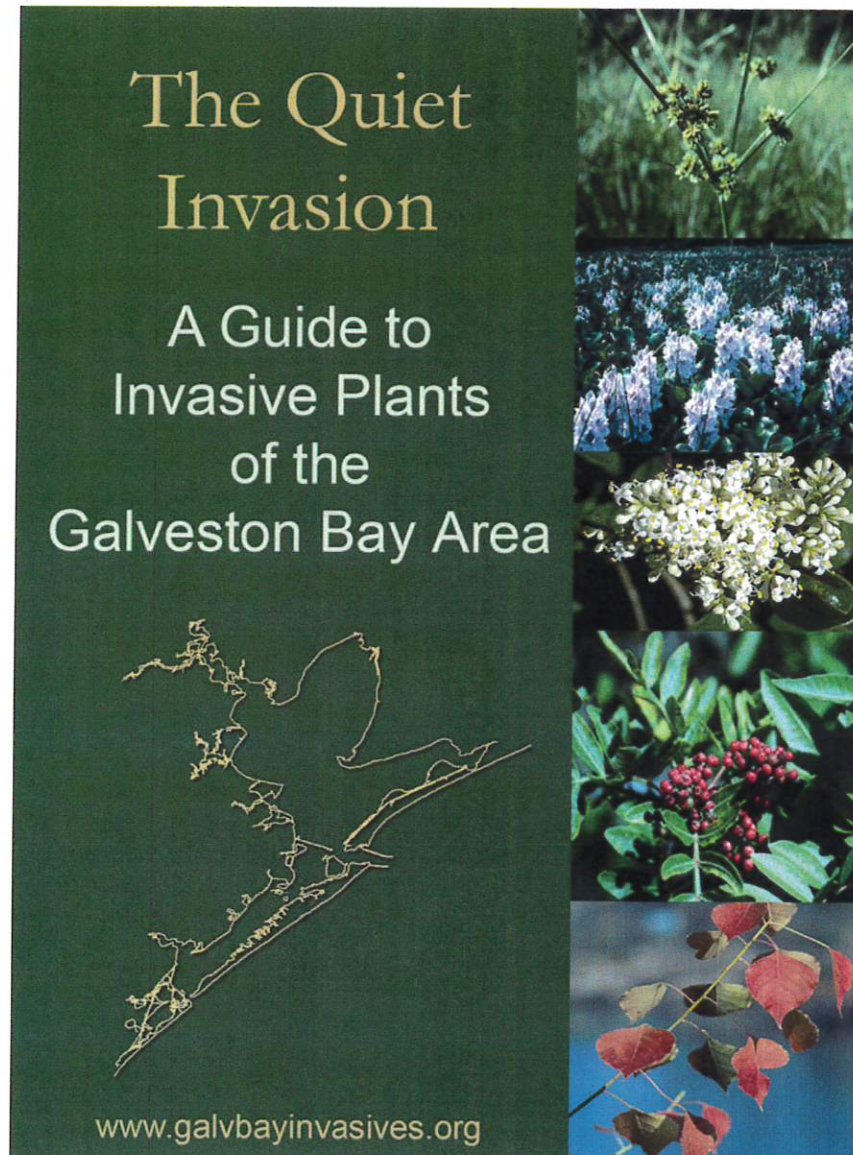


Galveston Bay Invasive Species Field Guide

Final Report

Contract Number 582-5-65092



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Texas Commission on Environmental Quality
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www.galvbayinvasives.org

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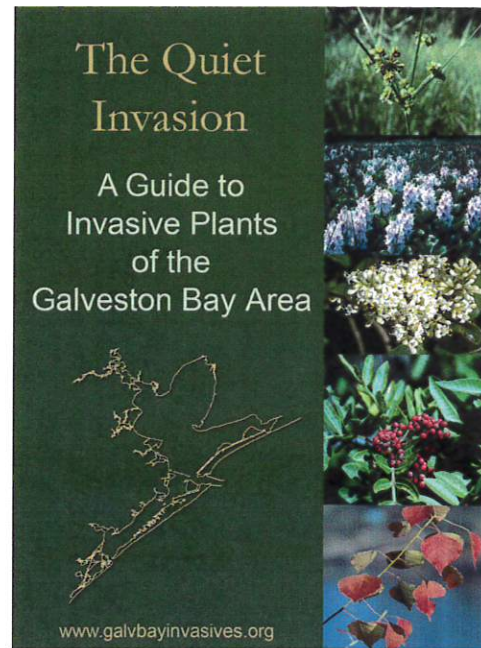
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1 Executive Summary

The Quiet Invasion: A Guide to Invasive Plants of the Galveston Bay Area, was created in 2006 by the Houston Advanced Research Center with funding from the Texas Commission on Environmental Quality, Galveston Bay Estuary Program. The pocket-sized field guide helps gardeners, land managers, and landscape architects identify invasive plants that can be harmful to local habitats. The guide suggests native species alternatives which are better choices for planting.

Species identified in the guide are plants from other parts of world that, when planted in the Houston-Galveston region, survive, reproduce and crowd out native plants. They eventually harm local habitats and the wildlife that depend on them. Examples of invasive plants include: Chinese tallow, deep-rooted sedge, and water hyacinth. On an annual basis, invasive plants and animals cost this country nearly \$137 billion in economic losses and control costs.

Color photos help the audience in Brazoria, Chambers, Galveston, Harris and Liberty counties identify each of the 20 invasive plant species described in the printed guide. An additional 20 species are presented in Web version at—www.galvbayinvasives.org. Information on each species' geographic distribution, pathway of introduction, physical characteristics, preferred habitat, reproduction and growth patterns is included.



To date, more than 3,100 field guides have been distributed via public outreach events and postal service (copies requested through the website). The website has received more than 9,600 visitors since its launch in June 2006. The field guide has been distributed by the project team at numerous outreach events. The field guide has also been highlighted in article in the Houston Chronicle, Houston Business Journal article, and the Citizen's Environmental Coalition weekly newsletter.

Feedback on the Galveston Bay Invasive Plant Field Guide has been overwhelmingly positive. Demand for the guide as well as demand for public outreach presentations related to the guide continues through spring 2007. The guide is a useful resource for homeowners, land and resource managers, and educators as evidenced from comments received by the project team via the online survey, emails, and field guide requests. The guide has raised public awareness regarding the invasive species issue in the Lower Galveston Bay Watershed. Additionally, the guide has assisted local and statewide efforts to implement a citizen science invasive species tracking program.

2 Introduction

Invasive species are identified as species that establish and successfully reproduce in regions where they do not naturally exist. The impacts of invasive species can be ecologically and economically devastating to a region and the Houston-Galveston metropolitan area, including the Lower Galveston Bay Watershed, is no exception.

During the 2001 review of the priorities and goals established in *The Galveston Bay Plan*, invasive species were identified as the second highest priority problem behind habitat loss. In 2004, the Galveston Bay Estuary Program (GBEP), the Houston Advanced Research Center (HARC), and the Environmental Institute of Houston at the University of Houston-Clear Lake (EIH-UHCL) completed an invasive species risk assessment for the Lower Galveston Bay Watershed. The project identified 296 species (including 166 plant species) as current and potential invaders of the Lower Galveston Bay Watershed. Each species was then ranked according to ecological risk by a group of experts. The risk assessment also outlined a series of recommendations to enhance prevention and control of invasive species.

The Invasive Species Field Guide (the Field Guide) is a follow-up outreach effort to the risk assessment. The goal of the Field Guide is to facilitate prevention and prompt control of invasive species in the Houston-Galveston region by providing information to the public regarding species identification, introduction pathway descriptions, native species alternatives, control strategies, and agency reporting contact information. The target audience for the guide consists of homeowners and land managers.

The Project has two primary components: 1) an Invasive Plant Field Guide and 2) a set of aquatic invasive posters. The Invasive Plant Field Guide identifies and provides information describing 40 of the highest risk invasive plants of the Lower Galveston Bay Watershed. The Invasive Plant Field Guide is available in two forms. A bound, color, pocket field guide, approximately 50 pages in total length was developed and printed for distribution (4,500 copies) to the public. The printed field guide provides information on 20 invasive plant species. A companion web-based field guide detailing 40 species was developed and is located on the internet at www.galvbayinvasive.org. The hard copy and electronic versions of the Field Guide are divided into four main content areas:

1. General Information about invasive species introductions. Information will include a general background of the establishment of invasive species and impacts.

2. Species Descriptions:
 - Scientific and common name (including synonyms)
 - Color photos
 - Primary introduction pathway(s)
 - Primary habitat(s)
 - General description and identifying characteristics
 - Reproduction and growth habits
 - Suggested control methods
 - Native species alternatives
3. Agency contacts for reporting invasive species
4. Additional resources describing control techniques for invasive species

An aquatic invasive poster, entitled the “Dirt Dozen: Prohibited Species in the Seafood Market” was developed by the TPWD for distribution to live seafood markets and exotic pet/aquarium dealers. The poster educates retailers and consumers about the impacts of aquatic invasive species and methods to prevent the incidental introduction of exotic animals to the regions’ waterways. An electronic version of the TPWD Dirty Dozen poster is located online at http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_br_k0700_1098.pdf. HARC coordinated with the TPWD as it developed the posters to ensure that there was not a duplication of information between the two projects.

3 Project Methodology

3.1 Invasive Species Chosen for Inclusion

As mentioned above, invasive plant species identified by the Galveston Bay Invasive Species Risk Assessment Project (TCEQ Contract number 582-2-53287) were considered for inclusion in the Field Guide. Of the 166 invasive plant species identified by the risk assessment, 34 were ranked according to ecological risk (see Appendix A). The list of 34 ranked invasive plant species served as the preliminary list of plants for inclusion in the field guide. The list was updated using information from several databases including the USDA Plants database (<http://plants.usda.gov/>) and the Texas Invasives.org database maintained by the Ladybird Johnson Wildflower Center in Austin, Texas (http://www.texasinvasives.org/Invasives_Database/Invasives.html).

Preliminary species lists (20 species for the hard copy guide and 40 species for the online version) were presented to the GBEP Invasive Species Working Group for review. The lists as modified and approved by the ISWG (see Appendix B) formed the basis for the field guide.

3.2 Data Collection and Database Creation

A number of sources were used to populate the field guide with descriptive information. Latin/botanical names were verified using the USDA Integrated Taxonomic Information System (ITIS) database (<http://www.itis.gov/>). All resources used for species profiles in the field guide are included in Section 7 of this final report. Examples of sources include databases, reports, and species profiles prepared by federal and state agencies, university programs, and non-governmental organizations with a reputation for well-documented information (e.g. Ladybird Johnson Wildflower Center and the Nature Conservancy). Native species alternatives were obtained from the Native Plant Database (<http://wildflower.utexas.edu/plants/>) maintained by the Ladybird Johnson Wildflower Center in Austin, Texas. Native species alternatives were chosen based on similarities of plant type (e.g. tree, grass, or shrub), bloom, sunlight, soil, and water requirements. Names of TPWD game warden and agriculture extension agents were obtained from the TPWD and Texas A&M Agriculture Extension Service, respectively.

Data were compiled and edited in a MS Access database to facilitate creation of the hard copy and online versions of the field guide. The Access database was converted to a SQL database to serve as the backend for the online version of the field guide.

More than 250 species-specific, high resolution photos were obtained with permission from individual photographers and from the Invasive.org online photo database (online at <http://www.invasive.org/>). All photos are open source and are cited in the field guide per instruction from the source of the photo.

3.3 Creation and Printing of the Field Guide

As mentioned in Section 3.2 above, the text compiled for species profiles was collected and edited in a MS Access database. Once complete the database was exported to a MS Word document and then imported into Microsoft Publisher for preliminary layout. The preliminary layout was designed by HARC.

The Microsoft Publisher document was then sent to Bayside Printing Company (<http://www.baysideprinting.com>) for final layout, print setting, and printing. Bayside Printing is a certified woman and minority business entrepreneur (WMBE) in the State of Texas and also has many other certifications that meet both local and national certification standards. Bayside is HUB Certified through the Texas Building and Procurement Commission (TBPC).

The hard copy field guide is pocket-size, wire-bound, and printed on recycled paper. The recycled paper is glossy, and of heavy stock to enable outside use. The front and back covers are reinforced to withstand repeated use outdoors. A ruler is printed on the back cover to enable field measurements. The master is held by Bayside Printing to enable easy reprints of the guide.

3.4 Website Development

The online version of the field guide is available at <http://www.galvbayinvasives.org/>. Users can browse species according to habitat (aquatic or terrestrial), presence in the Lower Galveston Bay Watershed (current invaders or future threats), state list (e.g. TPWD prohibited species, Texas Department of Agriculture Noxious Plant List, unlisted species of concern), or all 40 species can be viewed.

The “About Invasive Plants” section of the website provides general information about invasive species including management techniques for prevention and control, native species alternatives, and additional internet resources with invasive species information. An online survey regarding the field guide is also available. The survey is intended to provide information detailing who uses the guide and for what purpose. The survey is also a means to obtain feedback on the guide.

Each species page contains the species profile, links to the USDA Plants database, USDA Integrated Taxonomic Information System, information about state listed status, and photo thumbnails. Each thumbnail enlarges once clicked to facilitate its use in other publications.

4 Project Results

4.1 *Hard Copy, Field Guide Distribution*

An initial printing of 3,000 copies was completed in August 2006. By November 2006, all copies were distributed. In the Fall of 2006, GBEP authorized a second printing of 4,500 additional copies. To date, approximately 3,150 field guides have been distributed via public outreach events and postal service (copies requested through the website).

Table 1. of 3,150 field guides disseminated based on sector of the public requesting a copy.

Type	Total	
Citizens	1,228	39%
Federal Government	415	13%
NGO	393	12%
State Government	370	12%
Local/County Government	304	10%
K-12 Education	181	6%
Consultant	166	5%
University	93	3%
Total	3,150	

The field guide was distributed by the project team at numerous outreach events including the 2007 State of the Bay Symposium, the 2006 WaterSmart Landscapers workshop, and the 2006 Environmental Safety & Health Day at NASA Johnson Space Center. Additionally, the PI has given numerous presentations related to this project. Presentation audiences include Galveston Bay Area Master Naturalists, Heartwood Master Naturalists, Mercer Arboretum volunteers, K-12 educators attending UHCL-EIH science teacher mentoring workshops, the 2006 International

Conference on Aquatic Invasive Species (ICAIS), the 2005 Texas Invasives Conference, the Gulf of Mexico Regional Panel on Aquatic Nuisance Species, and several Houston area Master Naturalist and Master Gardener workshops. The field guide has also been highlighted in a Houston Chronicle article, a Houston Business Journal article, and the Citizen's Environmental Coalition weekly newsletter.

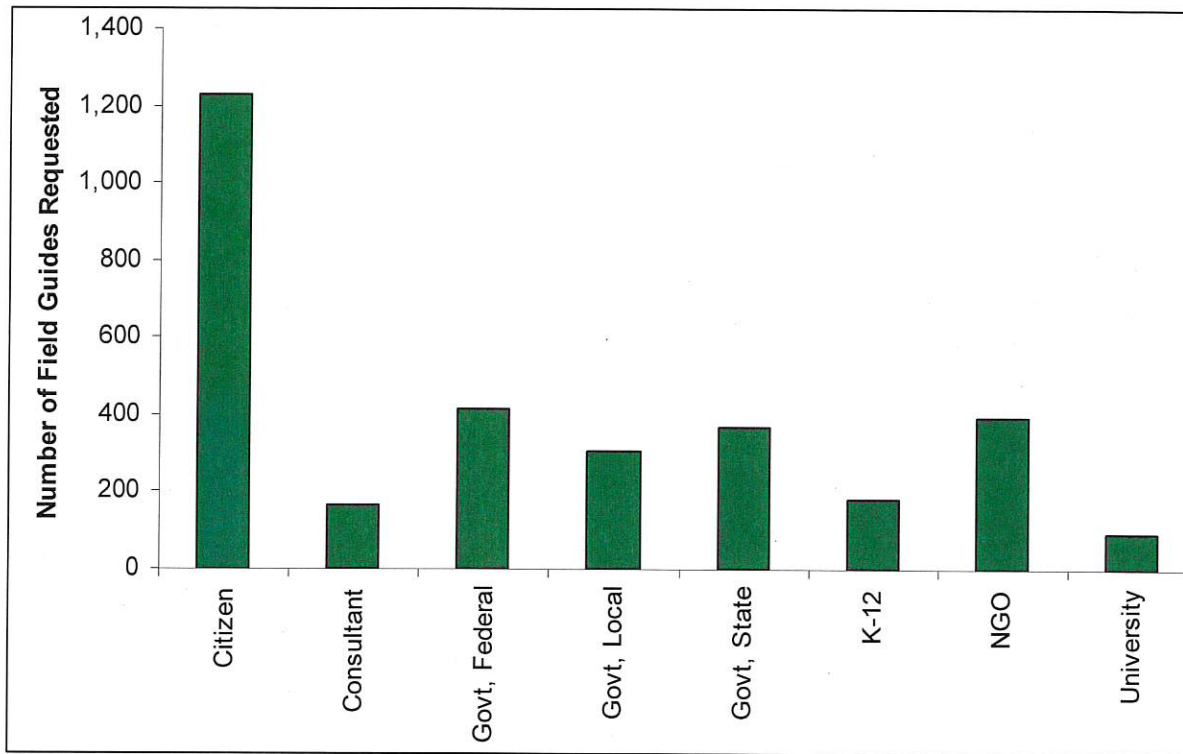



Figure 1. Distribution of 3,150 field guides disseminated based on sector of the public requesting a copy.

4.2 Website Use

Visits to the www.galvbayinvasives.org website are tracked using SiteMeter, a free web traffic tracking software application that runs on the website. Web traffic can be viewed any time by anyone visiting the site by clicking the  icon at the bottom of a webpage.

The website was launched in June 2006. Since that time more than 9,600 visitors have obtained information from the website. As seen in Figure 2, monthly web visits are continuing to increase with March 2007 seeing the highest visitation rate of nearly 1,500 unique visitors.

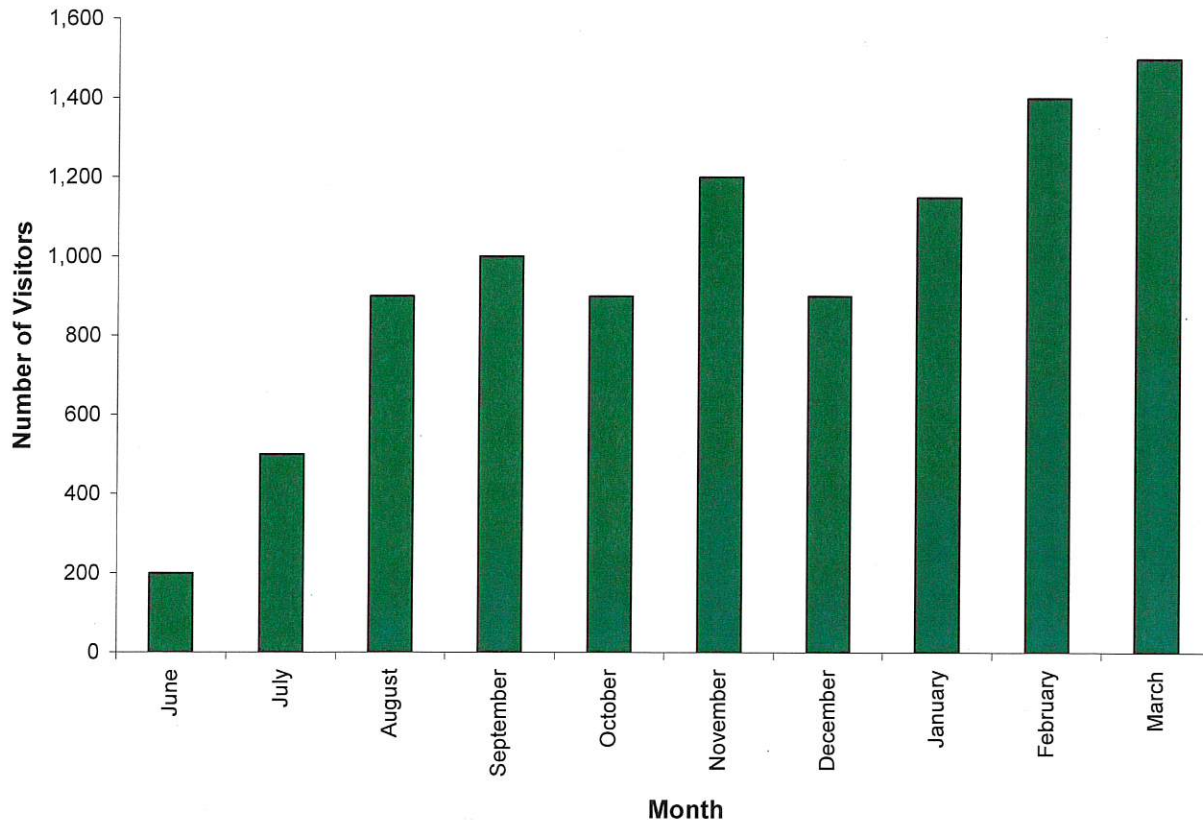


Figure 2. Monthly distribution of the more than 9,600 people that have visited the www.galvbayinvasives.org website since June 2006.

While the majority of visitors to the website are from North America (79%), the website is also viewed by people from Europe (10%), Asia (5%), and South America (3%). Of the visitors to the website, approximately 25% are from the Houston-Galveston region, while 50% of people who visit the website are within 1,000 miles of the Houston-Galveston Region.

The online survey associated with the website has received feedback from 62 people. While the majority of comments are very positive regarding the field guide, some suggestions for improvement are made. Suggestions include: the addition of botanical drawings, expansion of the species list, creation of a field guide for animals, and creation of educational posters. While the majority likes the size of the hard copy guide, there are several suggestions for a larger version.

5 Conclusions and Lessons Learned

Feedback on the Galveston Bay Invasive Plant Field Guide has been overwhelmingly positive. Demand for the guide as well as demand for public outreach presentations related to the guide continues through spring 2007.

Future recommendations made by users of the guide include: the addition of botanical drawings, expansion of the species list, creation of a field guide for animals, and creation of educational posters. While the majority likes the size of the hard copy guide, there are several suggestions for a larger version.

The large number of requests requiring mailing of the hard copy guide was not anticipated by the PI. Should the field guide be revised or reprinted in the future, GBEP and the managers of the project may want to consider providing funding to cover shipping and mailing costs. An alternative would be to charge a nominal fee for mailed guides to cover shipping costs.

Overall, the guide is a useful resource for homeowners, land and resource managers, and educators as evidenced from comments received by the project team via the online survey, emails, and field guide requests. The guide has raised public awareness regarding the invasive species issue in the Lower Galveston Bay Watershed. Additionally, the guide has assisted local and statewide efforts to implement a citizen science invasive species tracking program which uses the guides as an educational tool.

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<http://nas.er.usgs.gov/taxgroup/plants/>

7 Appendices

Appendix A – Galveston Bay Invasive Species Risk Assessment; Species Rankings, Kingdom Plantae

Kingdom	Phylum/Division	Botanical Name	Common Name	Sum
Plantae	Magnoliophyta	<i>Triadica sebifera</i>	Chinese tallow tree, popcorn tree	27
Plantae	Pteridophyta	<i>Salvinia molesta</i>	Giant salvinia, kariba weed	26
Plantae	Magnoliophyta	<i>Hydrilla verticillata</i>	Hydrilla, waterhyme, Florida elodea	26
Plantae	Magnoliophyta	<i>Eichhornia crassipes</i>	Common water hyacinth	25
Plantae	Magnoliophyta	<i>Schinus terebinthifolius</i>	Brazilian Pepper	25
Plantae	Magnoliophyta	<i>Pistia stratiotes</i>	Water lettuce	24
Plantae	Pteridophyta	<i>Salvinia minima</i>	Common salvinia, water spangles	24
Plantae	Magnoliophyta	<i>Cyperus entrerianus</i>	Deep-rooted sedge	23
Plantae	Magnoliophyta	<i>Tamarix ramosissima</i>	Saltcedar, tamarisk	23
Plantae	Magnoliophyta	<i>Pueraria lobata</i> , <i>Pueraria Montana</i>	Kudzu, Japanese arrowroot	22
Plantae	Magnoliophyta	<i>Ligustrum sinense</i>	Chinese privet	22
Plantae	Pyrrophycomphyta	<i>Gymnodinium sp.</i>	Exotic red tide species	21
Plantae	Magnoliophyta	<i>Cuscuta japonica</i>	Japanese dodder	21
Plantae	Magnoliophyta	<i>Myriophyllum spicatum</i>	Eurasian watermilfoil	21
Plantae	Magnoliophyta	<i>Paspalum urvillei</i>	Vaseygrass	21
Plantae	Magnoliophyta	<i>Colocasia esculenta</i>	Elephant ear, coco yam, Wild Taro	21
Plantae	Magnoliophyta	<i>Lythrum salicaria</i>	Purple loosestrife	20
Plantae	Magnoliophyta	<i>Alternanthera philoxeroides</i>	Alligatorweed	20
Plantae	Magnoliophyta	<i>Ipomoea aquatica</i>	Water spinach, swamp morning-glory	20
Plantae	Magnoliophyta	<i>Rosa bracteata</i>	Macartney rose	20
Plantae	Magnoliophyta	<i>Rosa multiflora</i>	Multiflora rose	20
Plantae	Magnoliophyta	<i>Ligustrum japonicum</i>	Japanese ligustrum	18
Plantae	Magnoliophyta	<i>Arundo donax</i>	Giant reed, giant cane	18
Plantae	Magnoliophyta	<i>Dichanthium aristatum</i>	Angleton bluestem	17
Plantae	Magnoliophyta	<i>Bothriochloa ischaemum</i> var. <i>songarica</i>	Yellow bluestem, King Ranch bluestem	17
Plantae	Magnoliophyta	<i>Sorghum halepense</i>	Johnsongrass	17
Plantae	Magnoliophyta	<i>Lonicera japonica</i>	Japanese honeysuckle, Hall's honeysuckle	17

Appendix A Continued...

Kingdom	Phylum/Division	Botanical Name	Common Name	Sum
Plantae	Magnoliophyta	<i>Wisteria sinensis</i>	Chinese & Japanese wisteria	17
Plantae	Magnoliophyta	<i>Melaleuca quinquenervia</i>	Melaleuca, punktree, cajeput, Australian paperbark	17
Plantae	Magnoliophyta	<i>Dichanthium annulatum</i>	Kleberg bluestem	17
Plantae	Magnoliophyta	<i>Imperata cylindrica</i>	Cogongrass	16
Plantae	Chlorophycota	<i>Codium fragile tomentosoides</i>	Dead man's fingers	15
Plantae	Chlorophycota	<i>Caulerpa taxifolia</i>	Caulerpa seaweed	14
Plantae	Chromophyta	<i>Heterosigma akashiwo</i>	Golden-brown micro-alga	12

Appendix B – Hard copy and online species lists approved by the GBEP Invasive Species Working Group

HARD COPY POCKET FIELD GUIDE (20 SPECIES)

Prohibited Species	Alligatorweed	<i>Alternanthera philoxeroides</i>
	Balloonvine, love in a puff	<i>Cardiospermum halicacabum</i>
	Brazilian Peppertree	<i>Schinus terebinthifolius</i>
	Chinese tallow tree, popcorn tree	<i>Triadica sebifera</i>
	Common water hyacinth; Rooted water hyacinth	<i>Eichhornia crassipes</i> ; <i>Eichhornia azurea</i>
	Deep-rooted sedge	<i>Cyperus entrerianus</i>
	Eurasian watermilfoil	<i>Myriophyllum spicatum</i>
	Giant reed, giant cane	<i>Arundo donax</i>
	Giant salvinia, kariba weed; Common salvinia, water spangles	<i>Salvinia molesta</i> ; <i>Salvinia minima</i>
	Hydrilla, waterhyme, Florida elodea	<i>Hydrilla verticillata</i>
	Japanese dodder	<i>Cuscuta japonica</i>
	Kudzu, Japanese arrowroot	<i>Pueraria lobata</i> , <i>Pueraria montana</i>
	Melaleuca, punktree, cajeput, Australian paperback	<i>Melaleuca quinquenervia</i>
	Purple loosestrife	<i>Lythrum salicaria</i>
	Saltcedar, tamarisk	<i>Tamarix ramosissima</i>
	Tropical soda apple	<i>Solanum viarum</i>
	Water lettuce	<i>Pistia stratiotes</i>
Species of Concern	Elephant ear, coco yam, Wild Taro	<i>Colocasia esculenta</i>
	Japanese privet; Chinese privet	<i>Ligustrum japonicum</i> ; <i>Ligustrum sinense</i>
	Vaseygrass	<i>Paspalum urvillei</i>

APPENDIX B CONTINUED... ONLINE VERSION OF THE FIELD GUIDE (40 SPECIES)

	Common Name	Scientific Name
Prohibited Species	Alligatorweed	<i>Alternanthera philoxeroides</i>
	Balloonvine, love in a puff	<i>Cardiospermum halicacabum</i>
	Brazilian Peppertree	<i>Schinus terebinthifolius</i>
	Chinese tallow tree, popcorn tree	<i>Triadica sebifera</i>
	Common water hyacinth; rooted water hyacinth	<i>Eichhornia crassipes; Eichhornia azurea</i>
	Deep-rooted sedge	<i>Cyperus entrerianus</i>
	Eurasian watermilfoil	<i>Myriophyllum spicatum</i>
	Giant reed, giant cane	<i>Arundo donax</i>
	Giant salvinia, kariba weed; Common salvinia,	<i>Salvinia molesta; Salvinia minima</i>
	Hydrilla, waterhyme, Florida elodea	<i>Hydrilla verticillata</i>
	Japanese dodder	<i>Cuscuta japonica</i>
	Kudzu, Japanese arrowroot	<i>Pueraria lobata, Pueraria montana</i>
	Melaleuca, punktree, cajeput, Australian paperback	<i>Melaleuca quinquenervia</i>
	Purple loosestrife	<i>Lythrum salicaria</i>
	Saltcedar, tamarisk	<i>Tamarix ramosissima</i>
	Tropical soda apple	<i>Solanum viarum</i>
	Water lettuce	<i>Pistia stratiotes</i>
	Water spinach, swamp morning-glory, hollow stem	<i>Ipomoea aquatica</i>
Species of Concern	Bamboo	<i>Phyllostachys spp.; Bambusa spp.</i>
	Bushkiller, Java, Javan grape	<i>Cayratia japonica</i>
	Castor Bean	<i>Ricinus communis</i>
	Chinaberry, pride of India, Indian lilac, Umbrella tree	<i>Melia azedarach</i>
	Chinese elm	<i>Ulmus parvifolia</i>
	Chinese wisteria	<i>Wisteria sinensis</i>
	Cogongrass	<i>Imperata cylindrica</i>
	Elephant ear, coco yam, Wild Taro	<i>Colocasia esculenta</i>
	Japanese climbing fern; Old world climbing fern	<i>Lygodium japonicum; L. microphyllum</i>
	Japanese honeysuckle, Hall's honeysuckle	<i>Lonicera japonica</i>
	Japanese privet; Chinese privet	<i>Ligustrum japonicum; Ligustrum sinense</i>
	Johnsongrass	<i>Sorghum halepense</i>
	Bluestem; Kleberg, Angleton, Yellow, King Ranch	<i>Dichanthium annulatum; D. aristatum; Bothriochloa ischaemum var. songarica</i>
	Lead tree, Leucaena, Haole koa	<i>Leucaena leucocephala</i>
	Macartney rose	<i>Rosa bracteata</i>
	Motojo-bobo, childa, alien weed, bitter gingerleaf	<i>Lycianthes asarifolia</i>
	Multiflora rose	<i>Rosa multiflora</i>
	Russian olive, oleaster	<i>Elaeagnus angustifolia</i>
	Silktree Mimosa	<i>Albizia julibrissin</i>
	Tree-o-heaven	<i>Ailanthus altissima</i>
	Vaseygrass	<i>Paspalum urvillei</i>