# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CH</th>
<th>TOPIC</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ABOUT THE INVADERS OF TEXAS PROGRAM</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>INTRODUCTION TO INVASIVE SPECIES</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>FIELD PREPARATION</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>SPECIES SELECTION</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>COLLECTING DATA USING THE TX INVADERS MOBILE APPLICATION</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>USING GPS</td>
<td>27</td>
</tr>
<tr>
<td>7</td>
<td>TAKING USEFUL PHOTOGRAPHS</td>
<td>29</td>
</tr>
<tr>
<td>8</td>
<td>THE SENTINEL PEST NETWORK</td>
<td>33</td>
</tr>
<tr>
<td>9</td>
<td>THE ERADICATOR CALCULATOR</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td><strong>Appendix A</strong> DATA COLLECTION FOR ONLINE SUBMISSION</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td><strong>Appendix B</strong> ONLINE DATA ENTRY</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td><strong>Appendix C</strong> AQUATIC INVASIVE SPECIES</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td><strong>Appendix D</strong> INVASIVE SPECIES LIST</td>
<td>59</td>
</tr>
</tbody>
</table>
This edition extensively revised by
Hans Landel, Ph.D., Invasive Species Program Coordinator
University of Texas at Austin Lady Bird Johnson Wildflower Center

2019
CHAPTER 1

ABOUT THE INVADERS OF TEXAS PROGRAM

Welcome to the Invaders of Texas volunteer citizen scientist team! You are part of an exciting program developed by the Lady Bird Johnson Wildflower Center in partnership with the Texas Forest Service, Texas Parks and Wildlife Department, Texas Master Naturalists, USDA APHIS and many others. This innovative initiative was launched with the April 20th, 2005 premiere of National Geographic’s Strange Days on Planet Earth TV series on PBS. The opening episode of this series was all about Invaders.

Invasive species – organisms that evolved in one area of the world and become problematic in other areas – are becoming increasingly worrisome. One reason for the concern is that we humans are major intentional and/or unwitting agents of transportation for these marauding plants and animals. How serious is the problem? What do we stand to lose? As renowned biologist E. O. Wilson states, “On a global basis…the two great destroyers of biodiversity are, first, habitat destruction and second, invasion by exotic species.” These invasive species aggressively overtake or displace native species, and their ecological and economic impacts can be enormous. In 2000, experts estimated the cost of invasive species to the US economy alone is over 135 billion dollars each year. It is much more now.

Invaders of Texas is an innovative campaign whereby volunteer "citizen scientists" are trained to detect the arrival and dispersal of invasive species in their own local areas. You will be working throughout Texas to help detect invasive plants and enter the data into the detection database through a web-based data entry form. The data you collect will be mapped and shared with managers on the ground for use in pest and weed management planning and eradication. The premise is simple. The more trained eyes watching for invasive species, the better our chances of lessening or avoiding damage to our native landscape.

In addition, you will be learning to identify invasive species and enter your detection data via a mobile app. Your participation in this initiative will not only benefit Texas, but will also contribute to national efforts to map the distribution and spread of invasive species.

This workbook, in association with the training program, will take you on a step-by-step journey through the Invaders of Texas Citizen Science program. By day’s end you will be trained and ready to join hundreds of citizen scientists like yourself engaged in the detection and reporting of invasive species throughout our fair state.
Being an Invaders Volunteer

We hope you will find volunteering in the Invaders of Texas Program as an opportunity to learn as much as possible about invasive species in Texas. We have goals for the outcomes of our program efforts as well as goals for your own development as volunteers. We will measure the former in an evaluation process at the end of the program. To measure the latter, we have established a series of benchmarks that you will be able to follow as you progress through your training and subsequent fieldwork.

Goals of the Invaders of Texas Citizen Science Program

In this program, we have several goals we hope to accomplish:

♦ Begin to develop a baseline map of targeted invasive species in Texas.
♦ Develop partnerships with regional resource management agencies to guide us toward sites where we can focus our detection and reporting efforts.
♦ Provide information to these partners that helps lead to the control and/or eradication of invasive species where possible, and through these connections, provide our volunteers an opportunity to help in these eradication efforts.
♦ Bring our cohort of Invaders volunteer trainees to a level at which they feel comfortable training other citizen scientists in the future.

Volunteer Activities

Volunteers in the Invaders of Texas Citizen Science program will be engaged in the following activities:

1. You will be trained in the identification and reporting of invasive species,
2. You will conduct surveys in the field to observe and record the presence of targeted species, and
3. You will use a mobile app to submit your observations to an online database.
4. If necessary, you can instead use GPS and a digital camera in the field to confirm location and identification of targeted species, and then use the web to post data and images to the online database.

Volunteer Qualifications

In order to perform the activities cited above, volunteers should have or be willing to acquire the following skills:

1. **Field experience**: Hiking skills, field-worthiness, and ability to walk on uneven terrain and work in all weather conditions. Ability to handle all situations in the field, including map reading, trail-finding, and first aid situations.

2. **Technical skills**: Ability to use (or be trained to use) digital cameras, GPS units, and an online database.
3. **Background**: Some background in natural history with an emphasis on plant identification. Familiarity with Texas ecosystems is helpful.

4. **Other**: A desire to help stop the spread of invasive species.

### Beyond Detection and Reporting

Finally, we hope that you will share what you learn with friends, family, and neighbors and take your interest to new levels. For those whose interest extends beyond early detection and reporting, we encourage you to form local partnerships with institutions and agencies that are doing eradication projects so that you might assist in the management of some of the species we track.

### Invaders Program Organizational Structure

The Invaders program is set up as a distributed network of satellites consisting of groups of volunteer citizen scientists under the direction of a satellite leader. The satellite leader recruits volunteers, organizes local workshops and outings and serves as the point of contact for the program administrators at the Lady Bird Johnson Wildflower Center.

While the satellites operate somewhat autonomously and report on different invasive species, they are all linked together by common training and the shared early detection and reporting database that resides at [www.texasinvasives.org](http://www.texasinvasives.org).

The **Citizen Scientists** section of the website lists all of the existing satellites and provides contact information for the satellite leaders. If there is already a satellite working in your area, we encourage you to join that group by contacting the satellite leader. If your location does not have an active satellite, you can register yourself as a **Voyager** or contact program administrators to make arrangements to establish a new satellite.
CHAPTER 2

INTRODUCTION TO INVASIVE SPECIES

What Is an Invasive Species?

An invasive species is non-native to the ecosystem in consideration and causes or is likely to cause economic or environmental harm or harm to human health (EO13112).

Sometimes you will see invasive species referred to as exotic, alien, or non-indigenous species. The problem with these names is that they only refer to the non-native part of the definition above. Many exotic or alien species do not cause harm to our economy, our environment, or our health. In fact, the vast majority of “introduced” species do not survive and only about 15% of those do go on to become “invasive” or harmful.

An invasive species grows/reproduces and spreads rapidly, establishes over large areas, and persists. Species that become invasive succeed due to favorable environmental conditions and lack of natural predators, competitors and diseases that normally regulate their populations.

How Did Invasive Species Get Here?

Plants and animals have been moving from one place to another for many millennia. These movements have been relatively slow, allowing for life forms to adapt to changes in habitat and species interactions. Humans have always been agents of dispersal for plants and animals either accidentally or intentionally. However, as humans began exploring the planet on a larger scale, rates of introductions of species to new areas accelerated. Now with our global economy and advanced technologies, these rates have reached a level never before seen in ecological history.

How Did Invasive Species Reach the Southwest?

For more than 2,000 years, Native Americans moved plants and animals all over the Southwest. Starting in the 1500’s, the number of new exotic species as well as the speed at which they moved increased. The Spanish brought exotic agricultural crops and domestic animals from other parts of the world to the Southwest during the Spanish conquest. The new species introduced to the Southwest between 1500 and 1900 were accompanied by changes in physical conditions in the landscape that accelerated the naturalization of these exotics. At the same time, native species were declining. Dams and grazing significantly contributed to the spread of exotic species. The arrival of the railroad resulted in another increase in invasive species. With the development of roads, airlines, and global commerce, species can now travel from one corner of the world to another in a matter of hours.
What Is an Introduction?

When a species ends up in a new ecosystem, it is considered “introduced.” Species do naturally change their ranges slowly over time, but it is not these “natural” events that we are concerned with. Most of the introductions that result in invasive species are human caused. In some cases, we deliberately introduce species. Examples of this include garden ornamentals, range forage plants for cattle, animals and insects used to control other organisms (particularly in agriculture), and plants used for erosion control and habitat enhancement for wildlife. Other species are introduced accidentally on imported nursery stock, fruits, and vegetables, in ship ballast waters, on vehicles, in packing materials and shipping containers, through human-built canals, and through human travel.

How Does a Species Become Invasive?

It is not enough for a species to be able to exist in its new environment, although a close match between environmental conditions in the species' home environment and the environment to which it is introduced is fundamental to its survival there. Beyond this, the organism must be able to establish a viable and growing population. To do so, the new species must be capable of out competing and/or displacing native organisms.

Lack of natural controls in the new environment is also a factor in the establishment of invasive species. Without the diseases, parasites, and predators that regulated the invader's population in its homeland, it can spread rapidly.

Native species may also lack adaptations that allow them to resist competition from or predation by invasive species. If the invasion (particularly with plant species) is coupled with other disturbances to the new ecosystem (e.g., earth moving, plowing, fire, livestock grazing, changes to surface and groundwater hydrology), native populations may be weakened from the start and the ecosystem rendered more susceptible to an invasion.

Why Do We Care?

Invasive species are a form of biological pollution. Invasive species decrease biodiversity by threatening the survival of native plants and animals. They interfere with ecosystem function by changing important processes like fire, nutrient flow, and flooding. Invasive species hybridize with native species resulting in negative genetic impacts. As renowned biologist E. O. Wilson states, “On a global basis...the two great destroyers of biodiversity are, first, habitat destruction and second, invasion by exotic species.”

Invasive species also have economic consequences and can endanger human health. Invasive species contaminate agricultural seed crops and reduce their value, pose health threats to livestock, and necessitate costly repairs to harvesting machinery. Invasive insects can harm crop plants and reduce their productivity, contaminate harvest surpluses, and act as vectors of disease among livestock or in human
populations. Invasive species can also destroy electrical equipment, homes, and buildings. Control of these organisms chemically, biologically, and mechanically exacts great expenditures of time and money in addition to the losses mentioned above. In the United States alone, these expenses may total many tens of billion (the latest National Geographic article on Invaders estimates the cost at $135 billion) dollars annually.

What Can You Do to Stop the Spread of Invasive Species?

Volunteer - You have already taken the first step to help stop the spread. Becoming a volunteer in the Invaders of Texas program is a great way to help invasive plant managers and eradication groups to successfully prevent and control invasions. You are also preparing yourself to be an educator of others in our community and beyond. You may also want to join an eradication program in your area.

Educate yourself and others - You will learn the basics of invasive species threats and issues during your citizen scientist training. There are many other sources of information available to you both in this handbook and on the website. Take this opportunity to expand your knowledge and share it with your family, friends, and others in the community. If you come upon information sources that you think would benefit other volunteers, please let us know so we can share that information. We are relying on you as a citizen scientist to not only collect scientific data, but to actively participate in our invasive species community awareness campaign.

Do not be a vehicle of dispersion - Most invasive species are introduced accidentally. Learn how to prevent carrying invasive species on your boats, cars, bicycles, motorcycles, and socks and hiking boots.

Be PlantWise - If you like to garden, follow guidelines that help prevent harmful invasive plants from invading our parklands and natural areas:

1. **Know your plants.** Find out which plants cause problems in parks or natural areas in your region to know which species to avoid.

2. **Use non-invasive alternatives.** Ask a nursery about non-invasive plant alternatives. Native plants often have similar characteristics to invasives without the damaging ecological side effects.

3. **Watch out for invasive plant hitchhikers.** Check clothes, belongings and vehicles for seeds and pieces of plants that attach and drop somewhere new.

4. **Have a care if you share.** Many invasive plants move around because they are attractive garden plants. Do not share cuttings, seedlings or plants that are invasive with neighbors and friends.

5. **Use only seed mixes that are invasive plant-free.** Check the ingredients of seed mixes to make sure invasive plants are not included. Buy seed mixes from
reputable sources that guarantee the purity and content of their seed. Take your regional native plant list with you when you buy the mix.

6. **Use weed-free soil and mulch mix.** Some invasive plants are introduced because they were contaminants in landfill soil and mulch mixes. Purchase from reputable manufacturers that guarantee the purity or weed-free content of their soil and mulch mixes. Look for a tag that says "Certified weed-free."

7. **Be especially careful with aquatic plants.** Don't just dump them! Invasive aquatic plants are often introduced as attractive water garden and aquarium decorations.

8. **Keep an eye on new sprouts and volunteers.** Invasive plants can come from anywhere and spread very quickly. Some make attractive additions to our gardens but can spread very quickly by producing lots of seedlings. Control your invasive garden plants by hand pulling or mowing unwanted seedlings to prevent them from growing to maturity. Be aware of what is coming up in your yard and take care to control these new volunteers.

9. **Dispose of invasive plants carefully.** When disposing of invasive plant material consider whether there are any seeds, fruits or cuttings that could re-sprout. At a minimum, bag these materials to help prevent their spread. If it is permitted in your area and can be safely done, consider burning the plant material.

10. **Contain it, control it or cage it.** If you can't part with your invasive plant, take special steps to keep it in your garden such as inserting root barriers, trimming regularly or harvesting fruits or seeds before they are spread.
CHAPTER 3

FIELD PREPARATION

Group Projects

Initially during training and for several planned outings after the initial training, we suggest the project be carried out in groups with satellite leaders supervising data collection. After these group outings, volunteers can choose to be part of a small group that works together to monitor specific sites. For organized, small group outings, be sure you don't record the same plants.

Individual Projects

Volunteers may choose after initial training to work individually either at assigned sites or on personal hiking/camping/birding outings. Volunteers choosing this method should still have a companion with them in the field for safety reasons.

Local Networks

We encourage teams to form a network of local partners involved in invasive species prevention, monitoring, control, and eradication. Monitoring sites will be chosen based on recommendations and requests from these local partners. In some cases, this may be an organization requesting help with early detection in previously unmonitored areas. Other sites may include areas that underwent eradication previously and the purpose of monitoring will be to determine eradication success. It is our goal to target areas that are most in need of monitoring.

We also encourage volunteers to collect data when out in the field on recreational outings. It is important that you be aware of the rules regarding public vs. private property and various agency requirements for data collection.

Public and Private Land Issues

The goal of the Invaders of Texas Program is to have many eyes detecting and reporting invaders in as many places as possible. However, we have to be mindful of both public land rules and regulations and the rights of private landowners.

Public Land - Some agencies have very strict rules concerning collection of data and specimens on public property. For example, the National Park Service requires researchers to obtain permits for these kinds of activities. When in doubt about the public ownership of a property you plan to survey or the rules of collecting data on public lands, contact the agency responsible for the management of that property. We think you will find that most, if not all, public land managers will be supportive of efforts to detect invasive species on publicly held lands.

Private Land - It is important that we respect the rights of private landowners and do not trespass on their land without their specific permission. Keep in mind that Public
Rights of Ways (ROW) like roads are not considered private land. Many of your surveys will be along these ROWs. On the inside back cover of this handbook is a letter that you can present to landowners or the public should you receive inquiries while doing your fieldwork. This letter expresses assurance that our research project will not be conducted on their private property without consent and summarizes the goals and purpose of the Invaders Program.

Field Safety

Due to the field-oriented nature of the Invaders Program, your work will present you with the inherent physical risks posed by walking in a natural environment and getting to field sites. We recommend you follow these suggested safety precautions:

- Do not walk where you cannot see your feet. Thick vegetation may hide venomous animals or uneven terrain from view.
- If searching for species patches from a vehicle, always go in teams. Vehicle drivers should pay attention to the road. Passengers can look for target species.
- When surveying on roadsides, pull vehicles far off the road, taking care to park on a firm surface. Be aware of passing traffic and stay clear of traffic lanes while collecting data.
- Bring a cell phone (but be aware that many remote areas are out of service range) and carry a topographic map or trail maps of the area in which you are hiking.
- Do not hike alone and inform someone not in your party of where you are going and when you plan to return.
- Bring sufficient water and sun protection.
- If you have known allergies or other medical conditions that might require that you take medications in the field, bring your medications with you.

We would never ask you to perform a service that is beyond your comfort level. If you are ever concerned about field conditions on any outing, please tell your satellite leader.
Preparation for Field Work

Prior to visiting your field site for data collection make sure you have **good maps** and directions for getting to your site. Do not forget to fill up your vehicle’s gas tank and bring extra water, particularly if you are traveling far from inhabited areas. If you plan on working far from trails and roads, you should also have topographic maps of your area with you. **Make sure that you have permission** to be in that area. If you are not sure if collecting data in a particular area is permissible, it is better to err on the side of caution.

Make sure that you **let someone know where you will be going and when you expect to return**. This is important to do even when you are with a group of people. You should always **have a companion when working in the field**.

**Check the weather** before you head to the field site. You should not work in adverse weather conditions such as thunder and lightning storms. Be aware of the danger of flash floods particularly if you are working in riparian areas, washes, or flood prone areas. While it may be sunny and clear where you are working, precipitation can produce flash floods that are swiftly carried down washes to areas away from the center of the storm.

Make sure you bring **plenty of water, sunscreen, a hat, appropriate clothing and footwear, and a first aid kit**. Many of you will be walking off trails and roads so shorts and sandals are not recommended. If you have a cell phone, bring that with you. Keep in mind that you may be in remote areas where you are out of service range. This is why it is so important to let someone know where you are going and when you will be back. If you have known allergies or other medical conditions that might require that you take **medications** in the field, make sure you put those medications in your field pack.

**Check your field equipment** before you leave. Turn on your GPS units and cameras to make sure they are working properly and have good batteries in them. Bring extra batteries with you just in case. Make sure your pencils are sharpened and that you have sufficient blank data sheets for the number of areas you plan on visiting. Check that you have your Invaders handbook, a working sharpie pen, and your Invaders datasheets. At a minimum, make sure you bring the most important components with you: datasheet, GPS unit and camera, and the information letter for curious landowners or others.
When you arrive at your field area…

Once you have reached your destination, you will want to make sure that you bring all needed items with you in a pack, particularly if you are leaving your vehicle behind. Many unfortunate hikers and researchers carefully bring their cell phones, enough water, and blank datasheets only to leave them in the vehicle and find those items in need miles away. Make sure your vehicle is parked in a safe place – far enough from the road that it does not impede traffic and do not block roads, driveways, etc. After strapping on your backpack and locking your vehicle you are ready to enter the exciting world of scientific data collection.

Be aware of your surroundings. Venomous animals can be found throughout Texas. Do not walk where you cannot see your feet. Be comfortable with the area you are working in. If you are leaving roads and trails, make sure you have good maps, a compass, and feel confident with map navigation.

Field Kit Contents

A well-equipped field kit should include the following:

- Backpack
- Camera
- Camera memory card
- USB card reader and cable
- Extra batteries
- GPS Unit
- Clipboard
- Blank data sheets
- Species ID cards (if available)
- Invaders handbook
- Pencils/sharpie pens
- Maps
- Seed removal brush
- First Aid kit
CHAPTER 4

SPECIES SELECTION

Selecting Target Species

While there is not a definitive list of invasive species in Texas, of the 4834 vascular plants that occur in Texas some 496 species (10.2%) are suspected of causing invasive problems in natural areas somewhere in the United States. This information comes from Weeds Gone Wild, a web-based project of the Alien Plant Working Group whose object is to maintain a national list of invasive plants compiled from a wide variety of publications, reports, and surveys from federal agencies, state and local natural resource agencies, and related departments.

WWW.TEXASINVASIVES.ORG maintains an online database devoted to plants known to occur in or around Texas that are suspected of causing invasive problems in natural areas around the United States. It also displays plants listed by the Texas Department of Agriculture as noxious plants under the Texas Administrative Code 19.300. The purpose of this database is to provide illustrated plant descriptions, ecological information, distributions & habitats, history of introductions, plant reproduction, management approaches, and other useful information about the species listed. In addition, there are a large number of web resources dealing with invasive plant species including those listed below.

Links to Invasive Species Lists and Information:

- The Bugwood Network (http://www.bugwood.org)
- Nonnative Invasive Plants of Southern Forests (http://www.invasive.org/eastern/srs/)
- USDA NRCS Plants Database (http://plants.usda.gov)
- The Quiet Invasion: A Guide to Invasive Plants of the Galveston Bay Area (http://www.galvbayinvasives.org/)
- TDA Noxious and Invasive Plant List (http://www.texasagriculture.gov/regulatoryprograms/plantquality/noxiousandinvasiveplants.aspx)
- TPWD Prohibited Exotic Species (http://www.tpwd.state.tx.us/huntwild/wild/species/exotic/)
Since each region of the state is unique in its flora (including the presence or absence of invasive species), each satellite of the Invaders of Texas program must develop its own species list. Check the appendix of your notebook for the current list of species that are being reported as part of the Invaders program. There are a number of criteria you will want to consider when selecting your Invaders species.

**Invasive Species Selection Criteria**

- Should be findable (reinforce volunteer interest and enthusiasm).
- Readily identifiable with training and tools (preferably macro).
- Representative of different taxa to make the project broad in scale (i.e., not all members of a single family or genus).
- Have a substantial negative impact on local ecosystems.
- Important (i.e., a species currently being monitored to support existing research as in tamarisk or one that is an expected new arrival like tropical soda apple).
- Species list should be small enough in total numbers (not more than a dozen species) to wrap the brain around, yet numerous enough to exemplify regional invasive species issues.

Using these criteria, develop a list of 8-12 invasive plant species for your region and fill in the table below:

<table>
<thead>
<tr>
<th>USDA Symbol*</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*USDA Symbol - USDA's PLANTS Database provides standardized information about U.S. plants, including an abbreviated code or symbol based on the first two letters of the Genus and first two letters of the specific epithet. For example, the USDA symbol for *Lupinus texensis* is LUTE.
Data collection for the Invaders program can be broken down into two basic questions: What is it and where is it? To answer these questions, you will record Species Observations. As we cover the procedures for collecting species observation data, you will find it helpful to refer to the blank datasheet at the end of Appendix A.

There are two methods for collecting and submitting data: by using a mobile app, and by using a combination of GPS unit, camera, and data sheet followed by submitting data online using your browser. We cover using the mobile app here, and cover the other method in Appendix A.

Using the TX Invaders mobile application, you can document invasive plant species with your Smart Phone (Android or iPhone). The TX Invaders app streamlines reporting with image capture, GPS and datasheet entry all in one device. It also contains much of the online Invasive Species database.

Reports generated in the TX Invaders mobile app are saved in an Upload Queue until your Smart Phone has wireless access and you can upload them into Recent Observations on your Citizen Scientist profile page. The reports remain in Recent Observations until validated.

The reporting function of the app uses your Invaders of Texas account login information. It allows for both online and offline reporting. When offline, reports are saved in your queue and uploaded when connectivity is restored.

How to Use the TX Invaders Mobile Application

Step 1: Download the TX Invaders Mobile Application by directing your Smart Phone’s web browser to the appropriate link below:

- IPhone: https://itunes.apple.com/app/texas-invaders/id572419215?mt=8

Step 2: Install the app. It may ask for permission to access your phone's camera and photo library/album, and your phone's location services/GPS. Grant it permission.
Once installed on your Smart Phone, open the app and the **Home Screen** will be displayed (Figure 1). From this screen you can access information on Texas invasive species, submit observations of invasive species, and log in.

![Home Screen](image)

**Figure 1.** Home Screen. (L: iOS. R: Android)

*Note: You do not need an Invaders of Texas (IT) username and password to use the app. You only need IT login credentials if you want to submit observations of invasive plants using the app.*

**Step 3: Getting Information on Particular Invasive Species**

A. Tapping on the **SPECIES BY CATEGORY** and the **ALL SPECIES** tiles of the home screen will allow you to find information on invasive species of Texas (Figure 2).

B. The list of species can be sorted by common name (default) or by scientific name, by tapping on the upper right button.

C. Plant lists have a **REPORT** button at the right. Avoid tapping it when selecting the plant. Species with the **REPORT** button are species on which you as a trained IT citizen scientist can submit an observation. See step 4 for how to use the **REPORT** button.

**Step 4: Reporting an Observation on a Species**

A. Before submitting an observation, you will need to log in to your IT citizen scientist account.

B. To log in, tap the **LOGIN** tile on the **Home** screen.
C. Once the Login Screen appears, enter your Invaders of Texas login credentials (Figure 3). Then return to the Home Screen by tapping on Invaders of Texas at the top of the screen in iOS (in Android, you will be taken back to the home screen).
D. To create an observation, walk up to the plant you are going to report. Navigate to the SPECIES BY CATEGORY or the ALL SPECIES list. Then find your species and tap on the REPORT button. The Observation screen will appear (Figure 4). Notice that it is automatically populated with the species name, date and GPS coordinates.

Note: You can manually select your GPS location by tapping on the map icon and dragging the pin to your location on the map that appears.

E. Complete the form, using the following guidelines.

Photos: We recommend that BEFORE you begin to fill out the form you take three or four photos and keep them in your phone's album/library and review
them to decide which is the best photo, THEN choose that photo from your phone's album/library by tapping on **Choose from Library** in iOS or on the photo library icon in Android.

Remember while taking photos to follow the recommendations in Chapter 7 to ensure your photos are useful. Note that a portrait mode photo will not completely fill the tiny space available for the photo.

**Location:** Tap on the map icon to change the location if necessary.

**Time Spent:** When filling out this section, we recommend that you take the view of someone who will be returning to the location to manage the invasive species. The time you enter will give that manager an idea as to how long it will take to find the species.

Indicate, in minutes, the total time spent making a species observation, including the time it took to get to the location. In iOS, tap on the appropriate time, or in Android, use the dropdown menu. If this is your first or last observation of the day, include the time needed to travel to or from the site.

**Disturbance:** This characteristic should define the area the invasive patch is occupying. Using the dropdown menu, you may choose any category under Disturbance or check **Other** and describe the disturbance in the Site Notes box. Select **None** if the site is undisturbed (other than the presence of the invasive species).

- Fire – Revealed by sparse vegetation and evident charcoal/ash
- Flood – Indicated by flattened and/or torn out vegetation and scouring of ground
- Graded – Scraped or smoothed to bare soil
- Cleared brush – Bulldozed with no mature woody vegetation
- Grazed – Land grazed by some sort of livestock (not pasture = grassland)
- Cropland – Established sown agricultural
- Roadside – Alongside a surface devoted to transportation

**Patch Type:** If you have not already done a visual or walking survey of the infestation of the invasive species, you should do that at this time. This will assist you with deciding whether the infestation is a single **point** (one or a few plants), a **linear** patch (plants extending along a line, which doesn't have to be straight), or a **polygon** (of non-linear shape). **Note:** If a point or linear patch has a diameter of more than 15 feet it would be considered a polygon. Choose the appropriate patch type from the dropdown menu.

**Abundance:** Data recorded here are key for managers and scientists who will be using your data. From the dropdown menu, choose **rare** if the species is hard to find and other plants are more common or check **common** if the species is one of the most common plants in area.
**Notes:** Tap on the *notes/comments* section to add notes. In iOS, exit the Notes section by tapping on the Return key.

For validation reasons, it is helpful but not necessary that you enter cross-streets of your site or a nearby roadway (e.g., corner of 290 and Circle Drive 4 miles west of Oak Hill), or other locations notes (e.g., in XXX Park, near the north entrance, near the first restroom, on XXX trail, etc.).

This is also your opportunity to describe the patch and abundance in more detail than you were allowed above. You can estimate the size of the infestation; mention that the infestation continues down the road or trail for yards/meters, is present in a very dense but confined patch and the surrounding area is free of the invasive species, that the plants are mostly saplings; add notes about the type of disturbance if you chose Other; etc., or any other descriptions that will help scientists and managers determine whether a return trip to that site is required for a more detailed survey, as well as help anyone returning to the site to manage the species understand what to look for.

If you will be removing/treating or removed/treated the plant(s), note that.

F. When you’re ready, tap on **Save** at the bottom of the screen.

**Step 5: Uploading your observation**

A. In iOS, note that a number icon has appeared on the **UPLOAD** tile on the **Home Screen** (Figure 5), indicating you have observations ready for uploading. You may continue making observations or upload. In Android, no number appears on the **UPLOAD** tile.

![Figure 5.](image)

B. When you are ready to submit your observation, tap on the **UPLOAD** tile. The **Upload Screen** will appear (Figure 6), listing each of your observations.

**Note:** The phone will store your observations in the upload queue until you are ready to submit them. This way you can accumulate multiple observations in your upload queue while in the field. If you don’t have cell reception and upload them simultaneously when you have restored cell or Wi-Fi service to your Smart Phone.
C. To edit an observation, simply tap on it. In iOS you’ll be brought back to the observation for editing. In Android, tap on **EDIT** in the dialog box that opens.

D. When you’re ready to submit your observation, tap on the **UPLOAD** button (iOS) or upload icon (Android) at the top right of the screen.

E. If you need to **Delete** an observation, in iOS, slide the observation to the left to expose the delete button, then tap on the **Delete** button (Figure 7). In Android, tap on the observation and tap **Delete**.

F. It is always a good idea to log in to your Citizen Scientist profile page at http://texasinvasives.org/observations/login.php to make sure your observations made it into your profile page. On that page, you can also edit, change the photo of, or delete your submitted observations.

---

Figure 6.

Figure 7.
Step 6: Using the “REPORT IT” function for the Sentinel Pest Network (See Chapter 10)

A. Tapping on the REPORT IT tile on the Home Screen (Figure 8) will bring up the Report It Screen (Figure 9).

*Note: You do not have to log in to use this function.*

![Figure 8.](image1)

![Figure 9.](image2)

B. Choose the species you would like to report (Figure 9) and complete the form (Figure 10). The form is long, so you will need to scroll to complete it. When ready, tap on the Submit button at the bottom of the screen.
Step 7: The “MORE OPTIONS” Tile

A. Tap on the **MORE OPTIONS** tile on the **Home Screen** (Figure 11) for information about the app, as well as to update the species list.
B. Tap on **RELOAD SPECIES LIST** to upload a revised species list (Figure 12). We recommend you do this every six months or so. Tap on the other lines for access to the indicated information.

![Invaders of Texas](image)

**Figure 12.**

**Frequently Asked Questions**

**What constitutes a Species Observation?**
Depending on whether you are hiking recreationally or targeting specific areas provided by a satellite leader, the answer to this question might take different forms. If you are hiking along a trail, your species observation will be a patch of invasives that you come across as you walk. When you reach a patch, you should do a visual survey of your surroundings to assess the extent of the infestation. This will help you decide where your site coordinates should be recorded.

**Can I record more than one species per observation?**
The answer is no. If you are working in an area with multiple invasive species and they are overlapping significantly, you should fill out a datasheet and photograph each of the species in that area.

**How big can a site be?**
Another consideration is whether you need to record multiple species observations (datasheets) for a particularly large infestation of one species. This will be a call you will make in the field. Remember that if this location ends up being particularly important, a scientist or manager will likely come back to do further surveys or to perform management actions, so you do not need to collect data every few feet for the same species infestation. However, if you walk more than 100 yards and find a couple of separate patches, you will want to fill out a datasheet at each patch. If you walk along a wash, trail, or road that is completely infested for miles, you may want to set up several collection points (for example: at either end of a trail, or every 100 yards in a wash, or every few miles along a road or highway).

Another way for you to look at it is as a manager using your observations to control the infestation. A manager will use the information to find the infestation and to plan how to manage it.
If you are still not sure about how you should approach data collection in an area, ask your satellite leader for advice.

**What Happens To Your Data Now?**

**Data Validation**
Program staff (or their designee) will validate your species observations using the GPS coordinates, images and other information that you provided to the database. If for some reason your data do not pass the validation test (e.g., GPS coordinates are off or the invasive species is misidentified), the program staff will contact you.

**Mapping**
The [www.texasinvasives.org](http://www.texasinvasives.org) website uses the data and GPS coordinates you submit to create dynamic Google maps of the infestations. See **Map Invasives** under the **Invasives Database Menu**. These maps are available online for managers, scientists, and others working with invasive species. Your data might be used to find areas that need more intense surveys or to develop management strategies including plans for prevention, control and removal.

**National Database**
The data collected in the Invaders of Texas program are submitted to the Center for Invasive Species and Ecosystem Health’s Early Detection & Distribution Mapping System ([www.eddmaps.org](http://www.eddmaps.org)), to become part of the national database on invasive species.
CHAPTER 6
USING GPS

Introduction

To map the location of an infestation of invasive plants, we need its coordinates. Your phone will automatically determine your location's coordinates, using GPS. This chapter explains how GPS works. It mostly does so with respect to hand-held GPS units, but the information applies to your phone as well, since it is a GPS receiver.

What is GPS?

GPS stands for Global Positioning System. It is a satellite-based navigation and positioning system originally developed for US military applications and, in recent years, made available for civilian use worldwide.

How does GPS work?

GPS measures the time difference between a signal sent from a satellite with a known position to a ground receiver. Four such signals will very accurately determine the position of the receiver. Twenty-four satellites, in very stable orbits at about 11,000 miles altitude constitute the heart of the system.

Your hand-held receiver (i.e., phone) searches from the signal from each of these satellites and in some cases, the signal from a satellite in geosynchronous orbit at about 23,000 miles altitude. It will read signals from any satellite within direct line of sight above the horizon. Signals from satellites 15 degrees above the horizon or higher will typically yield signals usable for accurate positioning.

GPS Accuracy

Most GPS receivers will generate a reasonably accurate position within a minute or two – often much faster. While GPS “fixes” are quite good, positional inaccuracy is great enough in most cases that you will want describe in your site notes which side of the road you're on (N,S,E,W) if you're collecting data on a roadside.

Setting Up Your Hand-Held Receiver

Note: the mobile app on your phone will automatically record the coordinates, and submit them as part of your observation when you submit the observation from the
phone. Please recognize that portions of this section apply only to hand-held GPS receivers and the manual online entry of data (Appendix A).

You will need to set up your receiver to display geographic coordinates in **decimal degrees**. GPS receiver menus often have this setting in the *Units* tab. On Garmin Etrex receivers decimal degrees appear as the menu choice, \texttt{hddd.ddddd}. Other GPS receiver models will feature slightly different set-ups, but all are similar.

Select “\texttt{WGS 84}” or “\texttt{NAD 83}” in the map datum category of your system set-up menu. This refers to the system that GPS uses to match coordinates with ground-based mapping systems. It will sometimes be listed as “\texttt{WGS84/NAD83}.” The difference of plotted points using the two systems will be of no consequence on this project.

**Reading and Recording Decimal Degrees**

Geographic coordinates historically were recorded in the format, degrees-minutes-seconds of latitude measured north and south and originating at the equator and degrees-minutes-seconds of longitude measured east and west and originating at the prime meridian which runs through Greenwich, England. Thus a point determined to occur at the Lady Bird Johnson Wildflower Center would appear as 30° 11' 09.2" N, 097° 52' 26.0" W. Using decimal degree notation, it is written 30.18588° N, 097.87388° W. All points in Texas are North latitude and West longitude. We use the decimal degree format for ease of data entry and for use with online mapping applications.

Degrees of longitude are recorded as negative numbers for positions located in the western hemisphere. Thus, many mapping and data entry applications require the entry of a minus sign before the longitude value in order to differentiate it from a point in the eastern hemisphere the same distance from the prime meridian. When entering data for the Invaders of Texas program online, the required minus-sign is provided by the system. Further, while properly written as a three-digit number (e.g. -097), many mapping and data entry applications require dropping any leading zeros. It is not necessary to enter the leading zero for degrees of longitude, though if you do, the database will accept the entry but drop the zero when displayed.
CHAPTER 7

TAKING USEFUL PHOTOGRAPHS

Digital images will be used to document your species observations. These images will be stored in the database along with the text and location data to allow an expert to validate your data submission. **Because they are used for validation, they must be high quality.** If we can't validate your observation, we will need to discard your observation, which means you will have wasted your time. Therefore, it is in your interest to take good photographs.

**Good Pictures vs. Bad Pictures**

The whole point of taking pictures for this project is to allow someone else to verify the identity of the species that you're recording. Bad images are very difficult to validate; really bad images are impossible. While the type of photography you will be doing on this project is more technical than artful, many of the principles for good photographs still apply. Following are some general photography hints that will help you capture better images.

**Take photos of the plant's identifying characteristics** – This allows the validator to validate your identification. *Know your plant!*

**Take multiple photos** – It is usually a good idea to shoot multiple images of the same subject from different angles, distances and, if using a camera and not a phone, with different camera settings, in order to ensure a suitable image for validation. *Check them to choose the best to submit.***

**Wind** – The Texas countryside is notoriously windy. Windy conditions make for especially difficult photography, especially close-up photography. Do what you can to ameliorate the problems caused by strong winds. Early mornings and late afternoons generally are less windy than midday. Those times of day also offer the advantages of typically more favorable light for photography and usually more pleasant temperatures for the photographer. Hold the specimen to keep it from moving in the wind if necessary. Creating a physical barrier to block the wind is sometimes an option. You can also remove the subject to a less windy position for the purposes of photographing it. However, if you do so please note that fact in your comments if the location is far from the location of the observation.

**Framing** – Get the subject in the frame. It is very important to frame the critical recognition features in the image.

While it is not critical to keep extraneous objects out of these images, it is nevertheless a good idea to minimize them as much as possible. Extraneous background objects can cause image interpretation problems in some cases, but more importantly, they can cause the phone/camera to choose the wrong aperture and shutter speed if the objects have a substantial tonal difference.
Focus – Auto-focus is a wonderful feature offered by all modern cameras. However, it can cause serious problems, especially when making close-up images of plants with small or thin features. The camera will focus on what its program tells it is the most likely subject you wish to shoot. Very often the camera ends up focusing on the soil or vegetation somewhere behind the subject you intended.

If you wish to use auto-focus, it is a good idea to use some technique to “trick” your camera into focusing on the intended subject. A handy object to use for close focusing is your own hand. While holding your camera with one hand, extend your other hand to the plane of the photographic subject with your palm facing the lens or with the subject touching your palm. Then take the picture.

If you’re using a camera, it might not focus close enough for you to use your hand. In that case, you may wish to make a focusing subject on a stick to use for that purpose. Otherwise you might consider using the manual-focus feature of the camera and measuring the distance between the camera and subject. If you are going to manually focus your camera using the camera’s built-in manual-focusing distances, it is a good idea to check those distances at home before going into the field.

Try to adjust your camera position so that, as much as possible, your subject lies on a plane parallel to the camera’s focal plane – the photo sensor. Not only will more of your subject be in focus, but it is less likely that parts of the subject that lie in the foreground will cause focusing problems in the auto-focus mode.

Exposure – After focusing problems, the most common photographic fault encountered is with exposure. That is, creating an image in which the subject appears too bright or too dark. Backlit subjects will almost invariably appear to be dark. Always try to keep the sun at your back, or at least not behind the subject when taking your field photographs. If you have no choice other than to shoot a backlit subject, you will need to find a way to supplement the lighting on your subject artificially. One way is to use a reflector to bounce some of the sunlight back onto the subject. For close-ups, a sheet of white paper will often work well enough for this purpose. You can also use your camera’s flash, but it is often tricky to get the exposure right. Also, you will need to operate your camera’s flash in manual mode to get it to fire when shooting into a bright light situation.

For close-ups, a handy trick to attain the proper exposure on your images is to use a “gray card” background. A gray card is a piece of poster board or paper that is of a neutral tone – somewhere near halfway between white and black. It doesn’t have to be gray; blue brown and even green are also good colors. Your camera will chose an exposure setting based largely on the background behind your subject. By filling that background area with a “gray card”, your subject is much more likely to be properly exposed.

Shutter Speed – This applies to an actual camera more than to a camera phone.

As previously stated, our Texas winds can cause significant problems with creating
good, identifiable images. If you’re shooting on a windy day, it may be necessary to set your shutter manually to a faster speed. However, please realize that the faster the shutter speed you use, the less depth of focus your image will display.

Of course, low-light conditions can also cause problems, particularly for hand-held photography. However, these days, cameras and camera phones are quite good at low light. In any case, check your photos before you use them to submit.

If your camera sets its shutter speed to slower than 1/60 second in auto mode, you will need to either shoot your picture using a flash or attach the camera to a tripod. Don’t assume that because the image looks fine in the LCD on the back of the camera that it will be identifiable when viewed at native size on the computer by the validator.

**Flash** – While your camera’s flash can be a useful tool, more often than not its use will result in worse images than if you didn’t use the flash. Close-up subjects are particularly prone to being overexposed because of the camera’s internal metering and flash intensity adjustments. Further, the light from a built-in flash tends to “flatten” the features of your subject causing it to lose some dimension. However, in the situations described in earlier sections, the flash is your friend if used properly.

**Close Up Image** – This image will help the scientist verify the species. *When taking a close-up picture for species ID, use the back of a clipboard, a dark background, your friend’s shirt, or some other object as a solid background.* (If you are using an actual camera, if your close-up shot is less than ~40cm from the subject, you should use the camera’s macro mode [usually a flower symbol] but this may differ on different camera models. In macro mode, frame your subject and press the shutter halfway to let the camera focus. Continue pressing the shutter button to take the picture. Take 2-3 close up images and record the file names on your collection datasheet. Later, when you are at your computer, you will choose the best one to upload to the database.)

![Easily validated](image1.jpg) ![Not easily validated](image2.jpg)

**Image Resolution** – The images you take will be used in a web format to help experts validate your data. The image resolution required for this purpose is a 1024x768 and medium quality. Larger images at a higher quality setting add no extra value and will only serve to slow the image upload process. If you’re using a phone camera, use whatever resolution the camera uses.
Image Orientation – Resist the urge to take portraits. Photos taken in landscape orientation fit better online and so are preferred. Note that if you take a portrait shot, it will not completely fill the little space for the photo in the mobile app form.

If Using A Camera, GPS Unit, and Datasheets to Record Your Observations:

- **Before you leave** - Check and inventory all of your photographic equipment before going into the field. Make sure your camera is loaded with fresh batteries and that you are carrying fully charged spare batteries as well. Be sure you have plenty of available memory for the amount of photography you plan to do on your outing. It’s generally a good idea to remove old images from your memory cards before beginning a new field trip. Finally, check your camera’s settings, making sure its time/date, auto/manual, flash, aperture and shutter speed settings are correct.

When you are in the field, you will need to take one or more images to go with each species observation. It is essential that you can associate the images you take with the species observation when you are ready to do the data entry. The data collection sheet has fields to record the camera’s automatically assigned image names for the close-up images. Be sure to record the image filenames on the collection data sheet while you are in the field.

- **Getting the pictures off the camera** - When you return from the field and are ready to enter your data, you need to be able to browse to your pictures with “My Computer”, “Windows Explorer” or the “Finder”

    **Method 1** - Connect the camera via a built in USB port to the computer. When they are connected and you turn on the camera, your computer will recognize it as another drive and allow you to view the pictures. Note: this uses the camera’s batteries, so be sure to turn the camera off when not in use.

    **Method 2** - Take the card out of the camera an insert it into a card reader. The reader plugs into a USB port on your computer. The reader should be automatically recognized by your computer and show up as another drive.

- **Post Production** - Please review your images before uploading them to the website. If you have taken multiple images, select the one image that you believe best illustrates the species observation. It is not necessary to do post-production work on your images. As a rule, it’s better to submit the images just as you shot them. An exception, if cropping will reduce confusion about what the subject of the image is supposed to be, then crop the image as necessary, but maintain the image’s aspect ratio when cropping.

- **What to do with your images** – Follow the instructions in the Data Entry tutorial (Appendix B) to upload your images to the Database.
CHAPTER 8

THE SENTINEL PEST NETWORK

The U.S. Department of Agriculture (USDA) has denoted 13 states within the continental U.S. as the “highest risk” for invasive pest introduction and spread. Texas is named as one of these 13 states, largely attributed to the volume of imports and proximity to current and past pest detections. Texas is a large (268,581 square-miles) ecologically diverse state with over 3,800 miles of border, directly connecting to Mexico, the southeast, west, and the Great Plains. Additionally, our warm summer climate and moderate winters bring an influx of seasonal residents from northern states where several pests of regulatory concern have already become established. These factors, along with Texas’ multiple ports of entry, make the state susceptible to potential new pest transplants.

The Sentinel Pest Network (SPN) was created to expand the knowledge and skill set of our citizen scientists to increase the probability of early detection of Emerald Ash Borer, Cactus Moth, Asian Longhorned Beetle, Tropical Soda Apple and other pests of regulatory significance. Texasinvasives.org serves as an outlet for agency partners like APHIS to disseminate information about these pests to the public, and REPORT IT allows the public to report pest sightings to the appropriate authorities. Both state (Texas A&M Forest Service, Texas Parks & Wildlife Department, Texas AgriLife Extension) and federal (APHIS, U.S. Fish & Wildlife Service, U.S. Forest Service) cooperators play a key role in this initiative to disseminate information and respond to pest reports.

Citizen Scientists who become involved with the SPN will:
- Learn to identify and/or recognize the symptoms of pest infestations.
- Work with state and federal agency partners to report pests to the appropriate authorities.
- Educate and engage other citizen scientists in early detection and ongoing monitoring of invasive pests.
- Participate in outreach campaigns to disseminate information about pests to the public such as the "Don't Move Firewood Campaign".

RESOURCES:

Resources include:
- Workshop Announcement
- Workshop Agenda
- Pest Dirty Dozen List
- Pest Dirty Dozen PowerPoint

An online training module (Ch. 9: The Sentinel Pest Network) and a continuing
education module (Emerald Ash Borer Tutorial) are available at the “Online Training” page under “Citizen Scientists” at http://texasinvasives.org/training/index.php.

REPORT IT

REPORT IT is an online pest reporting system available under “Take Action” at Texasinvasives.org (http://texasinvasives.org/action/report.php). REPORT IT simplifies reporting for pests of regulatory significance and streamlines action by directly contacting the Lady Bird Johnson Wildflower Center Invasive Species Program Coordinator and the designated federal or state agency lead for each of the 12 pests of regulatory significance.

THE DIRTY DOZEN

Through collaboration with USDA-APHIS, we identified 12 pests of regulatory significance that form the SPN foundation. On texasinvasives.org, each species has a designated REPORT IT page with a description and a link to the species profile page which includes images, taxonomic information, adult and larval characteristics (if insect), the ecological threat, basic biology, place of origin, current distribution and history of introduction into the U.S. Currently, the Dirty Dozen pests of regulatory significance include six insects, five plants, and one animal, as listed below.

1. Asian Longhorned Beetle - *Anoplophora glabripennis*
2. Brown Fir Longhorned Beetle - *Callidiellum villosulum*
3. Cactus Moth - *Cactoblastis cactorum*
4. Emerald Ash Borer - *Agrilus planipennis*
5. Gypsy Moth - *Lymantria dispar*
6. Sirex Woodwasp - *Sirex noctilio*
7. Cogongrass - *Imperata cylindrica*
8. Giant Hogweed - *Heracleum mantegazzianum*
9. Onionweed - *Asphodelus fistulosus*
10. Tropical Soda Apple - *Solanum viarum*
11. Tropical Spiderwort - *Commelina benghalensis*
12. Giant African Land Snail - *Lissachatina fulica*

Currently (2019), there are 22 REPORT IT species in the list. The most current information on the species can be found on the REPORT IT page under “Take Action” at Texasinvasives.org (http://texasinvasives.org/action/report.php).

What follows is information on the original "Dirty Dozen".
ASIAN LONGHORNED BEETLE
Anoplophora glabripennis

This insect is a serious threat to many species of deciduous hardwood trees in the United States (e.g., maple, elm, willow, birch, horsechestnut, and poplar). During its larval stage, the ALB bores deep into a tree’s heartwood, where it feeds on nutrients. This tunneling damages, and eventually kills, the tree. If the ALB were to become established here, it could be one of the most destructive and costly invasive species ever to enter the United States. It threatens urban and suburban shade trees and recreational and forest resources valued at hundreds of billions of dollars. It might also impact such industries as maple syrup production, hardwood lumber processing, nurseries, and tourism.

BROWN FIR LONGHORNED BEETLE
Callidiellum villosulum

Attacks trees in the Taxodiaceae. North American examples include the sequoia, redwood, and bald cypress. Due to the geographic isolation of some species, especially the sequoias, an infestation of these beetles could be especially dangerous. The Brown Fir longhorned beetle has been found in wood trunks of artificial Christmas trees imported from China. Between 1999 and 2001, more than 20 interceptions of this species were recorded.

CACTUS MOTH
Cactoblastis cactorum

Cactus moth larvae live and feed communally inside the pads of prickly pear cacti. Damaged pads will show characteristic oozing of internal plant juices and insect droppings. As of this printing, the cactus moth has not been reported in Texas. However, experts predict that their spread to Texas is expected to occur soon. The cactus moth is so efficient at eliminating Opuntia cacti species that it is used as a biological control agent in areas where Opuntia are invasive. Thus, the cactus moth is a considerable threat to the native Opuntia cactus population and the ecosystem it supports. It was found in Brazoria County in 2018.
EMERALD ASH BORER  
*Agrius planipennis*

In infested areas, this beetle has killed millions of ash trees and has led to major efforts by state and local officials to limit its spread through strict quarantines and fines for the movement of wood, especially firewood, out of infested areas. The emerald ash borer has not been detected in Texas to date, but its presence has been confirmed in 13 states in the upper Midwest and southern Canada and has been detected as far south as eastern Missouri. Currently (2019), adults were found in traps in Harrison, Marion, and Cass Counties and an infestation was found in 2018 in Tarrant County.

GYPSY MOTH  
*Lymantria dispar*

There are two varieties of concern, the European and the Asian gypsy moth (ASM). The European variety was introduced to the U.S. in the late 1800’s and has destroyed millions of acres of forestland. The AGM is not yet established, and has an appetite for more than 500 species of trees and shrubs. AGM defoliation would severely weaken trees and shrubs, killing them or making them susceptible to diseases and other pests. Caterpillar silk strands, droppings, destroyed leaves, and dead moths would be a nuisance in homes, yards, and parks.

SIREX WOODWASP  
*Sirex noctilio*

This woodwasp was introduced inadvertently into New Zealand, Australia, Uruguay, Argentina, Brazil, Chile, and South Africa. In these Southern Hemisphere countries, sirex woodwasp attacks exotic pine plantations, and it has caused up to 80 percent tree mortality. Most of the plantations are planted with North American pine species. Twenty-four counties in upstate New York and two counties in Pennsylvania have positively confirmed the presence of this pest.
**COGONGRASS**  
*Imperata cylindrica*

Cogongrass has been ranked as one of the ten worst weeds of the world. It can invade and overtake disturbed ecosystems, forming a dense mat that makes it nearly impossible for other plants to coexist. Large infestations can alter the normal fire regime of a fire-driven ecosystem by causing more frequent and intense fires that injure or destroy native plants.

**GIANT HOGWEED**  
*Heracleum mantegazzianum*

Giant Hogweed is an aggressive competitor. Because of its size and rapid growth, it outcompetes native plant species, reducing the amount of suitable habitat available for wildlife. Giant Hogweed dies back during the winter months, leaving bare ground that can lead to an increase in soil erosion on riverbanks and steep slopes. Giant Hogweed contains a substance within its sap that makes the skin sensitive to ultra violet light. This can result in severe burns to the affected areas, producing swelling and severe, painful blistering.

**ONIONWEED**  
*Asphodelus fistulosus*

Similar in appearance to wild onion but lacking the onion scent and taste. Found in pastures and rangeland, onionweed develops populations that exclude grasses and desirable forage species. This federally regulated weed poses a serious environmental and agricultural threat. It seeds prolifically and can establish large populations quickly.
TROPICAL SODA APPLE
*Solanum viarum*

Upright, thorny perennial subshrub or shrub, 3 to 6 feet (1 to 2 m) in height, with leaves shaped like oak leaves, clusters of tiny white flowers, and green-to-yellow golf-ball size fruit. Fruit sweet smelling and attractive to livestock and wildlife. Remains green over winter in most southern locations. Tropical soda apple is on the Federal Noxious Weed List. It reduces biological diversity in natural areas by displacing native plants and disrupting ecological integrity. This invader also serves as a host for viruses that infect important vegetable crops.

TROPICAL SPIDERWORT
*Commelina benghalensis*

Tropical spiderwort forms dense, pure stands, smothering out other plants, especially low-growing crops. It has been reported recently as a problem in cotton in Alabama. In pastures, it grows rapidly over desirable grasses and legumes, competing with them for light and nutrients. In rice and other lowland crops it may be almost subaquatic withstanding flooding and waterlogged conditions, but they can also be found in cultivated lands, field borders, gardens, grasslands, roadsides, and waste places, and can become the dominant species in pastures.

GIANT AFRICAN LAND SNAIL
*Lissachatina fulica*

A large terrestrial snail that can reach up to 8 inches in length and nearly 5 inches in diameter. The brownish shell covers at least half the length of the snail. Damages native plants and crops. Scientists consider the giant African snail to be one of the most damaging snails in the world. It is known to eat at least 500 different types of plants. Imported as pets and for educational purposes; may also arrive accidentally in cargo. First established population was found in 1966 in Miami County Florida.
CHAPTER 9
THE ERADICATOR CALCULATOR

The Eradicator Calculator serves as a centralized location to report and track volunteer-based invasive species control efforts throughout Texas. The time and money that volunteer, municipal and non-profit groups spend controlling invasive species often goes undocumented. This information is needed to more accurately assess the economic impacts of invasive species control, and helps agency decision-makers understand the financial burden of control efforts.

The Eradicator Calculator is available through the left menu on the “Take Action” page by clicking on the Take Action tab, or directly at http://texasinvasives.org/calculator/. It tracks invasive species control efforts by date and location, and quantifies the costs associated with individual events.

Specifically, the Eradicator Calculator tracks:
- Eradication event date
- Target invasive species
- Equipment cost
- Treatment type
- Volunteer time
- Staff time (if applicable)

Searching the Eradicator Calculator Database: The information stored in our database is available to the public and can be searched by:
- Target invasive species
- Group
- Date range

REPORTING ERADICATION EVENTS
Events include any volunteer-based effort to remove invasive plant species. These events can occur anywhere in Texas, and should be only be conducted with appropriate landowner approval (city, state, or private). You can submit past or future events, and submitting beforehand publicizes the event on the Eradication Event Calendar at http://www.texasinvasives.org/calculator to help with recruitment.
Step 1: Click on the “REPORT ERADICATION” button, and enter the following information:

1. Event Date
2. Location Description: general location description (e.g., city park, greenspace, or private property)
3. Contact Name
4. Group Name
5. Email
6. Publicize: adds your event to the Eradicator Calendar and the iWire
7. Event Details: includes information such as meeting spots, times and items volunteers should bring (e.g., hat, sunscreen, closed toe shoes)
8. Location: enter in the coordinates or find the location in Google Maps using the ‘Choose Location on Map’ button

Step 2: Once you have entered in your event information, select “Proceed to the Next Step” at the bottom of the screen. Depending on if your event was in the past or is in the future, you will be directed in one of the two following ways:

**Past Eradication Event:**
You will immediately be directed to the “Eradication Event Details” portion of the Eradicator Calculator – see Step 3 below.

**Future Eradication:**
You will receive an email confirming your Eradication Event. Your event will also be publicized on the Eradication Event Calendar. A reminder email will be sent 1 Day after your event directing you to the “Eradication Event Details” portion of the Eradicator Calculator.

**Note**: Additional reminder emails will be sent 48 hours and 5 days after your event if you do not submit your event data.
Step 3: Enter Eradication Event Details
We know there are occasions where different types of invasive species are targeted during a single eradication event. For each eradication event, you can report removal for up to 12 different invasive species. Remember, you can only report from the 175 species listed on our Invasive Plant Database.

For each target species, enter the following information:

1. **Treatment Method**: Drop-down list of method categories include:
   a. Cultural
   b. Manual
   c. Manual + Chemical
   d. Mechanical + Chemical
   e. Chemical only
   f. Biocontrol

   **Note**: If you are unsure under which category the treatment method you utilized falls, please see the Control and Management page (http://texasinvasives.org/professionals/management.php) for method descriptions and examples.

2. **Total Volunteer Hours**: enter the total number of volunteer hours (i.e., multiply the number of volunteers by the time each spent), and rate is defaulted to the federal volunteer exchange rate.

3. **Total Staff Hours**: enter the total number of staff hours (i.e., multiply the number of staff by the time each spent), rate is defaulted to the federal volunteer exchange rate, but please enter actual staff pay rate if known.

4. **Additional Supply Costs**: enter the costs of any materials purchased for your eradication event.

5. **Select "Confirm Your Details" to submit your report**: a summary page will appear. Please review the information and either “Change your details” if you see mistakes, or “Submit your eradication”.

   **Note**: Use your best judgment: If you are removing multiple invasive species, please divide eradication time and cost by species.

**CONGRATULATIONS**: You can now successfully enter information into and search the Eradicator Calculator database!
Appendix A

DATA COLLECTION FOR ONLINE SUBMISSION

Collecting Data for the Invaders Program

There are two methods for collecting and submitting data: by using a mobile app, and by using a combination of GPS unit, camera, and data sheet followed by submitting data online using your browser. We cover using the latter method here, and cover the mobile app method in Chapter 5. As we cover the procedures for collecting species observation data, you will find it helpful to refer to the blank datasheet at the end of this Appendix.

You will need a camera, a GPS unit, and, for each observation, a datasheet. You may also find it useful to use a clipboard.

Instructions

If you did not already turn on your GPS unit, you should do so now since it will need some time to acquire satellite signals.

Observation ID: Leave blank for now. This will be entered when the database issues a number for this species observation.

Species Name or Code: Record the USDA Plants symbol, scientific or common name of the invasive species on your datasheet (e.g., LOJA for Lonicera japonica or Japanese honeysuckle). Refer to the Appendix C for a list of names and their codes.

Date: Record the date in the appropriate field. The date should be recorded in year/month/day format (e.g., February 6, 2019 = 2019/02/06).

Time Spent: Indicate, in minutes, the total time spent making a species observation. If this is your first or last observation of the day, include the time needed to travel to or from the site.

Location & GPS Coordinates: The GPS coordinates of your location are displayed on the center of your Waypoint screen. You will need to set up your receiver to display coordinates in Lat/Long Decimal Degrees. It is usually identified on GPS receivers as hddd.ddddd. Refer to the GPS tutorial in your handbook for more information about GPS coordinates. Please enter the estimated error given by your GPS receiver and circle the units used. Most GPS receivers will display the error alongside the latitude and longitude coordinates. Remember, the more satellites your GPS receiver locates, the smaller the error.

NOTE: If a GPS receiver is not available to you, you can still get GPS Coordinates if you can fix your position on a map. When you return from the field and login to enter your data you will have the option to either enter the GPS coordinates from a GPS receiver or click the “Choose Location” button to look up the coordinates by navigating
to the location using Google Maps. If you use the latter approach, make sure you zoom into the exact location where you recorded your observation.

**Disturbance:** This characteristic should define the area the invasive patch is occupying. You may check any category under Disturbance or check Other and describe the disturbance in the Site Notes box. Select None if the site is undisturbed (other than the presence of the invasive species).

- Fire – Revealed by sparse vegetation and evident charcoal/ash
- Flood – Indicated by flattened and/or torn out vegetation and scouring of ground
- Graded – Scraped or smoothed to bare soil
- Cleared brush – Bulldozed with no mature woody vegetation
- Grazed – Land grazed by some sort of livestock
- Cropland – Established sown agricultural (not pasture = grassland)
- Roadside – Alongside a surface devoted to transportation

**Patch Type:** If you have not already done a visual or walking survey of the infestation of the invasive species, you should do that at this time. This will assist you with deciding whether the infestation is a single point (one or a few plants), a linear (plants extending along a line) patch, or a polygon (of non-linear shape). Note: If a point or linear patch has a diameter of more than 15 feet it would be considered a polygon.

**Abundance:** Data recorded here are key for managers and scientists who will be using your data. Check rare if the species is hard to find and other plants are more common or check common if the species is one of the most common plants in area.

**Notes:** For validation reasons, it is helpful but not necessary that you enter cross-streets of your site or a nearby roadway (e.g., corner of 290 and Circle Drive 4 miles west of Oak Hill), or other locations notes (e.g., in XXX Park, near the north entrance, near the first restroom, on XXX trail, etc.). If you are not sure where you are, many GPS units have a Point of Interest (POI) feature that can find the distance and bearing to the closest landmark feature.

This is also your opportunity to describe the patch and abundance in more detail than you were allowed above. You can estimate the size of the infestation, mention that the infestation continues down the road or trail for miles, is present in a very dense but confined patch and the surrounding area is free of the invasive species, that the plants are mostly saplings, etc., or any other descriptions that will help scientists and managers determine whether a return trip to that site is required for a more detailed survey, as well as help anyone returning to the site to manage the species understand what to look for.

**Images:** Use this field to write down the file names generated by your camera for the close up images associated with this species observation. It is important to capture this information in the field so that the right image is associated with the right observation when you enter your data.
**Consent**: If you are surveying privately owned property, use the consent form to obtain permission from the landowner or manager.

**Frequently Asked Questions**

See Chapter 5 for answers to these FAQs:
- What constitutes a Species Observation?
- Can I record more than one species per observation?
- How big can a site be?

**When Your Field Day Is Complete**

- Make sure you turn off your camera and GPS unit to save batteries. Store them in a safe place in your vehicle to protect them from damage.
- Before leaving the site, make sure to clean your socks and boots and pants legs so that you are not transporting invasive plant species seeds with you. Do this between sites as well.
- Put your datasheets in a safe place and enter your data as soon as possible into the web-based data entry forms at https://www.texasinvasives.org/observations/login.php.

**Congratulations!** Your efforts as a citizen scientist will go a long way towards assisting managers and scientists with the fight to “Stop the Spread” of invasive species in Texas.

**NEXT STEPS**: Submit your data online. See Appendix B for instructions.
INVADERS DATASHEET

Observation ID: __________(leave blank until assigned by system during data entry)
Species Name or Code: ____________________________ (e.g., AIAL or Ailanthus altissima)
Date: __________(use the format yyyy/mm/dd)

Time Spent* (circle one):  5  15  30  45  60  90  120  180  240  360
*Total time spent on an observation in minutes. If first or last observation for day, include time needed to travel to or from site.

Location & GPS Coordinates (in decimal degrees: e.g. N32.74452, W-097.67281)
Latitude: __________
Longitude: __________ Est. Error: __________ m/ft (circle one)

Disturbance (circle one):
Fire  Flood  Graded  Cleared Brush  Grazed  Cropland  Roadside  Other  None

Patch Type (check one):
_____Point (one or few plants)
_____Linear (plants extending along a line)
_____Polygon (of non-linear shape)

Abundance (check one):
_____Rare (hard to find, other plants more common)
_____Common (one of the common plants in area)

Notes: Include a description of the location plus any other notes.

Images - For verification purposes, take several close up digital images of the species and record the file names of the images below so you can refer to them during image upload.

Species Image (Close up View)

Consent: I (We), the undersigned, give consent to volunteers from the Invaders of Texas Citizen Science program to conduct surveys of invasive species on property that we own or manage and to use site specific information in the preparation of reports including sharing data and publication of survey results on the www.texasinvasives.org website.

Landowner or Authorized Agent: ____________________________ Date: __________
Appendix B

ONLINE DATA ENTRY

After each field expedition the data collected on the paper data sheets must be entered into the Invaders of Texas Early Detection and Reporting Database for validation. A web interface has been developed to allow multiple citizen scientists to enter their data remotely. All you need is a computer, access to the web, and to follow a few simple steps.

Create Your Citizen Scientist User Profile

If you are a newly trained citizen scientist who trained at a workshop:
Open your web browser and go to www.texasinvasives.org/invaders. Enter your login information in the login area on the left. You will be directed to your profile page from which you can
  • update your profile
  • view or map your species observations
  • edit observations before they are validated
  • change the photos for observations before they are validated
  • delete observations before they are validated
  • add a new species observation (not likely unless you are entering an observation online instead of by using the mobile app)

Once you are logged in you can return to your profile at any time by clicking the Return to Profile link in the menu on the left.

If you are a newly trained citizen scientist who trained as a Voyager online:
Open your web browser and go to www.texasinvasives.org/workshop. Create a unique username and password and fill out the form with your name, satellite, organization, contact information. For you GPS coordinates, please use a nearby intersection, but NOT your home, as your home can show on the inline mapping of citizen scientists. When you are satisfied with your entries, click Create Your Profile.

Please note:
  • While we will never share your personal information with anyone, please do not give us your high security login and password (e.g., your banking password).
  • Be sure to write down your username and password in the space provided on the inside front cover of this handbook so that you will remember them later.
  • Select Voyager as your satellite if you are not affiliated with a satellite group.
If successful, you will be directed to a login page to test your new username and password. Enter your username and password and click login to go to your personal profile page. From this page you can

- update your profile
- view or map your species observations
- edit observations before they are validated
- change the photos for observations before they are validated
- delete observations before they are validated
- add a new species observation (not likely unless you are entering an observation online instead of by using the mobile app)

Once you are logged in you can return to your profile at any time by clicking the Return to Profile link in the menu on the left.

Report Observations

Let’s review the options on your Personal Profile Page since you will login to this page often to either Add or Edit Species Observations, Map or View Your Species Observations or Update your Profile. The Update Your Profile feature is self-explanatory. It allows you to keep your contact information current so that we can keep you updated on the Invaders program. To transfer data from your data collection sheet to the Early Detection Database you will use the Add New Observation button.

Add New Observation

With your data sheet in front of you, click the Add New Observation button on your profile page. This will open the Species Observation Form. Notice that it closely mimics your datasheet.

Step 1. Upload Image
You will start by uploading the Close Up image you chose to represent the species observation. Click the Choose File or Browse button and navigate to the appropriate image on your computer’s hard drive. You can always refer to your datasheet if you can’t remember which image it is. Once you have selected the Close Up image, the original file name will appear on the web page. There is no need to rename or resize images before upload. That will take place automatically when you click the Upload button. While your image is uploading, you can proceed to Step 2 and fill out the Observation Information.

Step 2. Observation Information
Since you are already logged in, the website knows who you are and what satellite you belong to. Start by entering the species you observed and then fill in the data fields based on the information on your datasheet. The actual look and feel of the web form may vary slightly depending on your computer and web browser. When you have completed all the fields, click Insert Observation (or Reset Form to start over) and the data will automatically be entered into the database.
If your upload was successful, you will automatically be taken to the **Upload Complete** page. Notice an **Observation ID** is automatically assigned to your observation on the new page. Be sure to write the **Observation ID** from the website onto your datasheet for future reference. From the Upload Complete Page, you can **View Observation**, **Add Another Observation** or **Return to Your Profile**. Select **Return to Your Profile** to edit your observation.

**Step 3. Edit Your Observation**
On your profile page you can view, edit, replace the image or delete newly added observations. There is a 1-2 week grace period to modify your submitted observations after which they will be submitted for validation. Once your observations are validated, they will disappear from your profile page and can no longer be edited by you. You will still be able to **View or Map Your Observations** from your profile page and your observations will be viewable by the public under the **Map & Observations** menu. If you find a mistake in your data entry post-validation, send an email to your satellite leader explaining the correction that needs to be made.

**NOTE:** we recommend you keep your data sheet until at least your observation has been validated, in case any questions arise during the validation process.

See Chapter 5 for information on what happens next to your data: validation and submission to the national database.
Appendix C

AQUATIC INVASIVE SPECIES

Aquatic Invasive Species (AIS) include both plants and animals that have the potential to cause serious damage to aquatic ecosystems, our economy, and recreational opportunities. In Texas, AIS are one of the top conservation issues. These species impact not only the aquatic habitats and their native species but also the riparian habitats along their shorelines. This chapter covers the negative impacts of AIS, with case studies for specific species, as well as how they are introduced and spread, and how you can help to monitor for them and prevent their spread. The chapter also provides information on managing AIS and on key laws and regulations.

Introduction and Spread of AIS

Introduction and spread of AIS involves a number of vectors, or means of introduction, as well as various pathways, or sources. Vectors include natural means of movement such as being carried by water, air, or on or in animals, and, in the case of animals, simply moving to new areas. Individuals dispersing may be adults, larvae, young, seeds, or clones/fragments. Pathways include examples such as rivers and streams, and migrating birds. Plants can expand the area they occupy by sending out new shoots and stems.

We humans play a large role in mediating introduction and subsequent spread of AIS as active vectors—both accidentally and intentionally—through several pathways. We may unintentionally transport species such as zebra mussels and giant salvinia to new areas through the boat movement pathway as hitchhikers. We may use them as ornamentals in our garden water features from which they escape. We may grow them in fish farms or zoos from which they accidentally escape. We may plant invasive riparian plants along waterways without recognizing their invasive potential. We may introduce species brought in through the aquarium trade pathway by dumping our tanks. Increased awareness of the impacts of these activities is essential to preventing the introduction and spread of aquatic invasive species.

Negative Impacts of AIS

In general, AIS cause the standard problems other types of invasive species do. They compete with natives for space or resources, prey on native species, and degrade habitat. In addition to impacting aquatic and riparian ecosystems, many AIS can cause significant recreational and economic impacts.

Invasive Aquatic Plants

Aquatic plants can be classified according to how they grow in the water. *Submerged* plants grow, as the name implies, under and often up to the surface and are typically rooted in the
bottom substrate. *Floating* plants float on the surface and do not root in the bottom. Typically, they are found only in standing or slow-moving bodies of water, since they would be washed downstream in flowing water. *Emergent* aquatic plants are rooted to the bottom, usually in shallow water, and grow up out of the water or have leaves that float on the surface. *Riparian* plants are those that live along the shore of lakes, streams, rivers, and wetlands or in the flood plain--in other words, in the areas influenced by these bodies of water. Invasive aquatic plants from each of these growth habits have similar impacts.

*Submerged* species often shade out native plants or aggressively grow and replace them. Dense underwater stands of submerged aquatic plants can impede access for water recreation, including boating, fishing, hunting, and swimming, and impact the economic benefits of recreational activities. *Hydrilla* (*Hydrilla verticillata*) is one of many highly invasive submerged invasive plants that can also raise water pH and temperature, lower dissolved oxygen, and promote mosquito habitat. It is also known to affect power generation by clogging dams and intake pipes and restricts the flow rates in canals and rivers and can result in more water having to be released to meet downstream needs.

*Floating* species arguably can cause the most environmental damage because they can turn a body of water into a "desert". Because they float on the surface, they shade out all the plants and algae below them. This includes the microscopic algae, or phytoplankton, that form the basis of the food web. When the phytoplankton die, the rest of the food web collapses. In addition, the dead organisms including any dead floating plants decompose—a process that uses up oxygen in the water. This makes it even more difficult for aquatic animals to survive in the pond or lake. Giant salvinia (*Salvinia molesta*) is one of the most problematic invasive species in Texas. This plant grows rapidly to cover the surface of a pond or lake with dense mats, doubling its area in a week or less and leading to the problems described above. Severe giant salvinia infestations can completely prevent boater access. In Texas, giant salvinia mats can be so dense that grasses begin to grow on top of them.

*Emergent* species primarily exert their negative impacts by crowding out and replacing native plants, which result in problems for other organisms that depend on them. *Alligatorweed* (*Alternanthera philoxeroides*)—which looks very similar to native water willow (*Justicia americana*)—forms thick mats that crowd out native aquatic vegetation, retard water flow, lower dissolved oxygen levels, and increase sedimentation. Flooding may result from impeded drainage. It can also restrict water flow for irrigation. Because it can form thick mats, it can impede fishing and boating.

*Riparian* invasive plants that live along the edges of water bodies often outcompete and replace natives, especially when these habitats are disturbed (e.g., by mowing or construction). Not only do these species degrade riparian habitat for wildlife, but they can also reduce stream flow and water quality and impact instream habitat quality. Giant reed (*Arundo donax*; aka Carrizo cane) forms dense monoculture stands that crowd out native plants, inhibits the movement of wildlife, and impedes access. It also increases erosion of stream and riverbanks, deepens channels and reduces habitat diversity, and can worsen flooding by up to 10%. Along the Rio Grande, dense stands of giant reed pose a threat to border security as humans can move through them undetected and harbor cattle ticks that can spread disease to livestock.
**Invasive Aquatic Animals**

*Shellfish* can also become highly invasive and have significant impacts. Zebra mussels (*Dreissena polymorpha*)—a freshwater species—are one of the most problematic invasive species in North America. They reproduce prolifically and increase their population size and density rapidly. They also grow to sexual maturity very quickly and zebra mussels spawned in the spring can be reproducing by the fall. As they infest a water body, they change the whole aquatic food web by filtering out the plankton and compete with fish such as shad that form the forage base for sport fisheries. They also attach to native mussels, many of which are imperiled in Texas, and can essentially smother them. They exert economic impacts as they clog intake pipes and damage the infrastructure of any facility using raw surface water and damage watercraft and marinas. They also impact recreation by making beaches unusable as their sharp shells pile up.

*Fish* species that have invaded Texas can impact aquatic ecosystems in many ways. Some species have physical impacts on the environment. For example, armored suckermouth catfish (*Hypostomus & Pterigoplichthys* species; aka plecos or algae eaters) introduced via aquarium releases burrow into banks, increasing erosion and degrading water quality. Blue tilapia (*Oreochromis aureus*) compete with native bass and sunfish for nesting space and even prey upon young fishes. Still other invasive fish—including native species introduced outside their native range—can have negative impacts on other species through hybridization.

**Early Detection Monitoring**

Know it, Report It! Citizen scientists play a critical role in early detection of AIS from plants to animals. In fact, such reports have alerted Texas Parks and Wildlife Department (TPWD) to new infestations of zebra mussels in our lakes! You don’t need to be an expert in invasive plant identification to be able to make a difference—you just need to learn about and keep an eye out for a few especially concerning species. Visit https://texasinvasives.org/action/report.php or get the Texas Invaders app to learn about and report invasive floating hearts, giant salvinia, zebra mussels, and applesnails. If you live on a lake without zebra mussels, you can help by hanging a settlement sampler (e.g., a house brick) from your dock and checking it periodically or, when you visit a lake, turn over rocks to check for zebra mussels. When you visit a water body in east Texas, look for the bright pink eggs of invasive applesnails on emergent vegetation. If you take photos of invasive species, you should also send a report to the USGS Nonindigenous Aquatic Species database--visit https://nas.er.usgs.gov/SightingReport.aspx.

**Preventing the Spread of AIS**

Because we are more often than not the agent of dispersal for invasives, it is up to us to help to prevent their spread. The following are several ways we can do so:

**Clean, Drain, Dry & Decontaminate**

Several AIS frequently hitch a ride on and in watercraft of any kind—including kayaks and paddleboards—as well as on equipment such as trailers, life jackets, inner tubes, bait buckets, and anchors. The larvae of invasive zebra mussels can be transported in any
residual water carried by watercraft and equipment. Fragments of invasive plants can become trapped between the bunks of a trailer and the boat. After any water recreation, the best procedure to prevent the spread of AIS is to Clean, Drain, and Dry. Clean all visible organisms and mud that could hide plant fragments or shellfish off of your watercraft, trailer, and equipment. Drain all water from all watercraft, including the motor, bilge, live wells and bait buckets, before leaving the lake. Dry your watercraft and equipment for a week or more before entering another water body. If you are unable to let it dry for at least a week, wash it with a high-pressure washer such as at a self-serve car wash. Failing to remove invasive hitchhikers from your boat and trailer and drain all water from your boat and all onboard receptacles is a Class C Misdemeanor and could lead to a fine of up to $500. Visit TPWD's website at https://tpwd.texas.gov/fishboat/boat/protect_water/ for more information. View TPWD's video describing how to clean, drain and dry your watercraft at https://youtu.be/4jhz0KjNqdU.

Boats stored in the water on lakes with zebra mussels will likely need to be professionally decontaminated before moving to another lake. For a current lake list, visit https://www.texasinvasives.org/cleandraindry/. Zebra mussels attach to these boats and, even when they're not obvious, may be hidden in small crevices, through hull fittings, and motor intakes. Decontamination will involve pressure washing with 140°F water to kill any attached mussels and allowing the boat to dry completely before a final inspection. Boat owners should contact TPWD at (512) 389-4848 or aquaticinvasives@tpwd.texas.gov for guidance a few weeks before moving the boat.

**Don’t Dump Your Aquarium**

Never dump your aquarium into any body of fresh or salt water. Introducing fish, shellfish, or aquatic plants into public water without a permit is illegal! Do your homework before buying a new aquarium pet to be sure you’ll be able to keep it long term. For example, some fishes grow to very large sizes and don’t make good pets. If you can’t keep your aquarium fish, plants, or shellfish anymore, there are responsible alternatives to get rid of them. Plants can be thrown away in the trash, but you'll need to dispose of your fish and animals more thoughtfully. You can give fish or other animals away to friends or family. You may be able to donate them to a school or business. Another option is to sell your pet or trade with someone else for another species. Search online sites and blogs and social media for potential buyers. If you can’t find someone to give or sell to, you will have to euthanize the fish. Visit https://texasinvasives.org/neverdumpyourtank/ for more information and to download a fact sheet that describes various methods you can use to humanely and responsibly euthanize your fish.

**Know Your Ornamental Plants**

Some aquatic plants such as water hyacinth were introduced to North America as ornamental pond plants. Unfortunately, they escaped and have become big problems. Elephant ears planted along or near rivers have also escaped, infesting our rivers and crowding out native plants. To avoid becoming the person responsible for introducing invasives into your area, research thoroughly the aquatic or semi-aquatic plants and animals you choose to use in your garden to ensure they are not invasive. A good place to start is the weed risk assessments (WRAs) available on the Texasinvasives.org website at www.texasinvasives.org/professionals/assessments.php. These WRAs present information on the potential invasibility of 29 species, several of which are AIS.
Managing Your Property for Prevention
Property owners with wetland habitat may have invasives growing on their property that they would like to manage to prevent further spread. The next section discusses how to manage invasives responsibly in and near bodies of water.

Managing Aquatic and Riparian Invasive Plants on Private Property
Managing aquatic and riparian invasive plants in and near sensitive aquatic habitats is complex and should be approached with an integrated pest management (IPM) strategy in accordance with all applicable regulations. The principles of IPM involve using the right management tool for the situation—whether herbicide, physical removal, or biological control. The Texas A&M AgriLife’s Aqua Plant website is a great source of information and guidance on selecting the best management strategy: https://aquaplant.tamu.edu/management-options/.

Triploid (i.e., sterile) grass carp (*Ctenopharyngodon idella*) can be helpful for controlling some aquatic plants and may be stocked with a permit obtained for stocking these fish in ponds where escape is determined to be unlikely. Find permit information at: https://tpwd.texas.gov/landwater/water/habitats/private_water/gcarp.phtml. Some aquatic invasive plants cannot be physically removed, because fragments can float to new locations and establish new populations. Removing invasive riparian plants can increase erosion, which not only damages the banks but also impacts water quality. Often, herbicides are the best tool for managing invasive plants with the least environmental impact—provided they are used responsibly. Only herbicides specifically labeled for aquatic use may be applied over or beside the water and all label requirements must be followed carefully. The label is the law!

Management of any nuisance aquatic or riparian vegetation on public water bodies or on non-impounded creeks running through private property is regulated by TPWD. Before any biological, physical, or chemical control methods can be implemented, a treatment proposal must be approved by TPWD. When herbicides are to be applied, a notice of intent to apply aquatic herbicides must also be sent out at least two weeks in advance. For guidance on the regulations and procedures to follow when managing nuisance aquatic or riparian vegetation, visit the TPWD webpage at: https://tpwd.texas.gov/landwater/water/environconcerns/nuisance_plants/.

Laws and Regulations Concerning AIS

Federal Injurious Wildlife - The Lacey Act
Species listed as injurious wildlife under the federal Lacey Act may not be imported, exported or possessed and may not be transported into a state in violation of state laws. This list includes invasive fish such as the Bighead Carp and shellfish such as the Zebra Mussel. For more information and a current list of species designated as injurious wildlife, visit: https://www.fws.gov/injuriouslywildlife/.

TPWD-Regulated AIS
Harmful or potentially harmful fish, shellfish, and aquatic plants are regulated under Texas law and TPWD regulations. No person may possess, sell, import, export, transport,
propagate, or introduce any of the species listed in TPWD regulations without a permit and permits may only be issued for selected species for biological control of nuisance aquatic vegetation or aquaculture or for the purposes of research or zoological display. A complete list of these prohibited species can be found at: https://tpwd.texas.gov/huntwild/wild/species/exotic/prohibited_aquatic.phtml. This webpage also includes links to a quick reference guide with illustrations that can help identify these organisms and distinguish them from other species that share similar characteristics, as well as to a 370-page Guide to Identification of Harmful and Potentially Harmful Fishes, Shellfishes and Aquatic Plants Prohibited in Texas that includes additional information about each species/group and reasons for listing.

Selected AIS of Concern in Texas (*not yet present)

<table>
<thead>
<tr>
<th>PLANTS</th>
<th>SHELLFISH</th>
<th>FISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giant &amp; Common Salvinia <em>(Salvinia molesta &amp; S. minima)</em></td>
<td>Water Lettuce <em>(Pistia stratiotes)</em></td>
<td>Giant Reed <em>(Arundo donax)</em></td>
</tr>
<tr>
<td>Waterhyacinth <em>(Eichhornia crassipes)</em></td>
<td>Eurasian Watermilfoil <em>(Myriophyllum spicatum)</em></td>
<td>Yellow &amp; Crested Floating Hearts <em>(Nymphoides peltata &amp; N. cristata)</em></td>
</tr>
<tr>
<td><strong>SHELLFISH</strong></td>
<td><strong>FISH</strong></td>
<td><strong>ARMED SUCKERMOUTH CATFISHES</strong> <em>(Hypostomus &amp; Pterigoplightys spp.)</em></td>
</tr>
<tr>
<td>*<em>Zebra &amp; Quagga</em> Mussels <em>(Dreissena polymorpha &amp; D. bugensis)</em></td>
<td>**Asian Clams <em>(Corbicula fluminea)</em></td>
<td>**Bighead Carp <em>(Hypopthalmichthys nobilis)</em></td>
</tr>
<tr>
<td>*<em>Silver Carp</em> <em>(Hypopthalmichthys molitrix)</em></td>
<td>**Blue Tilapia <em>(Oreochromis aureus)</em></td>
<td>**Armored Suckermouth Catfishes <em>(Hypostomus &amp; Pterigoplightys spp.)</em></td>
</tr>
</tbody>
</table>

AIS Management Efforts in Texas

Bolstered by record appropriations from the Texas Legislature in recent years, TPWD, river authorities and other partners are stepping up the war against an army of non-native plants
and animals that threaten our waterways. Learn more about these efforts at https://tpwd.texas.gov/landwater/water/aquatic-invasives/.

This chapter co-created with Monica E. McGarrity, Senior Scientist for Aquatic Invasive Species Management, Inland Fisheries Division – Habitat Conservation Branch, Texas Parks and Wildlife Department
Appendix D

INVASIVE SPECIES LIST

Texasinvasives.org maintains an online database devoted to plants known to occur in or around Texas that are known to cause or are suspected of causing invasive problems. Some of the species on this list are economically important horticultural plants but cause problems when they escape and establish in natural areas. This list is not complete: the online database contains the complete set of invasive plants.

Disclaimer: This plant list is only a recommendation and has no legal effect in the state of Texas. It is lawful to sell, distribute, import, or possess a plant on this list unless the Texas Department of Agriculture labels the plant as noxious or invasive on the Department's plant list.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>FED</th>
<th>TDA</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACRE3</td>
<td>Acroptilon repens</td>
<td>Russian knapweed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIAL</td>
<td>Ailanthus altissima</td>
<td>Tree of heaven</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALJU</td>
<td>Albizia julibrissin</td>
<td>Mimosa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALMA12</td>
<td>Alhagi maurorum</td>
<td>Camelthorn</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>ALPE4</td>
<td>Allaria petiolata</td>
<td>Garlic mustard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALPH</td>
<td>Alternanthera philoxeroides</td>
<td>Alligatorweed</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>ANLE3</td>
<td>Antigonon leptopus</td>
<td>Coral vine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARDO4</td>
<td>Arundo donax</td>
<td>Giant reed</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASFI2</td>
<td>Asphodelus fistulosus</td>
<td>Onionweed</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOISS</td>
<td>Bothriochloa ischaemum var. songarica</td>
<td>King Ranch bluestem</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRAR5</td>
<td>Bromus arvensis</td>
<td>Field brome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRCA6</td>
<td>Bromus catharticus</td>
<td>Rescue grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRTE</td>
<td>Bromus tectorum</td>
<td>Cheat grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRPA4</td>
<td>Broussonetia papyrfera</td>
<td>Paper mulberry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALA20</td>
<td>Carthamus lanatus</td>
<td>Woolly distaff thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CASE13</td>
<td>Calystegia sepium</td>
<td>Hedge false bindweed</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>CANU4</td>
<td>Carduus nutans</td>
<td>Nodding plumeless thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAEJ7</td>
<td>Cayratia japonica</td>
<td>Bushkiller</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATE2</td>
<td>Carduus tenuiflorus</td>
<td>Slender-flowered thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CEME2</td>
<td>Centaurea melitensis</td>
<td>Malta star-thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CESO3</td>
<td>Centaurea solstitialis</td>
<td>Yellow star-thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CICA</td>
<td>Cinnamomum camphora</td>
<td>Camphor tree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIVU</td>
<td>Cirium vulgare</td>
<td>Bull thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COES</td>
<td>Colocasia esculenta</td>
<td>Elephant ears</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMA2</td>
<td>Conium maculatum</td>
<td>Poison hemlock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COAR4</td>
<td>Convolvulus arvensis</td>
<td>Field bindweed</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBE</td>
<td>Commelina benghalensis</td>
<td>Tropical spiderwort</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>COVA2</td>
<td>Coronilla varia</td>
<td>Purple crown-vetch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COSE4</td>
<td>Cortaderia selloana</td>
<td>Pampas grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRGR6</td>
<td>Cryptostegia grandiflora</td>
<td>Palay rubbervine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUAN4</td>
<td>Cupaniopsis anacardioides</td>
<td>Carrotwood Tree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUJA</td>
<td>Cuscuta japonica</td>
<td>Japanese dodder</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>CYC14</td>
<td>Cyanthillium cinereum</td>
<td>Little ironweed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CYDA</td>
<td>Cynodon dactylon</td>
<td>Bermudagrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CYEN2</td>
<td>Cyperus enterianus</td>
<td>Deep-rooted sedge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symbol</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>FED</td>
<td>TDA</td>
<td>TP</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------</td>
<td>------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>CYRO</td>
<td>Cyperus rotundus</td>
<td>Nutgrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CYFA2</td>
<td>Cyrtomium falcatum</td>
<td>Japanese netvein hollyfern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIAN</td>
<td>Dichanthium annulatum</td>
<td>Kleberg bluestem</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIAR5</td>
<td>Dichanthium aristatum</td>
<td>Angleton bluestem</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIBU</td>
<td>Dioscorea bulbifera</td>
<td>Air potato</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISE5</td>
<td>Dichanthium sericeum</td>
<td>Silky bluestem</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIOP</td>
<td>Dioscorea oppositifolia</td>
<td>Chinese yam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECVU</td>
<td>Echium vulgare</td>
<td>Blueweed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EIAZ2</td>
<td>Eichornia azurea</td>
<td>Anchored water hyacinth</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>EICR</td>
<td>Eichhornia crassipes</td>
<td>Common water hyacinth</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>ELAN</td>
<td>Elaeagnus angustifolia</td>
<td>Russian olive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELPU2</td>
<td>Elaeagnus pungens</td>
<td>Thorny olive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELUM</td>
<td>Elaeagnus umbellata</td>
<td>Autumn olive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERLE</td>
<td>Eragrostis lehmanniana</td>
<td>Lehman's love grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUES</td>
<td>Euphorbia esula</td>
<td>Leafy spurge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIRE3</td>
<td>Ficus religiosa</td>
<td>Peepul Tree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FISI2</td>
<td>Firmiana simplex</td>
<td>Chinese parasol tree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI GE</td>
<td>Gibasis geniculata</td>
<td>Tahitian bridal-veil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GIPE3</td>
<td>Gibasis pellucida</td>
<td>Dotted bridal-veil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLPU3</td>
<td>Glandularia pulchella</td>
<td>South American mock vervain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEHE</td>
<td>Hedera helix</td>
<td>English ivy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEMA17</td>
<td>Heracleum mantegazzianum</td>
<td>Giant hogweed</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HODU2</td>
<td>Hovenia dulcis</td>
<td>Japanese raisintree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYVE3</td>
<td>Hydrilla verticillata</td>
<td>Hydrilla</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>IMAQ80</td>
<td>Illex aquifolium</td>
<td>English holly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMCY</td>
<td>Imperata cylindrica</td>
<td>Cogongrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPAQ</td>
<td>Ipomoea aquatica</td>
<td>Swamp morning-glory</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>IRPS</td>
<td>Iris pseudacorus</td>
<td>Paleyellow iris</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KADA</td>
<td>Kalanchoe daigremontiana</td>
<td>Mother of thousands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KIEL</td>
<td>Kickxia elatine</td>
<td>Sharpleaf cancerwort</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOPA</td>
<td>Koelreuteria paniculata</td>
<td>Golden rain tree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAMA15</td>
<td>Lagarosiphon major</td>
<td>Oxygen-weed</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>LAPU12</td>
<td>Landoltia punctata</td>
<td>Dotted duckmeat</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAMO2</td>
<td>Lantana montevidensis</td>
<td>Trailing shrubverbenia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LE LA2</td>
<td>Lepidium latifolium</td>
<td>Perennial pepperweed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEBI2</td>
<td>Lespedeza bicolor</td>
<td>Shrubby lespedeza</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LECU</td>
<td>Lespedeza cuneata</td>
<td>Chinese lespedeza</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LELE10</td>
<td>Leucaena leucocephala</td>
<td>Popinac</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVU</td>
<td>Leucanthemum vulgare</td>
<td>Oxeye daisy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIA</td>
<td>Ligustrum japonicum</td>
<td>Japanese privet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LILU2</td>
<td>Ligustrum lucidum</td>
<td>Glossy privet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIQU2</td>
<td>Ligustrum quihoui</td>
<td>Waxleaf privet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LISI</td>
<td>Ligustrum sinense</td>
<td>Chinese privet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIVU</td>
<td>Ligustrum vulgar</td>
<td>European privet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOAR10</td>
<td>Lolium arundinaceum</td>
<td>Tall fescue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOFR</td>
<td>Lonicera fragrantissima</td>
<td>January jasmine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOJA</td>
<td>Lonicera japonica</td>
<td>Japanese honeysuckle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOMA6</td>
<td>Lonicera maackii</td>
<td>Amur honeysuckle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOMO2</td>
<td>Lonicera morrowii</td>
<td>Morrow's honeysuckle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOPE</td>
<td>Lolium perenne</td>
<td>Perennial ryegrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOTA</td>
<td>Lonicera tatarica</td>
<td>Bush honeysuckle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symbol</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>FED</td>
<td>TDA</td>
<td>TPW</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------</td>
<td>---------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>LYJA</td>
<td>Lygodium japonicum</td>
<td>Japanese climbing fern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LYSA2</td>
<td>Lythrum salicaria</td>
<td>Purple loosestrife</td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>MAUN3</td>
<td>Macfadyena unguis-cati</td>
<td>Catclawvine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAVU</td>
<td>Marrubium vulgare</td>
<td>Horehound</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEQU</td>
<td>Melaleuca quinquenervia</td>
<td>Melaleuca</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>MEAZ</td>
<td>Melia azedarach</td>
<td>Chinaberry tree</td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>MEMI</td>
<td>Medicago minima</td>
<td>Little bur-clover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEOF</td>
<td>Melilotus officinalis</td>
<td>Yellow sweet clover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIVI</td>
<td>Microstegium vimineum</td>
<td>Japanese stiltgrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MISI</td>
<td>Miscanthus sinensis</td>
<td>Chinese silvergrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOLA</td>
<td>Morus alba</td>
<td>White mulberry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MYAQ2</td>
<td>Myriophyllum aquaticum</td>
<td>Parrot feather watermilfoil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MYPE</td>
<td>Myagrum perfoliatum</td>
<td>Bird's eye-cress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MYSP2</td>
<td>Myriophyllum spicatum</td>
<td>Spike watermilfoil</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>NADO</td>
<td>Nandina domestica</td>
<td>Heavenly bamboo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NATR3</td>
<td>Nassella trichotoma</td>
<td>Serrated tussock grass</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>NIGL</td>
<td>Nicotiana glauca</td>
<td>Tree tobacco</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONAC</td>
<td>Onopordum acanthium</td>
<td>Scotch thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORRA</td>
<td>Orobanche ramosa</td>
<td>Hemp broomrape</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>PAP16</td>
<td>Pallurus spinia-christi</td>
<td>Jerusalem thorn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PARE3</td>
<td>Panicum repens</td>
<td>Couch panicum</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PADI3</td>
<td>Paspalum dilatatum</td>
<td>Dallisgrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAFO4</td>
<td>Paederia foetida</td>
<td>Skunkvine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PANO2</td>
<td>Paspalum notatum</td>
<td>Bahiagrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAUR2</td>
<td>Paspalum urvillei</td>
<td>Vasey grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PATO2</td>
<td>Paulownia tomentosa</td>
<td>Princess tree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEFR4</td>
<td>Perilla frutescens</td>
<td>Beefsteakplant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEHA</td>
<td>Peganum harmala</td>
<td>African rue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PECI</td>
<td>Pennisetum ciliare</td>
<td>Buffelgrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHSE17</td>
<td>Photinia serratifolia</td>
<td>Taiwanese photinia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHFR9</td>
<td>Photinia x fraseri</td>
<td>Redtip photinia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHAU8</td>
<td>Phyllostachys aurea</td>
<td>Golden bamboo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PICH4</td>
<td>Pistacia chinensis</td>
<td>Chinese pistache</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIST2</td>
<td>Pistia stratiotes</td>
<td>Water lettuce</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>POAL7</td>
<td>Populus alba</td>
<td>Alamo blanco</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTR4</td>
<td>Poncirus trifoliata</td>
<td>Trifoliolate orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUMOL</td>
<td>Pueraria montana var. lobata</td>
<td>Kudzu</td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>PYCO2</td>
<td>Pyracantha coccinea</td>
<td>Scarlet firethorn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RARU</td>
<td>Raphiolepis elata</td>
<td>Bastard cabbage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RICO3</td>
<td>Ricinus communis</td>
<td>Castor Bean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROBR</td>
<td>Rosa bracteata</td>
<td>Macartney rose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROLA</td>
<td>Rosa laevigata</td>
<td>Cherokee rose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROMU</td>
<td>Rosa multiflora</td>
<td>Multiflora rose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROCO6</td>
<td>Rottboellia cochinchinensis</td>
<td>Itchgrass</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>RUCA19</td>
<td>Ruellia caerulea</td>
<td>Britton's wild petunia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SATR12</td>
<td>Salsola tragus</td>
<td>Prickly Russian thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAMI7</td>
<td>Salvinia minima</td>
<td>Common salvinia</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SAMO5</td>
<td>Salvinia molesta</td>
<td>Giant salvinia</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SCAT</td>
<td>Scabiosa atropurpurea</td>
<td>Pincushions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCTE</td>
<td>Schinus terebinthifolius</td>
<td>Brazilian peppertree</td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Symbol</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>FED</td>
<td>TDA</td>
<td>TPW</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>SEPE4</td>
<td>Senna pendula</td>
<td>Valamuerto</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPU7</td>
<td>Sesbania punicea</td>
<td>Rattlebox</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOVI2</td>
<td>Solanum viarum</td>
<td>Tropical soda apple</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>SOHA</td>
<td>Sorghum halepense</td>
<td>Johnson grass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STME2</td>
<td>Stellaria media</td>
<td>Common chickweed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAAF</td>
<td>Tamarix africana</td>
<td>African tamarisk</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAAP</td>
<td>Tamarix aphylla</td>
<td>Athel tamarisk</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TACH2</td>
<td>Tamarix chinensis</td>
<td>Fivestamen tamarisk</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAGA</td>
<td>Tamarix gallica</td>
<td>French tamarisk</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAPA4</td>
<td>Tamarix parviflora</td>
<td>Smallflower tamarisk</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TARA</td>
<td>Tamarix ramosissima</td>
<td>Salt cedar</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>TAOF</td>
<td>Taraxacum officinale</td>
<td>Common dandelion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRSE6</td>
<td>Triadica sebifera</td>
<td>Chinese tallow tree</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTE</td>
<td>Tribulus terrestris</td>
<td>Puncturevine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRCA5</td>
<td>Trifolium campestre</td>
<td>Field clover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRDU2</td>
<td>Trifolium dubium</td>
<td>Suckling clover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULPU</td>
<td>Ulmus pumila</td>
<td>Siberian elm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>URMA3</td>
<td>Urochloa maxima</td>
<td>Guineagrass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEBR2</td>
<td>Verbena brasiliensis</td>
<td>Brazilian vervain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VETH</td>
<td>Verbascum thapsus</td>
<td>Common mullein</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIAG</td>
<td>Vitis agnus-castus</td>
<td>Lilac chastetree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIMA</td>
<td>Vinca major</td>
<td>Bigleaf periwinkle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIMI2</td>
<td>Vinca minor</td>
<td>Common periwinkle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIAG</td>
<td>Vitis agnus-castus</td>
<td>Lilac chastetree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WIFL</td>
<td>Wisteria floribunda</td>
<td>Japanese wisteria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WISI</td>
<td>Wisteria sinensis</td>
<td>Chinese wisteria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XASP2</td>
<td>Xanthium spinosum</td>
<td>Spiny cocklebur</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>