive plants?**

Conditions for question two to be coded *yes*:

- “Outreach and education” are considered present when the following terminology is present: educate, education, educational, awareness, outreach, disseminate.
- They must directly discuss terms considered to be “invasive species” (*See question one*). This can be a direct-wording connection.
- Example: Promote great public awareness of invasive plants, or reference a section or assessment in which invasive species are listed.
- Example: In Assessment Section *Issue 3.2: Invasive Species Present a Threat to Forest Health*. In Strategy Section: 3.2, Possible Strategies: *Create public education and outreach projects*

Question 3. **Do forest action plans include outreach and education as a strategy to address forest health which invasive species may or may not be a part of?**

Question 3 will be coded *yes* when the following conditions are met:

1. Question 1 has been coded: *yes*
2. Outreach and education are presented as a strategy for addressing “forest health

Appendix ii: Questionnaire for State Forestry Agency Representatives

Default Question Block

Public Outreach and Education in the Management of Invasive Plant Species Questionnaire

The purpose of this survey is to learn more about how State Forestry agencies use public outreach and education to address non-native invasive plant species in non-federal forests. This survey is part of a research study that is comparing how outreach and public education are used as management tools by different State Forestry agencies.

The survey results should provide a clearer picture of outreach and public education with regard to invasive species management in general and in terms of relevant agencies at state level. All respondents can receive a summary of the results of the report.

Various methods including professional networks have been used to identify appropriate respondents for this survey in each state including yourself. Please answer the following questions as a representative of your agency and to the best of your knowledge. However, if you feel that these questions would be much better answered by someone else in your agency please contact me and we will work to redirect the survey to that staff member.

Based on pretesting the overall survey should take about 15 minutes to complete and your time is greatly appreciated. The survey will save your progress as you go so you do not need to complete it all in one sitting. Please answer all questions within two weeks of receiving this survey. If you have any questions about this research project, or need any clarifications please email me at Daniel.Gleason@oregonstate.edu.

Sincere regards,

Daniel Gleason
MS Student
Department of Forest Ecosystems and Society
Oregon State University

Block 6

Clarification of "management" as used in the survey:

As used here, "management" includes all strategies and active efforts used to control the spread of, eradicate and prevent the introduction of non-native invasive plant species **found in forests**.

Click "Next" to begin the survey. Your answers will automatically be saved after each page is completed.

Block 1

Does your agency manage invasive plants on non-federal forests? **(Select one)**

- ☐ Yes
☐ No

How important to your agency is the management of invasive plants, pathogens and insects in your forests? **(Select one response for each)**

	Not at all Important	Slightly Important	Moderately Important	Extremely Important
The management of Invasive plants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The management of invasive pathogens	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The management of invasive insects

Rank the following management priorities within your agency
(Drag the answers so "1" reflects the highest priority, "2" the second and "3" for the lowest priority)

- The management of invasive plants
- The management of invasive pathogens
- The management of invasive insects

Is your agency **currently** using public outreach and education in the management of invasive plants? (Select one)

Yes

No

Unsure. Please explain

Is public outreach and education a part of your agency's **future strategy** for managing invasive plants? (Select one)

Yes

No

Unsure, please explain

How frequently does your agency use the following methods for public outreach or education about invasive plants?
(Select one response for each)

	Never	Rarely	Sometimes	Often	All of the Time
Radio ads					
Interpretive displays					
Social media (Facebook, Twitter, etc.)					
Paper brochures					
TV ads					
Billboards					
Web based videos					
Conferences/presentations					
Agency website					
Mobile "apps"					
Public talks/ meetings					
Other (Write in response)					
Other (Write in response)					

From the choices above, rank the top three methods that your agency feels are most effective for public outreach or education about invasive plants? (Mark a "1" for the most effective method, "2" for the second and "3" for the third)

Radio ads
 Interpretive displays
 Social media (Face book, Twitter, etc.)
 Paper brochures
 TV ads
 Billboards
 Web based videos
 Conferences/presentations
 Agency website
 Mobile "apps"
 Public talks/ meetings
 Other (Write in response)

How important are the following goals to your agency for public outreach and education about invasive plants? (Select one response for each)

	Not at all Important	Slightly Important	Moderately Important	Extremely Important
A greater public awareness of "invasive species"				
Assistance from the public in detecting specific invasive plant species				
Active engagement from the public in removing invasive plants				
Public support for the removal of invasive plant species				
Public support for invasive species management in general				
Preventing people from transporting or spreading invasive plants				
Improving forest health				
Improving private forest management of invasive plant species				
Other (Write in response)				

Rank the top three most desired outcomes from your agency's programs for public outreach and education about invasive plant species. (Mark a "1" for the most desired, "2" for the second and "3" for the third)

A greater public awareness of "invasive species"
 Assistance from the public in detecting specific invasive plant species
 Active engagement from the public in removing invasive plants
 Public support for the removal of invasive plant species
 Public support for invasive species management in general
 Preventing people from transporting or spreading invasive plants

species?

Does your agency have a method to evaluate the effectiveness of its outreach and education about invasive plant species? **(Select one)**

Yes

No

Please explain the evaluation method.

Block 2

In the section below, please select a bubble to indicate once choice from the following statements **(Select one response for each question)**

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
My agency has the resources it needs for effective outreach and education strategies for invasive plants					
My agency does not need resources for outreach and education because there are very few invasive plants in our forests					
Educating stakeholders about invasive plants is an important part of my agency's management of invasive plants in our forests					
Educating tourists about invasive plants is an important part of my agency's management of invasive plants in our forests					

How do the following limiting factors influence how effective your agency's use of public outreach and education is in the management of invasive plant species? **(Select one response for each)**

	Does not influence	Slightly influences	Moderately influences	Greatly influences
Limited budget for the management of invasive plants				
Limited leadership support				
Limited staffing to create and carry out outreach and education programs				
Limited outreach and education content				
Limited outreach and education delivery tools				
Outreach and education are not part of current invasive species management plans				
Limited groups to form collaborations with				
Difficulty identifying appropriate audiences for outreach and				

education

Limited public support

Outreach and education are handled by other agencies or groups

Limited budget for outreach and education about invasive plants

Other (Write in response)

17

From the limiting factors above, rank the **top three** that most greatly influences how effective your agency's use of public outreach and education is in the management of invasive plant species. (Mark a "1" for the factor with the greatest influence, "2" for the second and "3" for the third)

Limited budget for the management of invasive plants

Limited of leadership support

Limited staffing to create and carry out outreach and education programs

Limited outreach and education content

Limited outreach and education delivery tools

Outreach and education are not part of current invasive species management plans

Limited groups to form collaborations with

Difficulty identifying appropriate audiences for outreach and education

Limited of public support

Outreach and education are handled by other agencies or groups

Limited budget for outreach and education about invasive plants

Other (Write in response)

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Does your agency currently collaborate with other groups/agencies for the management of invasive plant species using public outreach and education? (Select one)

Yes

No

Block 3

How important are collaborations with other groups/agencies for the following aspects of your agency's outreach and education regarding invasive plant species? (Select one response for each)

	Not at all Important	Slightly Important	Moderately Important	Extremely Important
For content creation				
For reaching target audiences				
For content delivery				

Does your agency create its own content for public outreach and education regarding the management of invasive plants? (Select one)

Yes, we solely are involved in content creation

Yes, but we work with collaborators to create content

No, we only use materials made by other groups

No, we don't use outreach and education material

Unsure. (Please explain)

What has been your agency's most successfully method or campaign for public outreach and education about invasive plant species? (Please write a brief explanation in the space below)

Block 4

If you would like to receive a brief report on the results of this survey, leave your email address below.

Block 5

Please fill in the following information:

First Name:

Last Name:

State where you are
employed:

Name of the agency you
represent:

Title within your agency:

Thank you again for taking the time to participate in this study.

Appendix iii List of Results by State for Content Analysis

States	Invasive plants listed as threat in state	Outreach and education as part of strategy for invasive plant management	Outreach and education as part of strategy for forest health management
Alabama	Yes	Yes	Yes
Alaska	Yes	Yes	Yes
Arizona	Yes	No	Yes
Arkansas	Yes	Yes	Yes
California	Yes	Yes	Yes
Colorado	Yes	Yes	Yes
Connecticut	Yes	Yes	Yes
Delaware	Yes	No	Yes
Florida	Yes	Yes	Yes
Georgia	Yes	Yes	Yes
Hawaii	Yes	Yes	Yes
Idaho	Yes	No	Yes
Illinois	Yes	Yes	Yes
Indiana	Yes	Yes	Yes
Iowa	Yes	Yes	Yes
Kansas	Yes	Yes	Yes
Kentucky	Yes	Yes	Yes
Louisiana	Yes	Yes	Yes
Maryland	Yes	Yes	Yes
Massachusetts	Yes	Yes	Yes
Maine	Yes	No	Yes
Minnesota	Yes	No	Yes
Michigan	Yes	Yes	Yes
Mississippi	Yes	Yes	Yes
Missouri	Yes	Yes	Yes
Montana	No	No	
Nebraska	Yes	No	Yes
Nevada	Yes	Yes	Yes
New Hampshire	Yes	Yes	Yes
New Jersey	Yes	Yes	Yes
New Mexico	No	No	
New York	Yes	Yes	Yes
North Carolina	Yes	Yes	Yes
North Dakota	No	No	
Ohio	Yes	Yes	Yes

Oklahoma	Yes	Yes	Yes
Oregon	Yes	Yes	Yes
Pennsylvania	Yes	Yes	Yes
Rhode Island	Yes	No	Yes
South Carolina	Yes	Yes	Yes
South Dakota	Yes	Yes	Yes
Tennessee	Yes	Yes	Yes
Texas	Yes	Yes	Yes
Utah	Yes	No	Yes
Vermont	Yes	Yes	Yes
Virginia	Yes	Yes	Yes
Washington	Yes	Yes	Yes
West Virginia	Yes	Yes	Yes
Wisconsin	Yes	Yes	Yes
Wyoming	Yes	Yes	Yes

