BREC'S INVASIVE SPECIES MANAGEMENT PLAN

Natural Resource Management Division
Recreation and Park Commission for the Parish of East Baton Rouge

Approved by BREC Commission on:

Version Date: 20 November 2019

Scheduled to be reviewed by the Natural Resource Management Division annually. See review spreadsheet for review dates and signatures.

This document was review by the following agencies:

- United States Department of Agriculture
- Louisiana Department of Wildlife and Fisheries
- Louisiana State University

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1 Introduction

The Recreation and Park Commission for the Parish of East Baton Rouge (BREC) is one of the largest landowners in East Baton Rouge Parish with over 6,000 acres and around 180 parks. These parks contain unique and important habitats for native flora and fauna and include a wide range of amenities including but not limited to hiking and mountain biking trails, playgrounds, blueway launches, botanic gardens, nature centers, multi-use pathways, fishing ponds and more. The Natural Resource Management Division which is responsible for understanding and managing BREC's natural resources, is dedicated to the goals in the Natural Resource Management Plan.

- **Promote recreational and educational activities focusing on appreciation and understanding of the natural environment.**
- **Protect unique and historically representative habitats.**
- **Reduce the loss of species.**

The widespread and expanding nature of many invasive species throughout the parish has and will continue to result in reduced biodiversity and an altered landscape unconducive to outdoor recreational activities. It is important that BREC address this issue in our own parks and also work to educate the public to reduce the continued spread of species through the pathways discussed in this document. Non-native, invasive flora and fauna species are considered pests by the Louisiana Department of Agriculture and Forestry and should be treated as such when managing for removal or prevention. These species pose a critical threat to local ecosystems, and it is important that innovative and integrated techniques be used to stay ahead of the problem.

This document is meant to provide an overview of the invasive species most commonly found in BREC parks and ones that may become an issue in the future. It outlines ways to prevent the invasion of these species and also best methods for their removal. Although it provides specific information for each species, this plan in not meant to be all inclusive. When planning management strategies external references should be checked to confirm what is listed in this document. This document should be reviewed regularly combined with surveying and monitoring the parks to ensure it remains relevant and useful.

2 Overview

Invasive species are a widespread and serious threat to BREC's goal to protect unique and historically representative habitats and reduce loss of species, as well as to ecosystem and human health in Louisiana. The threat of invasive species continues to expand (Mack et al. 2000; Simberloff and Rejmánek 2011), but it can be addressed with preventative measures as well as monitoring and control of existing populations.

Invasive species are a subset of non-native or "exotic" species. Non-native species are those that are transferred to a geographic location previously unoccupied by that species via natural or anthropogenic means. The time frame between when a non-native species is introduced and when it becomes invasive is known as the lag phase (Mack et al. 2001). This lag phase can be very short or prolonged depending on a number of factors. Most extinctions of non-native species occur during this lag phase. Whether or not a non-native species becomes invasive remains difficult to predict.

Invasive, non-native species are exotic species that aggressively spread and outcompete native species. They often cause significant harm to native species and natural communities. The percentage of non-natives that will reach invasive status is 1% (Mack et al. 2000).

Native species can also become invasive, although such invasions are usually the result of anthropogenic changes in the environment (Simberloff and Rejmánek 2011). These invasions differ, as a native invasive may have a rapid or significant range expansion into new geographic locations, or it may become significantly more common in its original range.

Once established, invasive species can degrade the invaded environment. They impact food availability and habitat quality for native species, decrease species diversity, increase habitat fragmentation, and weaken the ecosystem's ability to defend against natural disasters and other sudden catastrophic events (Chapin III et al. 2000; Mack et al. 2000; Pimentel et al. 2000; Simberloff and Rejmánek 2011). Invasive species not only impact our ecosystems, but they also have far reaching consequences that impact industrial, agricultural, commercial, and private business sectors (Mehta et al. 2007). Pimental et al. (2000) even calculated that invasive species in the U.S. cause more than $138 billion annually in environmental damages and losses.

Invasive species also alter the capacity of ecosystems to deliver services that support the production of goods and to mitigate anthropogenic and environmental stresses without losing resilience (Simberloff and Rejmánek 2011). These losses can include, but are not limited to, degradation in number of cattle a field can support due to unpalatability of invasive plants, loss of recreation due to congested waterways, damaged or clogged filtration or cooling lines due to invasive mollusks, increased natural disaster risk after the loss in biodiversity, and an increase in maintenance costs due to damage caused by vines or an increase in mowing frequency due to rapid growth rate of invasive grasses.

BREC's parks are meant to be enjoyed by the public recreationally while also conserving native and historically represented habitats. Invasive species can threaten both of these objectives, as has been seen in BREC's Blackwater Conservation Area. After the 2016 flood, BREC's Blackwater Conservation Area pond became inundated with water hyacinth (*Eichhornia crassipes*) to the point where one could no longer fish, kayak or view the open water. After several years it became obvious that only a large mechanical removal project would rid the pond of the plant without killing the fish at the same time. While this is only one example of how quickly an invasive species has taken over a resource and impacted the user experience while also altering the ecosystem dynamics, it has occurred elsewhere in BREC's parks.

Figure 1. Water hyacinth at Blackwater Conservation Area in July 2019 prior to mechanical removal project. (Source: BREC staff)

3 Characteristics of Invasive Species

While much study has been done on invasive species it is still difficult to predict which ones will become invasive. The invasiveness (degree to which a species is able to reproduce, spread from its place of introduction, and establish in new locations) is dependent on a number of factors, including its natural history, physiology, genetics, behavior, and community characteristics. Overall, successful invasive species often exhibit one or more of the below characteristics (Meffe et al. 2006; Simberloff and Rejmánek 2011):

- High reproductive rate, short generation time
- Long-lived
- High dispersal rate
- Single parent reproduction (i.e. gravid or pregnant female can colonize)
- Vegetative or clonal reproduction
- High genetic variation
- Phenotypically plastic
- Habitat generalist
- Broad diet (polyphagous)
- Human commensal

3.1 Invasibility

On the other hand, the susceptibility of an environment to the colonization and establishment of a species (invasibility) is influenced by numerous factors. Communities likely to be invaded show the following characteristics (Meffe et al. 2006; Simberloff and Rejmánek 2011):

- *Habitat compatibility.* Habitats that are environmentally similar to the original habitat of the invader are more likely to be invaded. Generally, habitats with low net primary productivity, low diversity, located in proximity to residential areas, in low temperate latitudes, in open wetlands, and on islands are more prone to biological invasions. Furthermore, invasibility increases in habitats where predation, competition, and fire are absent in the evolutionary history
- *Early successional communities*. Communities that are in an early successional stage, in particular during the secondary successional stage, are more likely to be invaded. The disturbance created in the first succession can boost conditions favorable to non-native species.
- *Disturbed communities*. Anthropogenic disturbance often reduces ecosystem resilience and provides opportunities for invasive species. Invasive species not only take advantage of disturbed communities but can be a disturbance themselves by modifying natural disturbance regimes (e.g. impacting native herbivore populations).

3.2 Dispersal Mechanisms

Dispersal is the relocation of individuals from its place of origin to another (Simberloff and Rejmánek 2011). Both the extent and rate of dispersal is dependent on taxon, geographical area, and time. Dispersal is driven or assisted by different mechanisms such as natural phenomena or human activities.

3.2.1 Animal Dispersal

The first factor to consider in animal dispersal strategies is locomotory ability. Several animal species are non-motile, living stationary surrounded by their food supply. Examples of non-motile animals are sponges, corals, and oysters. These species rely on motile propagules to reach a suitable substratum for settlement. Most animals are motile, and they can disperse spontaneously and independently in the environment. Within motile species, some animals are able to travel vast distances. In certain situations, dispersal is assisted by natural phenomena, such as winds, ocean currents, or the downstream flow of rivers. In other cases, dispersal can be entirely driven by anthropogenic means, such as dispersal via human transportation (aircrafts or ships).

3.2.2 Plant Dispersal

Plants disperse in a variety of ways, are described in **Table 1.**

Table 1. Plant dispersal mechanisms

Type	Mechanism	Description
Autochory (without help of external vectors)	Gravity (barochory)	Gravity causes ripe fruits to fall from the plant. Gravity dispersal also allows dispersal by water and animals
	Ballistic (ballochory)	Seeds are ejected by explosive dehiscence of the fruit
	Blastochory	Stem of the plant crawls along the ground to deposit its seed far from the base of the plant
	Herpochory	Seeds crawl because of changes in humidity or by effect of trichomes
Allochory (with help of external agents)	Wind (anemochory)	Seeds have structures that allow them to float on the air
	Water (hydrochory)	Seeds can float and can travel long distances through water
	Animals, internal (endozoochory)	Seeds are ingested and dispersed mostly by vertebrate animals (birds and mammals)
	Animals, external (epizoochory)	Seeds are transport externally by animals
	Other animals	Ants (myrmecochory), bats (chiropterochory), mollusks (malacochory)
	Humans (anthropochory)	Voluntary or involuntary dispersal by humans
Mixed	Two-phase dispersal (diplochory)	Seeds are sequentially moved by more than one mechanism or vectors (i.e. wind dispersal and caching by animals)

Humans have had a considerable impact on the dispersion of invasive species, acting both as intentional and unintentional dispersal vectors and by altering the environment affecting the movement of seeds across landscapes. Intentional invasive species dispersal occurs when species are dispersed to new areas for reasons such as landscaping, erosion control, and wood and fiber production. Unintentional dispersal occurs in many ways: seeds can be attached to boats, trailers, tire treads, pants, socks, boot laces, fur of pets, livestock, and as contaminants of crop seed. Habitat alterations such as fragmentation, the creation of edges, and the availability of corridors affect species dispersal.

Within BREC parks, heavily disturbed areas, through either human activity (i.e. mowers or other heavy equipment) or natural events such as hurricanes or floods, are more susceptible to invasion and should be targeted for monitoring and removal efforts. Hikers, transportation devices such as ATVs and bicycles, dogs, and horses provide other ways for invasive species distribution. Boats and angling equipment are an avenue of transport for invasive aquatic pests. Special attention is needed on newly acquired properties with varied land use histories.

4 Invasive Species List

BREC's invasive species management programs exist within the context of the state and federal initiatives. There are many federal and Louisiana laws and regulations that address both aquatic and terrestrial invasive species and the management thereof, both directly and indirectly. As such, BREC built this management plan on the existing framework provided by state and federal categorization and regulation. The Louisiana Department of Wildlife and Fisheries (LDWF) compiled a list of invasive species and categorized them by their prevalence in Louisiana as well as the severity of their impacts (Holcomb et al. 2015). This list is divided into four Tiers:

- *Tier I* – Currently having severe or widespread negative impacts on wildlife or natural communities in Louisiana. This includes species that have a limited distribution in the state, but that have severe impacts where found.
- *Tier II* – Currently having moderate negative impacts on wildlife or natural communities in Louisiana, but of limited concern and/or extent. This includes species that have severe impacts in other states, but that have not reached Tier 1 status in Louisiana.
- *Tier III* – Currently occurring (or have occurred recently), but that have no known or anticipated significant impacts on wildlife or natural communities in Louisiana.
- *Tier IV* – Species not known to currently occur, or known to have occurred in the recent past, but that have the potential to invade in the near future.

Appendix 3 contains the state list compiled by Louisiana Department of Wildlife and Fisheries. Effectively addressing all invasive species in East Baton Rouge Parish is not within the existing means of BREC to manage effectively. Therefore, BREC has broken down this list to priority focal species (**Table 2.a** and **Table 2.b**). These focal species have a particularly heavy impact on BREC properties, and are of immediate conservation concern. These lists of focal species should be considered tentative as they are based on the currently available information in BREC parks. It is expected that list will change as more data is collected to determine the distribution and relationships of these species in our parks.

Focal Plant Species

1. Alligatorweed (*Alternanthera philoxeroides*)
2. Bermuda grass (*Cynodon dactylon*)
3. Chinese tallow tree (*Triadica sebifera*)
4. Cogon grass (*Imperata cylindrica*)
5. Coral ardisia (*Ardisia crenata*)
6. Elephant ear (*Colocasia esculenta*)
7. Japanese climbing fern *(Lygodium japonicum*)
8. Johnson grass (*Sorghum halepense*)
9. Paper mulberry (*Brussonetia papyrifera*)
10. Privets (*Ligustrum* spp.)
11. Trifoliate orange (*Poncirus trifoliata*)
12. Tungoil tree (*Vernicia fordii*)
13. Water hyacinth (*Eichhornia crassipes*)

In addition to invasive plants, there are also invasive animals in BREC parks. These animals are those that alter the environment or ecosystem to a degree that is damaging to the environment, human economy or human health. BREC has identified focal invasive animal species that have a particularly detrimental impact on BREC properties, or the potential to cause damage if no action is taken, and that have a feasible control method.

Focal Animal Species

1. Channelled apple snail (*Pomacea canaliculat*a and *P. maculata*)
2. Feral hog (*Sus scrofa*)
3. Feral/domestic cat (*Felis catus*)

BREC will also monitor the presence of certain species, which have not been observed or made a significant impact yet within BREC parks but constitute an issue in East Baton Rouge and other Louisiana parishes.

Supplementary Plant Species

1. Air Potato Vine (*Dioscorea bulbifera*)
2. Chinaberry (*Melia azedarach*)
3. Hydrilla (*Hydrilla verticillata*)
4. Kudzu (*Pueraria* sp.)
5. Mimosa (*Albizia julibrissin*)
6. Parrotfeather (*Myriophyllum aquaticum*)
7. Salvinia (*Salvinia minima* and *S. molesta*)
8. Torpedo Grass (*Panicum repens*)
9. Tree-of-Heaven (*Ailanthus altissima*)
10. Vasey Grass (*Paspalum urvillei*)
11. Water lettuce (*Pistia stratiotes*)

Supplementary Animal Species

1. Argentine Ant (*Linepithema humile*)
2. Bighead Carp (*Hypophthalmichthys nobilis)*
3. Black Carp (*Mylopharyngodon piceus*)
4. Common Carp (*Cyprinus carpio*)
5. Emerald Ash Borer (*Agrilus planipennis*)
6. Grass Carp (*Ctenopharyngodon Idella*)
7. Northern Snakehead (*Channa argus*)
8. Nutria (*Myocastor coypus*)
9. Red Imported Fire Ant (*Solenopsis invicta*)
10. Rio Grande Cichlid (*Herichthys cyanoguttatum*)
11. Silver Carp (*Hypophthalmichthys molitrix*)
12. Zebra mussel (*Dreissena polymorpha*)

Table 2.a BREC Invasive Plant Species Information Reference

Common Name	Scientific Name	Tier	Habitat	Impacts
Alligatorweed*	*Alternanthera philoxeroides*	II	Along canals, rivers, swamps, lakes, dams, ditches, and wetlands, rooted to the ground and emerging above the water surface. Also found in riparian habitats, free-floating in dense mats on the water surface.	Displaces native aquatic and shoreline vegetation, decreases water flow, increases sedimentation, shades submersed plants, and reduces oxygen concentration in water.
Bermuda grass*	*Cynodon dactylon*	I	Warm climates and areas with abundantlight, i.e. not shade tolerant.	Underground rhizomes cause this plant to out-compete native plants.
Chinaberry	*Melia azedarach*	II	Scrub, sandhill, mesic flatwoods, hardwood hammocks, maritime forests, beach dunes, stream and spring shores, and ruderal communities.	Fruits poisonous to humans and some other mammals, but seeds dispersed by a variety of songbirds, who relish the drupes and sometimes gorge themselves to the point of temporary intoxication.
Chinese, privet*	*Ligustrum sinense*	I	Versatile, with a specialty for wet conditions, mesic soils, and abundant sunlight.	Forms dense thickets that shade out native species.
Chinese tallow tree*	*Triadica sebifera*	I	Versatile, colonizing riverbanks, upland sites, and freshwater and saline soils. It is shade tolerant, flood tolerant, and allelopathic.	Forms monospecific forests with altered soils that deter native plant species. It reduces habitat for native wildlife that relies on forest biodiversity.
Cogon grass*	*Imperata cylindrica*	I	Tolerant of high salinity, moisture, and drought. Thrives on any substrate, from fine sand to heavy clay, and low-fertility soils. It readily invades disturbed areas, but will grow in coastland, natural and planted forests, shrub/scrub, grasslands, pastures, riparian zones, urban areas, and wetlands. Shade-tolerant ecotype capable of invading old-growth forests.	Cogon grass causes fires reaching higher temperatures, resulting in a much higher tree mortality. Dense thatch excludes some ground nesting birds.
Coral ardisia*	*Ardisia crenata*	I	Bottomland hardwoods and moist grazing fields.	Suspected to be toxic to livestock, pets, and humans. Shades out native seedlings and understory plants.
Elephant ear*	*Colocasia esculenta*	I	Swamps and stream banks.	The large leaves shade out and prevent regeneration of desired species.
Glossy privet*	*Ligustrum lucidum*	II	Versatile, with a specialty for wet conditions, mesic soils, and abundant sunlight.	Forms dense thickets that shade out native species.
Hydrilla or waterthyme	*Hydrilla verticillata*	I	All freshwater habitats, particularly those with slow-moving water.	Can exclude native aquatic plants, and lead to low levels of dissolved oxygen, causing negative impacts to native invertebrates and fishes.
Kudzu	*Pueraria montana*	I	Open disturbed areas,typically seen on forest edges, abandoned fields, and roadsides.	Susceptible to Asian soybean rust and tobacco ingspot virus, making it a potential vector for the

				infection of valuable economic crops or native legumes important to wildlife. Kudzu was discovered to reduce air quality by increasing nitrogen cycling in soils, causing soils to increase emissions of nitric oxide.
Japanese climbing fern*	*Lygodium japonicum*	I	Occurs along highway and open areas, invading into margins of bordering forests. Readily invades open plantations and pine stands. Can grow in sun or shade but prefers damp areas.	Shades out entire trees and forms dense, matted ground cover that prevents native plants to growth. It also acts as a ladder fuel leading to hazardous crown fires.
Japanese privet*	*Ligustrum japonicum*	II	Versatile, with a specialty for wet conditions, mesic soils, and abundant sunlight.	Forms dense thickets that shade out native species.
Johnson grass*	*Sorghum halepense*	II	Disturbed soils, along irrigation ditches, stream bottoms, roadsides, and cracks between sidewalks.	Out-competes native grasses and reduces diversity. Toxic cyanide concentrations in leaves growing under stressful conditions may be poisonous to livestock. High nitrate levels in the plant can produce nitrate poisoning in sheep and cattle.
Mimosa	*Albizia julibrissin*	II	Opportunist, found often along roadsides, open spots, banks of waterways, and disturbed areas.	Strong competitor able to grow in various soil types, producing large amounts of seed, and sprouts when cut back or damaged. Reduces sunlight and nutrients available to desired species because of the denseness of the stand.
Paper mulberry*	*Broussonetia papyrifera*	II	Prefers moist, well-drained soil. Does best in rich, sandy loam and light soils. It is highly adaptable and will adjust for altered conditions.	Slows the growth of other plants due to massive water consumption. Shades out native plants. High incidence of allergic reactions to pollen.
Parrotfeather	*Myriophyllum aquaticum*	II	Lakes, ponds and slow-moving waters.	Clogs waterways, impeding recreational and commercial boating activities.
Salvinia	*Salvinia minima* and *S. molesta*	I	All aquatic systems.	Forms dense mats that exclude native plants, which can have negative impacts on wildlife.
Torpedo grass	*Panicum repens*	I	In or near shallow waters but can be found in more upland areas as well.	Displaces marsh vegetation and impedes water flow in ditches and canals, resulting in reduced recreational use and increased chances of floods.
Tree-of-Heaven	*Ailanthus altissima*	II	Fields, meadows, and forests. Extremely tolerant to poor soil conditions.	Forms dense, clonal thickets which displace native species.
Trifoliate orange*	*Poncirus trifoliata*	I	Thrives in a wide variety of habitats, from disturbed communities to intact, natural communities with closed or open canopies. Grows best in full sun.	Shades out native plants, without providing suitable wildlife habitat.

Tungoil tree*	*Vernicia fordii*	I	Thrives best in full sun and mildly acidic soils.	Extremely toxic, with the leaves causing a poison ivy-like rash and the fruits being lethal if consumed. All parts of the tree are toxic to humans.
Vasey grass	*Paspalum urvillei*	I	Moist, open, disturbed sites.	Gains a foothold in disturbed areas and takes over, displacing native plants and animals. Allelopathic. Associated with the bacterium *Acidovorax avenae* that causes diseases in economically important plants such as corn and rice.
Water hyacinth*	*Eichhornia crassipes*	I	Freshwater. Cold intolerant.	Clogs waterways impeding boating, fishing, and other water activities. Reduces water flow and increases flood risk, decreases water oxygen levels increasing fish mortality, and reduces plant diversity.
Water lettuce	*Pistia stratiotes*	II	Occurs in lakes, rivers and canals, occasionally forming large dense mats.	Forms large infestations which prevent boating, fishing and other uses of lakes and rivers.

*Indicates focal species

Data synthesized from Miller 2003; Bois et al. 2011; Simberloff and Rejmánek 2011; DiTomaso et al. 2013; USDA 2015; CABI 2019; IUCN 2019

Table 2.b BREC Invasive Animal Species Information Reference

Common Name	Scientific Name	Tier	Habitat	Impacts
Bighead Carp	*Hypophthalmichthys nobilis*	I	Freshwater	Competes with native filter feeding fish and shellfish.
Black Carp	*Mylopharyngodon piceus*	I	Freshwater	Threatens populations of native snails and mussels.
Channeled apple snail*	*Pomacea canaliculata* and *P. maculata*	I	Freshwater	Denudes freshwater habitats. All native species are potentially at risk. Apple snails also serve as hosts for the rat lung worm (*Angiostrongylus cantonensis*), which has been shown to infect humans and other mammals.
Common Carp	*Cyprinus carpio*	I	Freshwater	Disturbs bottom sediments and uproots native aquatic vegetation when feeding.
Domestic cat*	*Felis catus*	I	Cosmopolitan, with greater concentrations near urban centers	Cats prey on birds, mammals, reptiles, and amphibians. Cats are vectors for infectious diseases and parasites such as rabies, toxoplasmosis and hookworms.
Emerald Ash Borer	*Agrilus planipennis*	NA	Bottomland Hardwood Forests	Damage to ash trees. The emerald ash borer kills ash trees by digging tunnels below the bark, cutting the flow of sap throughout the tree.
Feral hog*	*Sus scrofa*	I	Generalists, highly adaptable, can dwell in various climates and habitats	Feral hogs compete directly with native wildlife for mast crops, prey on reptiles, amphibians and invertebrates, and opportunistically on deer fawns, and eggs of ground-nesting birds and reptiles. They uproot tree seedlings, consume native plants, cause erosion, and contaminate waterways with coliform bacteria. They are vectors for several diseases, such as swine brucellosis, pseudorabies, leptospirosis, salmonellosis, and *Escherichia coli*
Grass Carp	*Ctenopharyngodon idella*	I	Freshwater	Can denude a habitat of all aquatic vegetation. Disturbs bottom sediments and uproots native aquatic vegetation when feeding.
Northern Snakehead	*Channa argus*	NA	Freshwater. Not in Louisiana but found in nearby states.	Aggressive predator.
Nutria	*Myocastor coypus*	I	Freshwater, brackish water, and saltwater	Aquatic communities, particularly fresh, intermediate, brackish, and salt marsh, via herbivory, accelerated land loss, and direct destruction through burrow construction.
Rio Grande Cichlid	*Herichthys cyanoguttatus*	I	Freshwater	Competes with and often confused with native sunfish.

Silver Carp	*Hypophthalmichthys molitrix*	I	Freshwater	Leaps out of water and injures boaters. Competes with native filter feeding fish and shellfish.
Zebra mussel	*Dreissena polymorpha*	II	Freshwater	Creates hazards for recreational users and can cause economic damage by clogging pumps, intakes, etc. Zebra mussels also filter out algae that native species need for food and they attach to and incapacitate native mussels.

*Indicates focal species

Data synthesized from Holcomb et at. 2015; Miller 2003; Bois et al. 2011; Simberloff and Rejmánek 2011; DiTomaso et al. 2013; USDA 2015; CABI 2019; IUCN 2019

5 Invasive Species Management

Invasive species are the greatest threat to the natural communities of East Baton Rouge, after habitat loss and destruction. Invasive species management must follow the principles of Adaptive Resource Management (ARM), using management strategies taken from previous experimentation and outcomes (Walters 1986; Lancia et al. 1996). Invasive species will be managed on different fronts by mapping areas with varying level of infestation and effort needed and prioritizing removal efforts on the basis of available resources. In the absence of volunteers, Natural Resource Management Staff will prioritize large reproductive individuals in areas of relatively low infestation and along ecotones, proceeding inwards to areas of high infestation, as illustrated in **Figure 2**. Additionally, staff will target areas that have identified invasive species in its lag phase which will allow a pre-emptive management approach. If these species can be removed prior to full establishment it could prevent an infestation.

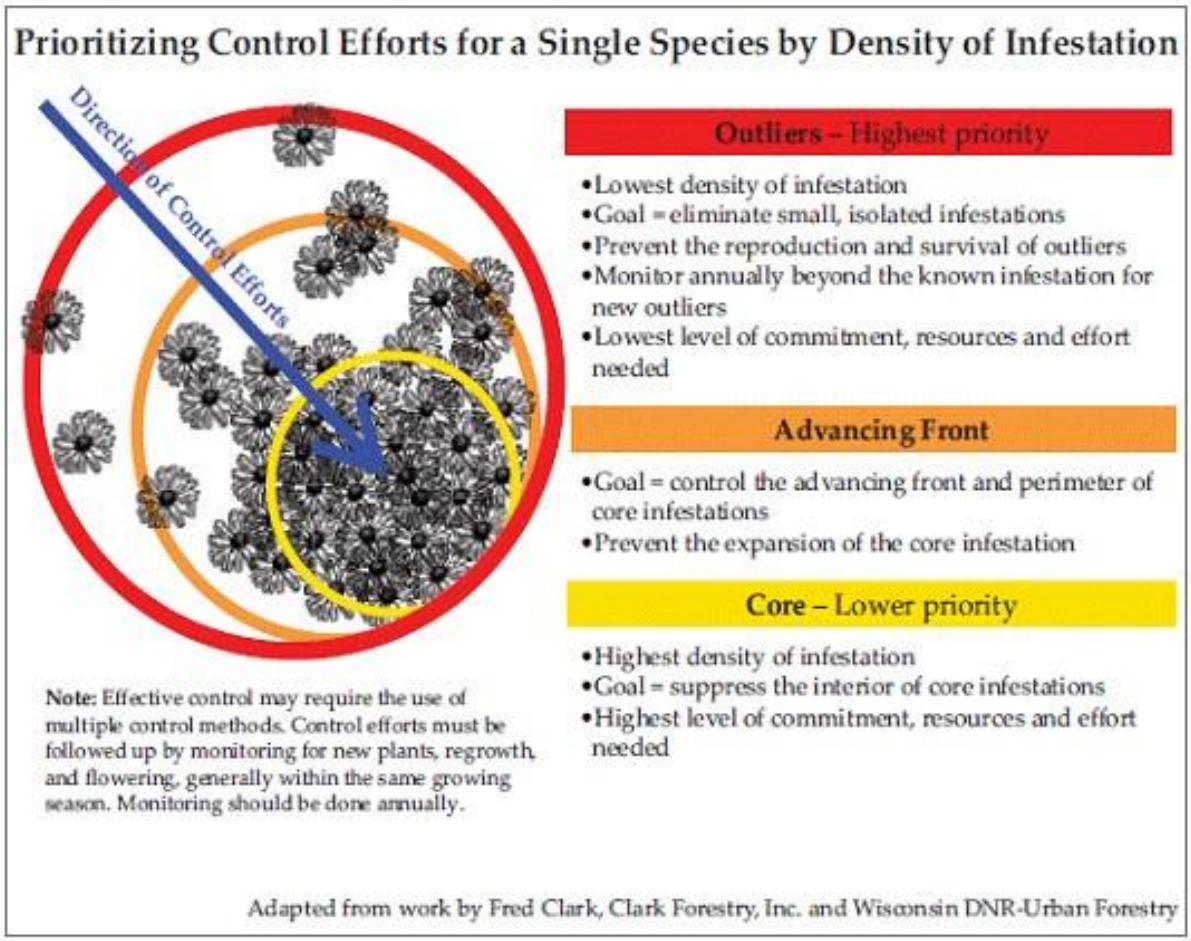

Figure 2. Invasive species prioritization model (Source: https://dnr.wi.gov/topic/Invasives/control.html)

In case of the availability of large number of volunteers, control efforts will be focused towards Core areas, were labor is maximized and impacts to native species are minimized. Efforts will be switched to areas of lower infestation when smaller groups of volunteers are available. Efforts should be made to pair dense infestation removals with replanting of well-suited native species.

5.1 Management Techniques

The primary defense against invasive species is prevention. Early detection and treatment of invading species saves time, money, and resources while preventing damage caused by the species. Preventing invasive species from becoming established is significantly more cost effective than working to restore a damaged ecosystem. Education, regulations, and screening should be employed to try to reduce the initial introductions of invasive species. Controlling invasive species is difficult and expensive, and complete removal of these species can take years of work. Reducing the chance of invasion is the most cost-effective means of preventative control.

Eradication (elimination from a site of all the individuals of a certain species), control (reduction of a species population density), and containment (limiting the diffusion of a species by containing its presence within defined geographical limits) are the tools used by managers to prevent the impacts caused by invasive species (Simberloff and Rejmánek 2011). Once a species has invaded, proper protocols must be followed to effectively treat and control invasive species while maintaining the health of the surrounding environment.

Invasive species can be treated with a combination of mechanical, chemical, and biological means. Since most of invasive species are not effectively controlled by one particular method alone, integrated methods may be necessary. **Table 3.a** and **Table 3.b** provide a quick reference about management treatments related to focal species, while more detailed information is listed in **Appendices 1** and **2**.

5.1.1 Mechanical

Mechanical control is defined as the physical manipulation or removal of plants or animals, with or without the aid of machines. Mechanical removal methods for plants include a large variety of techniques, from hand-pulling to specialized heavy equipment. Mechanical control of animals includes strategies such as trapping, hunting, and poisoning, or habitat modification. Mechanical control is often labor-intensive and costly, but it can have advantages in early detections and as component of integrated methods, flanking chemical and biological controls. A list of the most common mechanical control is listed as follows:

- Hand tools (handsaws, loppers, rakes, axes, puller bears, Pulaski's, pruners).
- Portable mechanized tools (chainsaws, brush-cutters, weed-eaters).
- Vehicle-mounted equipment (bobcats, bulldozers, excavators, backhoes, crusher boats, rotovators, flail choppers), as illustrated in **Figure 3**.
- Traps, snares, nets, baits, and hunting equipment.

- Habitat control (solarization, weed mats, bottom barriers, shading and light attenuation, hydrologic manipulation).

Figure 3. Mechanical removal of water hyacinth at Blackwater Conservation Area (Source: BREC staff)

Mechanical removal offers educational opportunities. Community building benefits when it is associated with conservation corps, youth corps, prison crews, and volunteers, especially in the case of limited or new infestations. BREC should look to develop partnerships where possible in order to assist with removal strategies. For example, BREC works with the Louisiana Department of Wildlife and Fisheries to obtain permits for outside contractors to remove certain nuisance wildlife species.

5.1.2 Chemical

Understanding how and when herbicides are used is critical to their effective and safe use. Generally, herbicides can be classified according to 1) chemical composition, 2) method of application, 3) selectivity, 4) translocation pathway, and 5) mode of action. For invasive plant management methods, application, timing, and selectivity are the three most important factors that influence the effectiveness of herbicide treatments (Simberloff and Rejmánek 2011). Herbicides can be applied to the soil, directly to the water columns, or to the foliage or stems of plants. The application can be broad over vast areas (broadcast) or restricted to specific spots/small areas. Herbicides can be applied different ways, including aerial, boat, or ground equipment, or by individuals (backpack sprayers or wicks).

Herbicides can be applied on leaves/stems of newly emerged seedlings and larger established perennials and woody species (postemergence application), or they can be applied directly on the soil prior to the emergence of a seedling (preemergence application). Timing of application will depend on the translocation pathway (phloem, xylem, contact) and the target site. In general, the most effective treatment time to control perennial weeds occurs from summer to early fall, because at the beginning of the emergence (spring), very little herbicide is translocated on the vegetative reproductive structures.

Different species require different herbicide treatments. The selectivity is determined by the total amount of herbicide that reaches a sensitive metabolic site. A certain herbicide is selective to a particular species/vegetation type only within certain limits, normally determined by the plant-herbicide-environment interaction, making the selectivity relative rather than absolute. Selectivity is also rate-dependent, so it is important to use herbicides at recommended rates.

Herbicide should be used in accordance to the most effective method feasible, with the minimum amount required dispersed. This will minimize environmental impact of the herbicide, while maximizing the effect of the treatment.

Foliar application is when herbicide is applied directly to the leaf blades. These applications are typically best when applied during the growing season, but timing may be adjusted based on different species. Applications should cover 50% of the foliage if possible and be applied on all sides. If possible, the top half of the plant is the best place to apply herbicide.

Cut stump applications are when a tree or shrub is cut down as close to the ground as possible, and herbicide is applied to the cut surface. For large trees, cambial area around the entire circumference is the most critical area to cover. This application is best done in late summer and fall since will not be as effective in the spring.

In hack and squirt applications, a series of gashes are cut into a tree, and herbicide is sprayed in each cut. The trunk is cut around chest height, making sure the cut reaches the cambium layer below the bark. The cut will act as a "cup" and will hold the herbicide. It is most effective if the cut is such that herbicide does not leak out. One ml of herbicide mix should be sprayed in each cut. All utility spray bottles deliver 1 ml per trigger pull. The number of cuts made in the tree will vary depending on the herbicide used and the size of the tree. For large trees requiring multiple cuts, space the cuts evenly around the trunk. For trees and shrubs with multiple trunks, be sure to treat every trunk. This application should always be done in the fall, since application is not effective in the spring.

Basal bark applications of herbicide are completed by spraying the lower 12-15 inches of a trunk or stem with a low-pressure backpack sprayer. To be effective, the band of applied herbicide must wrap entirely around the tree. If possible, spraying any exposed roots of the treated plant in addition to the bark application will help kill the plant.

Figure 4. Hack and squirt method (Source:https://conference.ifas.ufl.edu/aw17/presentations/3%20Thurs%209B%20850am%20Enloe.pdf)

Table 3.a. provides recommendations for types of treatments to use per species and the time of year that treatments should be used to be most effective. It should be noted that **Table 3.a.** is intended to be for guidance only. The specific herbicide used should always be used in a manner consistent with its label. There are several different types of treatment methods. Each has an optimal time of application due to plant physiology. Any herbicide treatment should not be done if rain is expected within 4-6 hours unless a longer time is noted on the herbicide label.

Safety precautions should always be taken when applying herbicide. Always follow the herbicide label and wear appropriate personal protective equipment. Avoid leather gloves and leather boots as they will readily absorb many herbicides. See **Appendix 5** for BREC's Natural Resource Management Health and Safety Plan regarding Pesticide/Herbicide use.

5.1.2.1 Herbicide Permitting Requirements

BREC requires that all supervisors of herbicide applicators have a commercial license per the Louisiana Department of Agriculture and Forestry. A certified supervisor may provide direct supervision for the application of restricted use pesticide by competent uncertified employees. The supervisor need not be physically present unless mandated by the particular pesticide restrictions but must be available when and if their presence is needed. This rule is in accordance with federal and Louisiana state laws. No part of this manual is to be used as a substitute for appropriate herbicide applicator training.5.1.3 Biological

Figure 5. Use of the air potato leaf beetle (*Lilioceris cheni*) as a biological control agent on the invasive air potato vine (*Dioscorea bulbifera*) (Source: John Hartgerink)

Biological control is the use of a living species (agent) against a target species (pest) (**Figure 5**). Its origin is in the observation that populations may be lowered by natural enemies (herbivores, predators, parasites, parasitoids, and pathogens) (Simberloff and Rejmánek 2011). Biological control approaches can be grouped in four strategies:

1. *Introduction:* the movement of selected natural enemies of the target pest (preferably coevolved and highly specific natural enemy) from the native range of the pest to the new area invaded by the pest.
2. *Augmentation:* is the enhancement of a natural enemy already present in the area and is typically achieved by adding more individuals.
3. *Conservation:* is the attempt to make specific sites (i.e. a crop field) better habitats for natural enemies by enhancing key resources.
4. *Biopesticides:* living viruses, bacteria, entomopathogenic nematodes, or fungal pathogens produced on industrial scale for broadcast application into the environment.

Biological control strategies represent an attractive alternative in terms of reduction of chemical inputs, increase of biodiversity, and enhancement of ecosystem services. However, there are specific disadvantages associated with biological control, such as higher costs, risk of damaging non-target species, uncertainties related to food web effects, and potential inability to remove a control agent once it has been released. To ensure successful biological control of targeted species, biological strategies must follow the International Code of Best Practices for Classical Biological Control of Invasive Weeds (Balciunas et al. 2004):

1. Ensure that the target weed's potential impact justifies the risk of releasing non-endemic agents.
2. Obtain multi-agency approval for the target weed
3. Select agents with potential to control the target weed
4. Release safe and approved agents
5. Ensure that only the intended agent is released
6. Use appropriate protocols for release and documentation
7. Monitor impact on the target weed
8. Stop releases of ineffective agents, or when control is achieved
9. Monitor impacts on potential nontarget species
10. Encourage assessment of changes in plant and animal communities
11. Monitor interactions among biological control agents
12. Communicate results to the public

5.1.4 Integrated Approaches

Integrated approaches manage noxious species using multiple control methods, combining physical/mechanical, chemical, and biological control strategies. Simberloff and Rejmánek (2011) listed five general approaches within Integrated Weed Management (IWM) and Integrated Pest Management (IPM) strategies:

1. *Prevention:* preventing invasive species from becoming established.
2. *Temporary alleviation:* specific control strategies aimed to contain localized outbreaks.
3. *Ongoing management:* accepting the presence of an invasive species, understanding that continuous management actions are necessary to keep the invasive population at acceptable levels.
4. *Area-wide management:* strategies aimed to control invasive species population that have extended beyond the boundaries of a single managed unit.
5. *Eradication:* feasible only on a small scale.

5.2 Management Prioritization

Priority will be given to the parks designated as Conservation Areas and Nature Reserves because of their intrinsic conservation and recreation value. Conservation areas are designated to protect unique habitats, while offering a variety of recreation opportunities. On the other hand, Nature Reserves are completely undeveloped and set aside for habitats and wildlife

protection. Depending on a park's type and classification, it will either receive a full Management Plan or Biodiversity Survey. A full management plan includes the full history of the park, habitat designations, cultural impacts, interpretive considerations and management prescriptions. Typically, only designated Conservation Areas or Conservation Management Units within high profile Community Parks or with enhanced recreation access will receive full Management Plans. Other parks will still be surveyed but will receive a shortened Biodiversity Survey. Regardless of this, parks which are impacted by invasive species and have been prioritized, will receive a plan which describe the invasive species management approaches and tactics specific for that area.

5.3 Monitoring

Post-treatment site restoration will help prevent the invasive species from returning, as most invasives do best in areas of high disturbance. A thriving native community will slow the spread of non-native species. Regardless of the treatment prescribed, some invasive species will likely return after the restoration treatments. Sites should be monitored on a periodic/systematic basis. This is vital to the thorough removal of invasive species. Monitoring plays a central role in management strategies, and results can be useful to determine whether actions are effective and successful and to detect and modify activities that are ineffective. Monitoring can also be used to detect new populations and assess spatial and temporal trends of a specific invasive species. US Fish and Wildlife Service classifies the types of monitoring as follows:

Figure 6. Students plant native trees at a BREC park where Chinese privet was previously removed. (Source: BREC staff)

- *Monitoring for early detection.* It aims to detect species as they first appear in a site.
- *Monitoring for the effect of management actions on target invasive species*. It measures the degree of effectiveness of management activities (i.e. herbicides, mowing, grazing, prescribed fire) in containing or eradicating a certain invasive species.
- *Monitoring for the effect of management actions on non-target species and the environment.* It measures the impact on native species and/or ecological process
- *Monitoring for the status and trends of target species populations*. It quantifies the current status or the trend over the time of a parameter (abundance/distribution/vigor) related to invasive species.

Finally, monitoring protocols should include: 1) a statement of the problem and invasive species management objectives, 2) sampling design and field sampling methods, 3) data management

and analysis, 4) evaluation of results in achieving invasive species management objectives, and 5) adjustment of management actions if needed.

Table 3.a BREC Plant Invasive Species Treatment Quick Reference

Common Name	Scientific Name	Tier	Herbicide	Notes	Spring	Summer	Fall	Winter
Alligatorweed*	*Alternanthera philoxeroides*	II	Triclopyr, Glyphosate	Bentazone, Bifenox, Dicamba, Fenoprop, Pendimethalin, and Propanil are also effective herbicides. Aquatic vegetation should be treated in sections. The alligatorweed flea beetle, *Agasicles hygrophila*, has also been used as a biological control agent.	Foliar application (Glyphosate)		Foliar application (Glyphosate)	Manual removal
Bermuda grass*	*Cynodon dactylon*	I	Glyphosate		Foliar application (Glyphosate)	Foliar application (Glyphosate)		
Chinaberry	*Melia azedarach*	II	Triclopyr, Glyphosate		Foliar application (Glyphosate)		Bark application (Triclopyr)	
Chinese privet*	*Ligustrum sinense*	I	Triclopyr, Glyphosate		Foliar application (Glyphosate)		Hack and squirt, bark application (Triclopyr)	
Chinese tallow tree*	*Triadica sebifera*	I	Triclopyr	Triclopyr (15-20%) banded application (6" wide around the lowest 12-24" of the trunk); *Bikasha collaris*, a flea beetle native to China, and *Gadirtha fusca*, a nolid moth native to China, are both currently being evaluated for potential as a biological control agent.			Bark application (Triclopyr)	

Cogon grass*	*Imperata cylindrica*	I	Glyphosate	Soil sterilants such as Prometon (Pramitol), Tebuthiuron (Spike), and Imazapyr (Arsenal) with erosion control preferred. Glyphosate might be active	Plant	Mow	Foliar application (Glyphosate)	Foliar application (Glyphosate), Plant
Coral ardisia*	*Ardisia crenata*	I	Glyphosate	Glyphosate (3%) and 2,4-D (0.5%) with basal oil	Foliar application (Glyphosate)		Foliar application (Glyphosate)	Manual removal
Elephant ear*	*Colocasia esculenta*	I	Glyphosate		Foliar application (Glyphosate)		Foliar application (Glyphosate)	
Glossy privet*	*Ligustrum lucidum*	II	Triclopyr, Glyphosate		Foliar application (Glyphosate)	Foliar application (Glyphosate)	Hack and squirt, cut and paint (Triclopyr)	Mechanical removal
Hydrilla or waterthyme	*Hydrilla verticillata*	I	Copper, Diquat, Endothall, Fluridone	Aquatic herbicides do provide temporary control, Sterile, triploid grass carp can also be used as biological control agents, as well as the hydrilla stem weevil, Asian hydrilla moth, hydrilla leaf-mining flies, hydrilla stem borers, and hydrilla tuber weevils	Foliar application			Mechanical removal
Japanese climbing fern*	*Lygodium japonicum*	I	Glyphosate				Foliar application (Glyphosate)	
Japanese privet*	*Ligustrum japonicum*	II	Triclopyr, Glyphosate		Foliar application (Glyphosate)		Hack and squirt, bark application (Triclopyr)	
Johnson grass*	*Sorghum halepense*	II	Glyphosate	Some varieties resistant to Glyphosate and to group B/2 herbicides	Mow	Foliar application (Glyphosate)	Foliar application (Glyphosate)	

Kudzu	*Pueraria montana*	I	2,4-D, Picloram, Dicamba	Tordon 101 Mixture (2,4-D + Picloram) and Tordon K (picloram liquid) proved to be the most cost-effective herbicide, in conjunction with mechanical removal	Foliar application			Mechanical removal
Mimosa	*Albizia julibrissin*	II	Triclopyr, Glyphosate	For larger trees stem injections of imazapyr or triclopyr can be used	Foliar application (Glyphosate)		Bark application (Triclopyr)	Mechanical removal
Paper mulberry*	*Broussonetia papyrifera*	II	Triclopyr, Glyphosate		Foliar application (Glyphosate)	Foliar application (Glyphosate)	Hack and squirt application (Triclopyr)	
Parrotfeather	*Myriophyllum aquaticum*	II	Diquat, Endothall, Fluridone, 2,4 D		Foliar applications			Mechanical removal
Salvinia	*Salvinia minima* and *S. molesta*	I	Fluridone, Flumioxazin, Imazamox, Penoxulam	The salvinia weevil, *Cyrtobagous salvinae*, has proven to be the best biological control agent for use against giant salvinia	Foliar application			Mechanical removal
Torpedo grass	*Panicum repens*	I	Glyphosate		Foliar application (Glyphosate)		Foliar application (Glyphosate)	
Tree-of-Heaven	*Ailanthus altissima*	II	Triclopyr, Glyphosate,	Due to its extensive root system and resprouting ability, tree-of-heaven is difficult to control, making mechanical methods ineffective	Foliar application (Glyphosate)	Foliar application (Glyphosate)	Cut and Paint (Triclopyr	
Trifoliate orange*	*Poncirus trifoliata*	I	Triclopyr, Glyphosate				Cut and Paint (Triclopyr)	
Tungoil tree*	*Vernicia fordii*	I	Triclopyr, Glyphosate				Cut and Paint (Triclopyr)	

Vasey grass	*Paspalum urvillei*	I	Glyphosate		Foliar application (Glyphosate)		Foliar application (Glyphosate)	
Water hyacinth*	*Eichhornia crassipes*	I	Glyphosate	Two species of water hyacinth weevils (*Neochetina bruchi* and *N. eichhorniae*) have been used in the U.S. Water hyacinth mites and water hyacinth moths can also be used.	Foliar application (Glyphosate)		Foliar application (Glyphosate)	
Water lettuce	*Pistia stratiotes*	II	Bispyribac, Carfentrazone, Diquat, Flumioxazin, Imazapyr, Penoxulam	Insects such as the leaf weevil, *Neohydronomous affinis*, or leaf moth, *Spodoptera pectinicornis*, feed on water lettuce and have been used as biological control agents	Foliar application		Mechanical removal	

*Indicates focal species

Data synthesized from Miller 2003; Bois et al. 2011; Simberloff and Rejmánek 2011; DiTomaso et al. 2013; USDA 2015; CABI 2019; IUCN 2019

Table 3.b BREC Animal Invasive Species Treatment Quick Reference

Common Name	Scientific Name	Tier	Treatment	Notes
Argentine Ant	*Linepithema humile*	I		
Bighead Carp	*Hypophthalmichthys nobilis*	I	Manual removal (electrofishing, commercial fishing, and recreational fishing).	Efforts have been made to promote demand for carp meat.
Black Carp	*Mylopharyngodon piceus*	I	Manual removal (electrofishing, commercial fishing, and recreational fishing).	Efforts have been made to promote demand for carp meat.
Channeled apple snail*	*Pomacea canaliculata* and *P. maculata*	I	Hand or mechanical removal of individuals and eggs.	The most effective control method seems to be hand-picking, but this is a labor-intensive method. Cooking oil has shown to control hatching success but research is ongoing.
Common Carp	*Cyprinus carpio*	I	Manual removal (electrofishing, commercial fishing, and recreational fishing).	Efforts have been made to promote demand for carp meat.
Domestic cat*	*Felis catus*	I	Non-lethal methods include habitat modification, exclusion, frightening devices, repellents, trapping with removal, and fertility control. Lethal methods include euthanasia, kill-trapping, and shooting.	Control of cat populations is controversial: cat advocates fight against killing cats, bird advocates and others see them as destructive to protected species. Trap-Neuter-Vaccinate-Release (TNVR) has been suggested as a humane and non-lethal solution to reduce populations, but there is still much debate regarding its effectiveness.
Emerald Ash Borer	*Agrilus planipennis*	NA	Quarantines, infested tree removal, insecticides, and biological control agents.	
Feral hog*	*Sus scrofa*	I	Hunting, trapping, snaring, use of specialized dogs.	Trapping combined with other techniques will have the largest impact in reducing feral hogs' population. Use of sodium nitrate has also been used.
Grass Carp	*Ctenopharyngodon idella*	I	Manual removal (electrofishing, commercial fishing, and recreational fishing).	Efforts have been made to promote demand for carp meat.
Northern Snakhead	*Channa argus*	NA	Manual removal.	Not in Louisiana but found in nearby states.
Nutria	*Myocastor coypus*	I	Exclusion, habitat modification, frightening, toxicants (zinc phosphide), trapping, shooting.	Protect seedlings with hardware cloth tubes around individual plants or wire mesh fencing around the perimeter of a stand. Fences, walls, and other structures can reduce nutria damage, but high costs usually limit their use. Sheet piling, bulkheads,

				and riprap can effectively protect stream banks from burrowing. Land that is well-drained and free of dense, weedy vegetation is generally unattractive to nutria.
Red Imported Fire Ant	*Solenopsis invicta*	I		
Rio Grande Cichlid	*Herichthys cyanoguttatus*	I	Manual removal.	'Fishing rodeos' have been promoted to remove Rio Grande Cichlid from waterways.
Silver Carp	*Hypophthalmichthys molitrix*	I	Manual removal (electrofishing, commercial fishing, and recreational fishing).	Efforts have been made to promote demand for carp meat.
Zebra mussel	*Dreissena polymorpha*	II	Chemical (chlorination, bromine, ammonium compounds, aromatic hydrocarbons, copper, endothall, biopesticides) and non-chemical (coatings, thermal, UV light, filtration, mechanical removal).	Various design techniques have been employed to control infestations of zebra mussels, including a combination of chemical treatment and mechanical removal. Concerns have been raised about the harmful effects on non-target aquatic species.

*Indicates focal species

Data synthesized from Holcomb et al. 2015; Miller 2003; Bois et al. 2011; Simberloff and Rejmánek 2011; DiTomaso et al. 2013; USDA 2015; CABI 2019; IUCN 2019

6 Recommendations

Based on the provided information in this document, the following recommendations are suggested in order for BREC to most effectively combat invasive species. The implementation of these actions would benefit our parks and surrounding communities. This list should not be considered exhaustive as there are many strategies that can and will be used when they are deemed necessary. Given the high degree of threat posed by invasive species to our parks and the surrounding areas, any opportunities for control should be utilized and the below recommendations should help guide the establishment of protocols, monitoring and management efforts and the education of BREC staff and the public.

6.1 Mapping and Surveying

The identification of which species pose the greatest threat to ecosystems found in BREC parks and where they are located are the first steps to controlling invasive species. The large amount of property that BREC operates and maintains will make this task challenging. Volunteers, the Bioblitz and other citizen scientist events should be utilized whenever possible. New GIS technology should assist in this process and allow for a more streamlined data collection and management process.

6.1.1 REAP Survey Methods

BREC's Rapid Ecological Assessment Protocol (REAP) is a relatively quick and thorough way to collect field data and should serve as a starting point when developing survey protocols and methods. In order to ensure volunteers can be utilized on a variety of different platforms, the REAP can be modified accordingly to streamline the collection to just invasive species. Utilizing the REAP strategy ensures data can be reproduced easily over time so that monitoring data and baseline surveys are comparable. The following points should be addressed when developing the protocol.

- Identify highest priority data within the REAP to include in invasive species-specific surveys.
- Utilize parameters that are easy for volunteers with a range of content knowledge to complete.
- Provide necessary training and Reference Guides to ensure high quality data is collected.
- Ensure data can easily be nested into GIS Geodatabase and other REAP data.
- Evaluate location collection methods to ensure best practice are used for accurate data (i.e. points vs polygons, aerial maps, reference points, etc.)
- Incorporate quality control guidelines such as staff review of photos, location data, etc.

6.1.2 Utilize Citizen Science

With platforms like iNaturalist (Ueda 2017; Van Horn et al. 2018) and Survey 123 by ESRI, utilizing volunteers to gather data can be easy and effective. This technology can be used to organize large volunteer monitoring events such as BREC's Bioblitz to gather survey data but can also be used to gather data from independent researchers and citizens using the platform on their own. Because iNaturalist stores data by location and allows users to explore data by species, it will be easy for BREC staff to search for occurrences of certain species in parks. These data can then be checked since pictures often accompany the location and identification of the species and then added to existing maps and occurrence zones. This objective is two-fold because eradication of certain species will require volunteer assistance and engagement at the surveying stage could provoke active volunteerism for stages of mechanical removal. Additionally, the more people aware of the wide-spread nature and threat of invasive species, more education and outreach will occur organically throughout the community.

6.1.3 Establish and Maintain an Invasive Species Database

As data is collected through various surveying methods, it will be important to organize and map species occurrences in order to track management techniques, geographical range and decline or spread. As species are tracked overtime, this will allow correlations in data to assess management progress and stay ahead of new threats. It is the thought that focal species identified in this document may change over time as species occurrences change. An up-to-date database may also allow for additional partnerships with researchers, local universities and state/federal agencies who have their own invasive species management programs.

6.1.4 Incorporate Information into BREC's GIS Geodatabase

Once the invasive species database is developed, it will be incorporated into the larger BREC GIS geodatabase. The BREC GIS geodatabase is a digital inventory of the BREC park system and is used for planning, maintenance, and communication. Incorporating georeferenced survey results of invasive species occurrences will allow real-time mapping of species impact and allow for better analysis of data. The Geodatabase will not only allow for an organized and standardized method of data management but also for spatial analysis which is crucial to invasive species management.

Portions of BREC's GIS geodatabase will be incorporated into the BREC website and ESRI open source data platforms where information can be viewed and analyzed with other park features in a fully interactive park system map. This can make important data available to the public and other agencies which may be helpful in spreading awareness in education campaigns and in collaboration of research projects.

6.2 Internal Education and Preventative Planning

BREC is a large agency which maintains thousands of acres of land in the parish. With only a handful of staff in the Natural Resource Management Division, communication and teamwork with other BREC departments and divisions is crucial to ensure invasive species management objectives are met. Recreation staff can assist with external education and outreach, Park Operations staff can assist in species identification and applying management techniques and Planning and Engineering can incorporate native plantings and habitat restoration into landscaping and design plans. In order for all departments to work together to achieve these goals, access to information, resources and trainings is essential.

6.2.1 Educate BREC Personnel

As outlined in BREC's Planning and Engineering Standard Operating Procedures, controlling the spread of invasive species and incorporating native plantings is an important component of BREC's sustainability and resiliency initiatives. It is important that every department within BREC is aware of invasive species and is capable of acting as an advocate for our management and education initiatives. Because BREC employs staff with a wide-variety of backgrounds and content knowledge, internal training and education campaigns are crucial to provide the necessary information to all staff. Below are a few key points that internal education and trainings should focus on and suggested methods for relaying the messages.

Primary Training and Education Themes:

- Identification of invasive species and similar native species
- Negative impacts of invasive species
- Benefits of native plants
- Invasive species management techniques
- Why should you care about invasive species?
- Ways you can reduce the spread of invasive species at work and at home.

Suggested Training and Education Methods:

- Lunch and Learn programs with local experts.
- Trainings and Workshops provided by both internal staff and external partners.
- Educational videos
- Fact sheets and infographics on species identification, hazards, etc.
- Brief talks at morning safety talks and meetings.
- Email blasts, Park Bench, etc.

6.2.2 Native Species Prioritization, Planning and Invasive Species Prevention

As discussed in this plan, prevention of the spread of invasive species and an integrated approach to managing them are important techniques for maintaining healthy, stable ecosystems. Establishing strong native plant communities which are resilient and well suited

for local habitats is an important strategy that BREC must utilize in these integrated approaches. Native species must be given priority in planning and landscaping projects and the removal of native plant species should be minimized during construction. Below are general guidelines that should be considered during planning projects and when site disturbance is inevitable.

- Planting plans should place a heavy priority on native plant species, and should non-native species be used, they must not be a listed LDWF invasive species.
- Site disturbance should be kept at a minimum in order to not disturb the seed bank and introduce dormant invasive species or provide a pathway for invasives to navigate into a park.
- Consideration of introduction pathways, canopy cover and prevention techniques should be incorporated into the planning and design process of parks and amenities.
- Native tree species which provide beneficial canopy coverage should not be removed unless it is deemed a safety hazard or high risk. If removal is unavoidable due to site development plans and priorities, a remediation plan must be in place to assist in maintaining native species dominance.
- Restoration and resiliency initiatives which incorporate native species establishment should be prioritized in the system such as Grow Zones, Pollinator Gardens, dry and wet retention areas which incorporate native plants, bioswales, reforestation, etc.
- Site development and planning projects which require heavy soil disturbance, forest fragmentation, native species removal, etc. must have a remediation/invasive species management plan specific to that site in order to curb the introduction and spread of undesirable species once construction and development are complete.
- Heavily invaded parks should be considered a teaching tool and interpretation of the impacts of invasive species and importance of native species should be incorporated into the park's master and interpretive plans where feasible.

6.3 External Education and Outreach

Due to the nature of invasive species, using preventative measures and management techniques in BREC parks will not be enough to eradicate them from BREC properties. Seeds from adjacent properties, waterways and flooding, adjacent construction, etc. can all result in the introduction of invasive species to BREC parks even in those that are heavily monitored and managed. Although BREC cannot control the actions of the communities of East Baton Rouge Parish and beyond, as a public agency we can serve as a leader in invasive species prevention initiatives and set a local precedent for native plantings and landscape design. Additionally, a more informed local community will better understand the impacts of their own actions and will have a higher probability of making better decisions regarding plant selection and removal at their own homes. With this in mind, external education and outreach should be a high priority in order to inform the public about the negative impacts of invasive species.

6.3.1 Education and Outreach Campaigns

BREC's Communications Department and Conservation, Outdoor Recreation and Environmental Education (CORE) Division have a variety of outlets to reach the public which if combined, can reach a large percentage of the population of East Baton Rouge Parish. It is important that all departments within BREC work together to interpret this message in whatever capacity they interact with the public. Word of mouth is an important mechanism for message delivery and often an individual will remember something learned from a one-on-one personal conversation with a BREC staff, volunteer or friend opposed to what they read in a flier or social media post. With this in mind, even BREC departments that don't deliver programs such as Park Operations and Planning and Engineering, can still have an impact on the public if they take the opportunity to share information in whatever capacity they can.

External and internal education campaigns will share Primary Education Themes which are stated above in 6.2.1. Therefor infographics, emails and interpretive materials generated for one can be used simultaneously in both campaigns. Because BREC has a variety of outward facing communication tools for interacting with the public, such as programs, signage, social media, etc., the education methods may differ from those used internally. Below are suggested education and outreach methods for the general public.

- Interpretive Signage in parks.
- Email blasts, Social Media and Infographics. See **Appendix 6** for an example of an infographic from LDWF summarizing specific invasive species identification, why they are bad and what action they can take to assist.
- Interpretive programming.
- Outreach at community events.
- Workshops.
- Volunteer projects

6.3.2 Utilize Partnerships to Spread Awareness

Message delivery seems to be one of the most challenging aspects of public education. In order to reach the most individuals possible, a variety of techniques should be used in order to capture target audiences in a variety of different avenues. Partnerships with local organizations, research institutions, landowners and state and federal agencies can be mutually beneficial. By capitalizing on each other's target audience and communication strategies, a larger population can be reached with information that was generated cooperatively.

6.3.3 Engage the Community

The next step beyond public education is community engagement. By engaging the community through volunteerism and citizen science, the public is transformed from passive bystander to an involved activist. Volunteers who feel like they are making a difference in their local

community are more likely to become ambassadors to the cause and ultimately assist in education and outreach campaigns. Engaging the community in this manner not only assist in achieving important management objectives but also assist in interpreting the importance of those objectives.

6.4 Prioritize Efforts and Management Techniques

Prioritization must be used in order to effectively manage invasive species in BREC's parks with the staffing and resources available. Prevention should be the first line of defense along with early detection and treatment. Preventing invasive species from becoming established is significantly more cost effective than working to restore a damaged ecosystem. Eradication and containment are other techniques but in most cases are difficult and expensive.

An effective monitoring plan should be established in order to detect the establishment of invasive species in BREC's parks. See Recommendation 6.5 for establishing monitoring protocols. Only with data collection can early detection and treatment be an effective management technique. Use of GIS, in particular the invasive species database mentioned in 6.1 and the BREC GIS geodatabase, will greatly improve BREC's monitoring capabilities.

Habitats that are susceptible to invasive species as well as rare and unique habitats should be prioritized. If invasive species are found in or near these habitat types, in particular Tier I and Tier II invasive species, prevention and eradication techniques should be used.

In summary, a rubric needs to be established in which BREC prioritizes it's affected habitats, as well as their susceptibility to invasive species. Priority should be given to those habitats that are rare and unique, and that are more susceptible to invasive species or in which invasive species could be significantly impacted by management prescriptions. The developed rubric should address the following:

- Prioritization of habitats based on susceptibility, rare and unique species.
- Impacts to recreational use of the park.
- Level of existing impact from invasive species.
- Invasibility
- Level of infestation and presence of lag phase.
- Potential impact of available management prescriptions.
- Potential impact to habitat if not addressed.
- Tier of invasive species present or potentially present.

Once parks or park units are prioritized, a Management Plan or Invasive Species Action Plan should be created specific to that park and the priority assigned. Although some parks will have full management plans, some parks may only have Biodiversity Surveys in which case, if a plan is required, an Invasive Species Action plan will be developed and appended to the Biodiversity Survey. Management prescription should take into account rubric rating and the techniques

outlined in this plan. The following considerations are suggested when developing a Management Plan or Invasive Species Action Plan.

- An effective monitoring plan
- Early detection and treatment
- Use of innovative management techniques
- Effective use of personnel to maximize efforts
- Effective communication to the public

6.5 Monitoring and Assessment

As stated previously, BREC utilizes an ARM (Adaptive Resource Management) approach to ensure the most accurate data is being used for prescriptions and management techniques are effective and align with the newest research. As described in section 3, the characteristics of invasive species allow them to easily adapt to thrive in our habitats and spread quickly. This means that monitoring must be done consistently to ensure accurate data is used to prescribe treatments. Additionally, seasonal changes, climate and natural disasters can speed up or slow down the spread of certain species making frequent monitoring critical. Below are a few guidelines to help develop and implement an effective monitoring program.

- Develop monitoring protocols for the four types of monitoring including specific sampling protocols. Utilize similar methods to baseline surveys to ensure consistent data. Modify techniques for the objectives of each monitoring type.
- Establish a monitoring schedule based on the management techniques prescribed to ensure analysis can be compared from park to park and there are no gaps in data. Schedules should be adjusted to accommodate weather events or changes to park landscape such as construction and development.
- Establish a rubric for assessing the effectiveness of treatments
- Maintain records of chemical treatments per Louisiana law including ancillary data on weather, water quality, etc. to allow the assessment of a variety of parameters in the event the treatment is ineffective.
- Update management plans regularly to include monitoring data and treatment assessments to ensure techniques are adapted to accommodate the most effective prescription.

Monitoring the effectiveness of internal and external education campaigns should also take place to ensure the best communication techniques are used. Surveys would also show which areas need to be addressed the most by evaluating existing knowledge on the subject. A baseline survey should be sent out initially to provide data to guide initial efforts and subsequent surveys conducted every three to five years following to monitor the effects of the campaigns.

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Appendix 1: Plant Focal Species

This section presents species accounts for each of BREC's focus invasive species. These accounts contain the following information:

- General information about the species
- Communities/Species Impacted
- Management Actions

1.1 Alligatorweed (*Alternanthera philoxeroides*)

Native to South America, Alligatorweed was accidentally introduced in the 1980s via ballast water. Capable of growing on land or in slow-moving water, it typically roots to the ground and the leaves emerge on the water's surface; however, it can also grow in dense, free-floating mats in riparian habitats. It displaces native vegetation while decreasing water flow, increasing sedimentation, decreasing water oxygen levels, and clogging up formerly open water habitat.

1.1.1 Communities/Species Impacted:

Native fauna and all native freshwater communities are negatively impacted. Additionally, those species that require a substantial open water habitat component are negatively impacted by the dense mats formed by this species.

1.1.2 Management Actions

Infestations can be controlled with herbicides. The alligatorweed flea beetle, *Agasicles hygrophila*, and alligatorweed thrips, *Amynothrips andersoni*, have also been used as biocontrol agents. Remove by hand where it is impeding recreation areas.

Source: https://static.inaturalist.org/photos/2730886/large.jpg?1544091889

1.2 Bermuda grass (*Cynodon dactylon*)

Bermuda grass is a popular commercial grass native to Africa that was introduced to the southern US in the early 1800s as a grass from lawns and recreational fields. Although it is a nuisance in agricultural and natural settings, it is wildly used for lawns, sport fields, and golf courses. It is a sod-forming grass that is highly variable in appearance. The genus has nodes that look like they have multiple leaves per node due to long internodes that alternate in length and overlap with other stems.

1.2.1 Communities/Species Impacted

Longleaf-slash pine, Loblolly-shortleaf pine, Oak-pine, Oak-hickory, Oak-gum-cypress, Elm-ash-cottonwood.

1.2.2 Management Actions

Cover small infestations in mulched areas with geotextile fabric and wood mulch. Place black polyethylene over small infestations during the summer and leave in place for 6-8 weeks. If the areas are cultivated deeper than 3 inches after this treatment, bermudagrass may return from seeds. Apply grass-selective herbicides in the spring (Sethoxydim, Fluazifop, or Clethodim) when growth is less than 6 inches. Reapply the herbicide before the regrowth reaches 6 inches again. Apply Glyphosate in the late summer when the grass is storing food in the roots. Do not mow for 2-3 weeks before the application. Wait 7 days, and then mow.

Source: http://serv.biokic.asu.edu/imglib/seinet/misc/201412/Cynodon-dactylon-P-web-10_05_1_1419369560_web..jpg

1.3 Chinese Privet (*Ligustrum sinense*), Japanese privet (*L. japonicum*), and glossy privet (*L. lucidum*)

Privets were introduced as an ornamental species. In particular, Chinese privet is one of the most problematic weeds in the southern U.S., and once introduced to an area Chinese privet can quickly outcompete native shrubs and trees, reduce ground layer species cover, and alter community structure. This plant has a wide tolerance range in soil type and will grow both in heavy shade and direct sun, which allows it to invade a wide variety of habitat types. Chinese privet creates large seedbanks in infested areas and also spreads through root suckers, making this species difficult to eradicate from an area.

1.3.1 Communities/Species Impacted

Bottomland Hardwood Forest, Coastal Prairie, Eastern and Western Upland Longleaf Pine Woodland, Hardwood Slope Forest, Mixed Hardwood-Loblolly Pine Forest, Small Stream Forest, Southern Mesophytic Hardwood Forest.

1.3.2 Management Actions

Apply Tricoplyr with the Hack and Squirt or Cut and Paint methods in the fall season just before leaves fall. Foliar application of Glyphosate in the spring on any regrowth from trees treated in the fall. Follow up with planting of native trees and vegetation after removing a dense stand

Source: http://nwdistrict.ifas.ufl.edu/hort/2015/01/13/chinese-privet/

1.4 Chinese tallow tree (*Triadica sebifera*)

Chinese tallow tree is an aggressive invader of wetlands and grasslands. Native to East Asia, it was introduced to the U.S. in the late 1700s as an ornamental. It takes hold best in disturbed areas; however, the seeds are readily dispersed and can appear in undisturbed forests. The seeds are persistent in soil and can germinate after five years. It forms monospecific stands that are less resistant to natural disasters and disease, as well as reduce habitat for native wildlife that rely on native forest biodiversity.

1.4.1 Communities/Species Impacted

Bottomland Hardwood Forest, Coastal Prairie, Cypress-Tupelo-Blackgum Swamp, Ephemeral Pond, Live Oak Natural Levee Forest, Eastern and Western Longleaf Pine Flatwoods Savanna, Small Stream Forest.

1.4.2 Management Actions

Apply Triclopyr with the hack-and-squirt or cut-and-paint methods in the fall season just before leaves fall. Foliar application of Glyphosate in the spring on any regrowth from trees treated in the fall. Pull up seedlings if found. Follow up with planting of native trees and vegetation after removing a dense stand.

Source: https://www.aces.edu/wp-content/uploads/2018/07/Photo-1-2-njl-edits.jpg

1.5 Cogon grass (*Imperata cylindrica*, including *I. brasiliensis*)

Cogon grass was introduced in 1912 accidentally in packaging material but was reintroduced later as a potential forage grass. The extensive rhizomes of this coarse, robust grass allow it to form dense colonies. Grazing animals do not use it for forage, and monocultures of this grass are detrimental to wildlife such as deer as well as domestic cattle. Fire and disturbance are beneficial to this plant, and it causes any fires that burn to be much hotter than they would normally be in the natural environment. Tolerant of high salinity, moisture, and drought, Cogon grass thrives on anything from fine sand to heavy clay, and low-fertility soils. There is also a shade-tolerant ecotype in the U.S. that allows it to invade old-growth forests. These attributes make Cogon Grass a formidable weed. Cogon Grass ranges from one to several feet in height. The midrib of the leaf blade is off-centered, and the blade margins are scabrid. The flowers it produces in the spring are a white, silky contracted panicle that is above the foliage. Cogon grass has been documented in the parish, and if it is located in BREC parks it is of primary removal priority. The fire hazard and ecological risk associated with this plant makes it extremely dangerous, and once established it is extremely difficult to control.

1.5.1 Communities/Species Impacted:

Eastern and Western Longleaf Pine Flatwoods Savannas, Eastern and Western Upland Longleaf Pine Woodlands, Sandbar. Forest margins and heavily disturbed sites.

1.5.2 Management Actions.

Encourage diligent cleaning of mowing equipment after use, especially around known infestations. Conduct field surveys for timely detection of new occurrences, especially those outside the known range of cogon grass. Intensive control of existing occurrences with Glyphosate during the growing season. Multiple applications will be necessary.

Source: https://hgic.clemson.edu/wp-content/uploads/2018/03/cogongrass-imperata-cylindrica-in-bloom-in-early.jpeg

1.6 Coral ardisia (*Ardisia crenata*)

Coral ardisia is an evergreen shrub native to East Asia. It was introduced into the U.S. in the early 1900s as an ornamental and is still used in landscaping. Densities of coral ardisia can reach more than 100 plants/m^2, significantly decreasing native species diversity and richness. This species disperses poorly due to a low palatability of the seeds for wildlife; however, the high germination rate leads to the dense stands around parent plants. This species is typically found in areas with moist rich soils and is tolerant of deep shade.

1.6.1 Communities/Species Impacted

Bottomland Hardwood Forest, Mixed Hardwood-Loblolly Pine Forest, Salt Dome Hardwood Forest, Small Stream Forest, Southern Mesophytic Forest. Native plant species may be negatively impacted.

1.6.2 Management Actions

Control by hand pulling and cutting down plants. Apply Glyphosate in the spring while the plant is actively growing.

Source: https://www.floridamuseum.ufl.edu/science/five-facts-about-coral-ardisia-in-florida/

1.7 Elephant ear (*Colocasia esculenta*)

Elephant ear is a southeast Asian native that was originally planted as a food sources as the corms are edible if cooked. It often forms dense stands along shorelines and in Cypress-Tupelo-Blackgum Swamps, displacing native vegetation.

1.7.1 Communities/Species Impacted:

All freshwater wetland habitats, including Cypress-Tupelo-Blackgum Swamp. Shorelines of sluggish waterways throughout the state.

1.7.2 Management Actions:

Control local infestations with a combination of digging corms from soil and application of Glyphosate plus surfactant. (Monitor habitat responses following implementation of control efforts.

Source: https://plants.ces.ncsu.edu/plants/colocasia-esculenta/

1.8 Japanese climbing fern (*Lygodium japonicum*)

Japanese climbing fern is a vine-like fern that climbs by twining fronds. Reproduction is by spores and rhizomes. Japanese climbing fern climbs on trees and over understory vegetation, creating dense mats that prevent sunlight from reaching native species. Additionally, in the case of a fire, the fronds act as ladder fuels and enable fire to reach the canopy. Japanese climbing fern is usually much more abundant in disturbed forests, and along forest edges, however it can invade undisturbed forests.

1.8.1 Communities/Species Impacted

Bottomland Hardwood Forest, Hardwood Slope Forest, Mixed Hardwood-Loblolly Pine Forest, Salt Dome Hardwood Forest, Small Stream Forest, Southern Mesophytic Forest, Spruce Pine-Hardwood Flatwoods, Eastern and Western Upland Longleaf Pine Woodlands.

1.8.2 Management Actions

Cut and apply Glyphosate to the cut stem or cut in the fall and apply Glyphosate to spring regrowth. Document success of each method and proceed with the more effective route.

Source: https://plants.ifas.ufl.edu/plant-directory/lygodium-japonicum/

1.9 Johnson grass (*Sorghum halepense*)

Johnson grass is native to Turkey and was planted in the 1800s as a forage crop. It resembles young corn, growing in spreading, leafy tufts with shoots sprouting from the base. The leaves have a prominent white midvein and produce toxic amounts of hydrocyanic acid, which can poison livestock when ingested.

1.9.1 Communities/Species Impacted

Longleaf-slash pine, Loblolly-shortleaf pine, Oak-pine, Oak-hickory, Oak-gum-cypress, Elm-ash-cottonwood.

1.9.2 Management Actions

In areas intended for pollinator gardens, no-mow zones, or community gardens, repeatedly tilling the area every few weeks over the summer provides good control. Apply Glyphosate in the late summer and fall when the grass is storing food in the roots. Do not mow for 2-3 weeks before the application. Wait 7 days, and then mow. Reapply as necessary.

Source: http://swbiodiversity.org/seinet/taxa/index.php?taxon=sorghum%20halepense

1.10 Paper mulberry (*Broussonetia papyrifera*)

Paper mulberry is originally from East Asia and was introduced as an ornamental. It does best in rich, sandy loams and light soils that are well drained, but is highly adaptable. The massive water consumption of this tree slows the growth of other plants, and there are high occurrences of allergic reactions to the pollen. The trees also exude a sticky sap which is damaging to clothing. The seeds are persistent in seed banks but will not germinate in the shade.

1.10.1 Communities/Species Impacted

Primarily well-drained, highly disturbed sites.

1.10.2 Management Actions

Paper mulberry is only likely to occur on heavily disturbed sites. Due to its nature, removal efforts can result in stands that are denser with paper mulberry. Remove small patches of trees at a time using cut and paint with Triclopyr in the fall. Replant as soon as possible that year or the following spring with native tree species. Spot treat any regrowth in the spring with a foliar application of Glyphosate. Monitor success of removal efforts.

Source: https://plants.ifas.ufl.edu/plant-directory/broussonetia-papyrifera/

1.11 Trifoliate orange (*Poncirus trifoliata*)

Trifoliate orange is native to China and was introduced in the late 1800s as an ornamental and hedge plant. It is now used as stock to graft commercial citrus, which is an additional avenue for escape. Trifoliate Orange occurs in wetlands and mesic forests where it can form extensive thorny thickets, outcompeting native species and impeding recreation use.

1.11.1 Communities/Species Impacted:

Bottomland Hardwood Forest, Hardwood Flatwoods, Hardwood Slope Forest, Southern Mesophytic Forest.

1.11.2 Management Actions

Apply Tricoplyr with the hack-and-squirt or cut-and-paint methods in the fall season just before leaves fall. Foliar application of Glyphosate in the spring on any regrowth from trees treated in the fall. Document habitat recovery following control of trifoliate orange, and replant with native species after the removal of dense thickets.

Source: https://en.wikipedia.org/wiki/Trifoliate_orange

1.12 Tungoil tree (*Vernicia fordii*)

Tungoil tree is a small deciduous tree native to China that was introduced to the U.S as a failed cash crop intended to produce tung oil, a component in lacquers, varnishes, polishes, and other products. A distinctive feature is the presence of two red glands located on the petiole (leaf stalk) at the junction with the leaf blade. All parts of the plant are toxic, especially the fruits and seeds. Contact with the oils of the plant can produce a poison ivy-like rash.

1.12.1 Communities/Species Impacted

Eastern Upland Longleaf Pine Woodland, Mixed Hardwood-Loblolly Pine Forest, Shortleaf Pine-Oak-Hickory Forest, Southern Mesophytic Hardwood Forest, Small Stream Forest.

1.12.2 Management Actions

Apply Tricoplyr with the hack-and-squirt or cut-and-paint methods in the fall season just before leaves fall. Foliar application of Glyphosate in the spring on any regrowth from trees treated in the fall. Document habitat responses following control efforts.

Source: http://www.rnr.lsu.edu/plantid/species/tungoiltree/tungoiltree.htm

1.13 Water hyacinth (*Eichhornia crassipes*)

Water hyacinth is a South American native and was first introduced into the U.S. in 1884 via New Orleans as an ornamental plant. It frequently clogs bayous and canals, impedes boat traffic, slows water currents, and blocks sunlight to native submersed aquatic vegetation which degrades water quality through reduced oxygen exchange and harms wildlife. It is generally associated with reduced phytoplankton communities which impacts macroinvertebrate and fish populations. Decomposition of water hyacinth lowers dissolved oxygen levels, thus negatively affecting aquatic wildlife and causing fish kills.

1.13.1 Communities/Species Impacted:

Native fauna and all native freshwater communities are negatively impacted. Additionally, those species that require a substantial open water habitat component are negatively impacted by the dense mats formed by this species.

1.13.2 Management Actions

Water hyacinth infestations can be controlled with herbicides. Water hyacinth weevils (*Neochetina eichhorniae* and *Neochetina bruchi*) are established throughout the state and do reduce the reproductive capacity and growth rate of this plant. Remove by hand where it is impeding recreation areas. Host events to encourage public investment and innovation in removing this species. Research more effective mechanical hyacinth removal prospects

Source: http://florawww.eeb.uconn.edu/200300241.html

Appendix 2: Animal Focal Species

2.1 Channeled apple snail (*Pomacea canaliculata* & *Pomacea maculata*)

Native to Argentina, the earliest record of channeled apple snail in the southeastern US in 1990. Snails wreak havoc on natural ecosystems and agriculture alike, with damage in rice fields reaching as high as 100% of germinating seedlings. They also can cause clear freshwater ecosystems to become turbid due to depleted densities of aquatic plants.

2.1.1 Communities/Species Impacted

Channeled apple snails are devastating to wetlands, lakes, and slow-moving waterways. They are destructive to native vegetation, and in doing so they destroy fish habitat.

2.1.2 Management Actions

Use paddles, sticks, or other objects to crush the eggs and scrape them into the water. Any adults found can be crushed and dropped back into the water for the fish to eat. Baited traps filled with lettuce can be used to attract the snails and to facilitate the collection.

Source: https://axcela.lonza.com/slugs-and-snails/pomacea-canaliculata

2.2 Domestic cat (*Felis catus*)

A common household pet, cats are a destructive force when allowed to live outside. Domestic cats are prolific breeders. A single female cat can reach sexual maturity at just six months of age and produce up to three litters per year with two to four kittens per litter. Free-ranging pet cats and unowned feral cats both post a risk to humans and the environment. While feral cats pose the biggest threat to wildlife, all domestic cats, regardless of their habituation to humans and feeding schedule, will hunt prey if released outdoors. Domestic cats serve as a vector for rabies and toxoplasmosis, both of which are transmittable to humans. It is estimated that cats kill between 1.3-4.0 billion birds and 6.3-22.3 billion mammals annually, and they have directly resulted in the extinction of several mammals, reptiles, and at least 33 bird species globally (Loss et al. 2013).

2.2.1 Communities/Species Impacted

Domestic cats have the largest impact on small mammal, reptile, amphibian, and avian populations. They are highly adaptive but are typically found closer to human populations.

2.2.2 Management Actions

Avoid feeding feral cat colonies**,** trap and surrender to shelters when possible**.** Trap, neuter, and release (TNR) when possible. Do not feed cats that have been through the TNR process. Implement education programs: studies have shown that TNR programs are ineffective or counterproductive due to the abandonment or release of pet cats into feral cat colonies (Barrows 2004).

Source: https://www.humanesociety.org/news/keeping-neighborhood-cats-safe

2.3 Feral hogs (*Sus scrofa*)

Feral swine were brought to the Americas in the 1500s as a food source. Historical practices of free-range livestock management led to the establishment of unmanaged feral hog populations. In the 1900s, the Eurasian wild boar was introduced for sport hunting and readily hybridized with feral swine populations. The feral hogs today are a mix of domestic pigs, Eurasian wild boars, and hybrids. They destroy farmland, bottomland hardwood habitats, and can be a danger to hikers.

2.3.1 Communities/Species Impacted

Feral hogs damage property, agriculture, and native ecosystems, as well as being a threat to the safety of wildlife, pets, and people.

2.3.2 Management Actions

If BREC parks are invaded by a sounder of hogs, the entire sounder should be removed simultaneously using a corral trap and game cameras. December-March are the best times to trap while the hogs are looking for new food sources. Specifically: (1) set out game cameras and corn on suspected infestation sites; (2) build a corral trap on the bait site once hogs are regularly visiting and continue to bait without setting the trap; (3) set the trap when all hogs are regularly entering the trap; (4) humanely euthanize all trapped hogs via gunshot in accordance with the American Veterinary Medical Association Guidelines for the Humane Euthanasia of Animals; (5) continue trapping until all feral hogs are removed from the area; and (6) dispose of all carcasses in accordance with the Louisiana Sanitary Code.

Source: https://www.lsuagcenter.com/profiles/lbenedict/articles/page1461709666438

Appendix 3: Supplementary Invasive Species Pictures

This section presents information for species that do not pose an immediate threat to BREC's areas, but might in the near future. The purpose of this section is to provide a visual tool to aid the identification of the listed species.

3.1 Air Potato Vine (*Dioscorea bulbifera*)

Air Potato Vine is native to Africa, Asia, and northern Australia but has become naturalized in many regions including the southeastern United States. It is a perennial vine that grows quickly and shades plants beneath it.

3.1.1 Communities/Species Impacted

Air Potato Vine is considered invasive due to its quick growth and ability to shade out plants beneath it. This plant invades a variety of habitats climbing high into mature tree canopies.

Source: https://plants.ifas.ufl.edu/plant-directory/dioscorea-bulbifera/

3.2 Chinaberry (*Melia azedarach*)

Native of Asia, chinaberry and was introduced the U.S. in the late 1700's and has been used as an ornamental plant, shade tree, and fuel wood. Chinaberry can adapt to several environmental conditions, is virtually disease and insect free, and thrives in disturbed or open areas.

3.2.1 Communities/Species Impacted

Chinaberry is known to form dense thickets in forests and marshes, displacing native vegetation as it grows. It is also a very common hedgerow tree.

Source: https://en.wikipedia.org/wiki/Melia_azedarach

3.3 Hydrilla (*Hydrilla verticillata*)

Native of Asia, is a rooted aquatic weed found in a variety of aquatic habitats, including both shallow and deep areas. In shallower areas, hydrilla can form extremely dense mats. Hydrilla can affect water quality by shading out native vegetation and reduce dissolved oxygen concentration, which may lead to fish kills. Hydrilla spreads easily between water bodies via boats and trailers.

3.3.1 Communities/Species Impacted

All freshwater habitats, particularly those with slow-moving water, such as Oxbows and Cypress-Tupelo-Blackgum Swamps. Hydrilla can exclude native aquatic plants, and lead to low levels of dissolved oxygen, causing negative impacts to native invertebrates and fishes.

Source: http://nyis.info/invasive_species/hydrilla/

3.4 Kudzu (*Pueraria montana*)

Native of Asia, Kudzu is a fast-growing deciduous legume. It may suppress all other vegetation, leading to decreased structural and species diversity. Kudzu thrives in open disturbed areas and is typically seen on forest edges, abandoned fields, and roadsides. Kudzu is susceptible to Asian soybean rust and tobacco ringspot virus, making it a potential infectious vector for crops or native legumes important to wildlife. Kudzu was discovered to reduce air quality by increasing nitrogen cycling in soils, causing soils to increase emissions of nitric oxide.

3.4.1 Communities/Species Impacted

Highly adaptable, capable of shade out natives, girdle stems and trunks, break branches, ad uproot trees and shrubs.

Source: https://en.wikipedia.org/wiki/Pueraria_montana

3.5 Mimosa (*Albizia julibrissin*)

Native of China, mimosa was introduced to the United States in 1745 and cultivated since the 18th century primarily as an ornamental. Mimosa remains a popular ornamental because of its fragrant and showy flowers. It has the ability to grow and reproduce along roadways and disturbed areas, readily establishing after escaping from cultivation.

3.5.1 Communities/Species Impacted

Opportunistic competitor in open areas or forest edges, able to grow in various soil types, produce large amounts of seed, and resprout when cut back or damaged. Mimosa reduces sunlight and nutrients available to desired species because of the denseness of the stand.

Source: https://emeraldplants.co.uk/product/albizia-julibrissin-rosea/

3.6 Parrotfeather (*Myriophyllum aquaticum*)

Native to the Amazon River in South America, was introduced to North America around the late 1800s. It typically grows in freshwater streams, ponds, lakes, rivers, and canals that have a high nutrient content.

3.6.1 Communities/Species Impacted

It can alter the physical and chemical characteristics of water, grows abundantly, shades out naturally occurring algae, and clogs irrigation ducts and canals.

Source: https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/parrot-feather.aspx

3.7 Salvinia (*Salvinia minima* and *S. molesta*)

A floating fern native of Central and South American, it has been cultivated in the U.S. since the 1880s for water gardens, and then likely accidentally introduced into the wild. This species is often spread via boats and trailers.

3.7.1 Communities/Species Impacted

All aquatic systems, including Lakes and Ponds, Cypress-Tupelo-Blackgum Swamps, and Freshwater Marsh.

Source: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=298

3.8 Torpedo Grass (*Panicum repens*)

Torpedo grass grows throughout the world in tropical and subtropical areas. It is a perennial grass that spreads via its large branching rhizomes.

3.8.1 Communities/Species Impacted

Torepdo grass can form dense stands in a variety of habitats, from sandy beaches to shorelines.

Source: https://warcapps.usgs.gov/PlantID/Species/Details/3492

3.9 Tree-of-Heaven (*Ailanthus altissima*)

Native of China, introduced in the U.S. as ornamental in 1784. This species has become invasive due to its ability both to colonize disturbed areas quickly and to suppress competition with allelopathic chemicals.

3.9.1 Communities/Species Impacted

Ailanthus altissima forms dense clonal thickets which displace native species and can rapidly invade fields, meadows, and harvested forests. It is extremely tolerant of poor soil conditions and can easily invades disturbed forests or forest edges causing habitat damage.

Source: https://www.chesapeakebay.net/discover/field-guide/entry/tree_of_heaven

3.10 Vasey Grass (*Paspalum urvillei*)

Vasey grass is native to South America but is now common in the eastern United States. It is a frequent invader to disturbed areas in Louisiana.

3.10.1 Communities/Species Impacted

Vasey grass grows in disturbed moist areas and is commonly seen along roadsides and neglected agricultural fields where it can be problematic for land managers. On grazed lands it is avoided by livestock.

Source: https://warcapps.usgs.gov/PlantID/Species/Details/3534

3.11 Water lettuce (*Pistia stratiotes*)

Native of Africa, but its origin is difficult to ascertain for sure. It was first described from Lake Victoria in Africa, but its distribution is now pantropical, occurring in nearly all tropical and subtropical fresh waterway. The plant can reproduce by stolons, allowing to grow quickly to cover the water surface.

3.11.1 Communities/Species Impacted

This floating plant commonly forms large infestations which prevent boating, fishing and other uses of lakes and rivers. Water lettuce occurs in lakes, rivers and canals, occasionally forming large dense mats.

Source: https://www.michigan.gov/invasives/0,5664,7-324-68002_71240_73848-367856--,00.html

3.12 Argentine Ant (*Linepithema humile*)

A native of South America, it was introduced to the United States through the port of New Orleans in the late 1800's, it now occurs throughout the southern U.S. Although it does not sting, it forms 'supercolonies' which are extremely difficult to remove.

3.12.1 Communities/Species Impacted

All terrestrial communities, in particular habitats near water. Both terrestrial vertebrate and invertebrate species are at risk. Can displace most or all native ants.

Source: https://en.wikipedia.org/wiki/Argentine_ant#/media/File:Linepithema_Argentine_ant.jpg

3.13 Carp

Five species of non-native carp are currently found in Louisiana, Common Carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon Idella*), Black carp (*Mylopharyngodon piceus*), Silver Carp (*Hypophthalmichthys molitrix*), and Bighead Carp (*Hypophthalmichthys nobilis)*.

3.13.1 Communities/Species Impacted

Carp compete with native fish and shellfish and disturb bottom sediments. They are also known to leap out of the water and injure boaters, particularly Silver Carp.

Source: https://www.lsuagcenter.com/topics/environment/invasive%20species/carp/common%20carp

3.14 Emerald Ash Borer (*Agrilus planipennis*)

The emerald ash borer is an invasive beetle that attacks ash trees. It is currently not found in East Baton Rouge Parish but has been found in northern Louisiana. The beetle is native to Asia but was most likely introduced to the United States via wooden pallets.

3.14.1 Communities/Species Impacted

The emerald ash borer exclusively attacks ash trees. Emerald ash borers attack ash trees by digging tunnels below the bark, cutting the flow of sap throughout the tree.

Source: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/emerald-ash-borer/emerald-ash-borer-beetle

3.15 Northern Snakehead (*Channa argus*)

Northern snakehead is native to Asia but has been introduced to Europe and North America. It is an obligate air breather, able to survive in poorly oxygenated waters as well as cross short sections of land. It has not been found in Louisiana but has been found in nearby states.

3.15.1 Communities/Species Impacted

Northern snakehead occur in freshwater habitats where they compete with native species for food and habitat.

Source: https://nas.er.usgs.gov/queries/factsheet.aspx?speciesid=2265

3.15 Nutria (*Myocastor coypus*)

Nutria are large herbivorous aquatic rodents native Argentina. Nutria typically feed on the roots of semiaquatic and aquatic vegetation, leading to a loss of vegetative cover, and consequently to soil erosion. The end result of this process is the conversion of marsh to open water.

3.15.1 Communities/Species Impacted

Aquatic communities, particularly fresh, intermediate, brackish, and salt marsh, via herbivory accelerated land loss and direct destruction through burrow construction.

Source: https://www.themonitor.com/2018/12/24/nutria-may-look-cute-considered-invasive-species/

3.16 Red Imported Fire Ant (*Solenopsis invicta*)

The Red Imported Fire Ant is native to South America, but now occurs throughout the southern U.S. Red Imported Fire Ants live in a wide variety of habitats, in particular disturbed areas. They are considered a nuisance due to their large mounds and painful sting. Adults are reddish brown with a black posterior.

3.16.1 Communities/Species Impacted

All terrestrial habitats are vulnerable, in particular open, disturbed habitats near water grasslands and open pine systems. Both terrestrial vertebrates and invertebrates can be impacted.

Source: https://www.225batonrouge.com/our-city/unleashed-controlling-fire-ants-south-louisiana

3.17 Rio Grande Cichlid (*Herichthys cyanoguttatum*)

The Rio Grande Cichlid is native to Texas and Mexico but is a popular ornamental fish that has spread through the aquarium trade to other US states. It is highly adaptable to different environments and is considered a habitat generalist.

3.17.1 Communities/Species Impacted

The Rio Grande Cichlid poses a threat to native freshwater species through both competition and predation.

Source: https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=443

3.18 Zebra mussel (*Dreissena polymorpha*)

Small freshwater mussel native to the lakes of southern Russia and Ukraine. Zebra mussels were first discovered in North America in 1988 in the Great Lakes, and then have spread across the continental U.S. Zebra mussels attach to any stable substrate in the water column or benthos. Long-term stability of substrate affects population density and age distributions on those substrates

3.18.1 Communities/Species Impacted

As a result of high densities of colonies, zebra mussels may cause major shifts in the plankton communities of lakes and rivers. Reductions in phytoplankton numbers and biomass also limit food to fish larvae and other consumers further up the food chain.

Source: https://huntfish.mdc.mo.gov/fishing/protect-missouri-fishing/zebra-mussels

Appendix 4: LDWF Invasive Species Ranking Chart

Tier	Scientific Name	Common Name	Type
I	*Pomacea canaliculata* and *P. maculata*	Channeled apple snail	Mollusks
I	*Linepithema humile*	Argentine ant	Non-crustacean Arthropods
I	*Solenopsis invicta*	Red imported fire ant	Non-crustacean arthropods
I	*Herichthys cyanoguttatus*	Rio Grande cichlid	Non-crustacean arthropods
I	*Ctenopharyngodon idella*	Grass carp	Inland fishes
I	*Cyprinus carpio*	Common carp	Inland fishes
I	*Hypophthalmichthys molitrix*	Silver carp	Inland fishes
I	*Hypophthalmichthys nobilis*	Bighead carp	Inland fishes
I	*Mylopharyngodon piceus*	Black carp	Inland fishes
I	*Pterois volitans* and *P. miles*	Lionfish	Marine fishes
I	*Sturnus vulgaris*	European starling	Birds
I	*Passer domesticus*	House sparrow	Birds
I	*Rattus norvegicus*	Norway rat	Mammals
I	*Rattus*	Black rat	Mammals
I	*Myocastor coypus*	Nutria	Mammals
I	*Felis catus*	Feral/domestic cat	Mammals
I	*Sus scrofa*	Feral hog	Mammals
I	*Ardisia crenata*	Coral ardisia	Plants
I	*Cinnamomum camphora*	Camphor tree	Plants
I	*Colocasia esculenta*	Elephant ear	Plants
I	*Cynodon dactylon*	Bermuda grass	Plants
I	*Deparia petersenii*	Japanese twin-sorus fern	Plants
I	*Dioscorea alata* and *D. bulbifera*	Air yam	Plants
I	*Egeria densa*	Brazilian waterweed	Plants
I	*Eichhornia crassipes*	Water hyacinth	Plants
I	*Firmiana simplex*	Chinese parasol tree	Plants
I	*Hydrilla verticillata*	Hydrilla or waterthyme	Plants
I	*Imperata cylindrica*	Cogon grass	Plants
I	*Iris pseudacorus*	Yellow flag iris	Plants
I	*Ligustrum sinense*	Chinese privet	Plants
I	*Lygodium japonicum*	Japanese climbing fern	Plants
I	*Panicum repens*	Torpedo grass	Plants
I	*Paspalum modestum*	Holmwood grass	Plants
I	*Paspalum urvillei*	Vasey grass	Plants

I	*Poncirus trifoliata*	Trifoliate orange	Plants
I	*montana*	Kudzu pueraria	Plants
I	*Rosa bracteata*	Mccartney rose	Plants
I	*Rosa laevigata*	Cherokee rose	Plants
I	*Salvinia minima*	Common salvinia (water spangles)	Plants
I	*Salvinia molesta*	Giant salvinia	Plants
I	*Sporobolus indicus*	Smut grass	Plants
I	*Triadica sebifera*	Chinese tallow tree	Plants
I	*Vernicia fordii*	Tungoil tree	Plants
II	*Corbicula fluminea*	Asian clam	Mollusks
II	*Dreissena polymorpha*	Zebra mussel	Mollusks
II	*Latrodectus geometricus*	Brown widow	Non-crustacean arthropods
II	*Daphnia lumholzi*	Water flea	Non-crustacean arthropods
II	*Penaeus monodon*	Asian tiger shrimp	Crustaceans
II	*Coptotermes formosanus*	Formosan termite	Non-crustacean arthropods
II	*Aedes albopictus*	Asian tiger mosquito	Non-crustacean arthropods
II	*Nylanderia fulva*	Tawny crazy ant	Non-crustacean arthropods
II	*Apis mellifera*	European honeybee	Non-crustacean arthropods
II	*Cactoblastis cactorum*	Cactus moth	Non-crustacean arthropods
II	*Eleutherodactylus coqui*	Puerto Rican coqui	Reptiles and amphibians
II	*Eleutherodactylus cystignathoides*	Rio Grande chirping frog	Reptiles and amphibians
II	*Eleutherodactylus planirostris*	Greenhouse frog	Reptiles and amphibians
II	*Apalone ferox*	Florida softshell	Reptiles and amphibians
II	*Anolis sagrei*	Brown anole	Reptiles and amphibians
II	*Columba livia*	Rock pigeon	Birds
II	*Streptopelia decaocto*	Eurasian collared dove	Birds
II	*Mus musculus*	House mouse	Mammals
II	*Aeschynomene fluitans*	Giant water sensitive plant	Plants
II	*Ailanthus altissima*	Tree-of-Heaven	Plants
II	*Albizia julibrissin*	Mimosa	Plants

II	*Alternanthera philoxeroides*	Alligatorweed	Plants
II	*Alternanthera sessilis*	Chaff-weed	Plants
II	*Arundo donax*	Giant reed	Plants
II	*Azolla pinatta*	Mosquito fern	Plants
II	*Bothriochloa bladhii*	Australian bluestem	Plants
II	*Bothriochloa ischaemum var. songarica*	King ranch bluestem	Plants
II	*Briza minor*	Little quaking grass	Plants
II	*Broussonetia papyrifera*	Paper mulberry	Plants
II	*Cardiospermum halicacabum*	Balloon vine	Plants
II	*Carduus nutans*	Nodding thistle	Plants
II	*Cayratia japonica*	Bushkiller	Plants
II	*Ceratopteris thalictroides*	Water sprite	Plants
II	*Chloris canterai*	Paraguayan windmill grass	Plants
II	*Cirsium vulgare*	Bull thistle	Plants
II	*Conyza bonariensis*	Large-head horseweed	Plants
II	*Cyperus entrerianus*	Deep-rooted Sedge	Plants
II	*Cyperus iria*	Ricefield flatsedge	Plants
II	*Cyperus pilosus*	Fuzzy flatsedge	Plants
II	*Cyperus rotundus*	Purple nutsedge	Plants
II	*Cyrtomium fortunei*	Fortune's net veined holly fern	Plants
II	*Dichanthium annulatum*	Kleberg bluestem	Plants
II	*Digitaria ischaemum*	Smooth crabgrass	Plants
II	*Digitaria sanguinalis*	Hairy crabgrass	Plants
II	*Dopatrium junceum*	Dopatrium	Plants
II	*Echinochloa colona*	Jungle rice	Plants
II	*Echinochloa crus-galli*	Barnyardgrass	Plants
II	*Elaeagnus pungens*	Thorny olive	Plants
II	*Elaeagnus umbellata*	Autumn olive	Plants
II	*Elodea canadensis*	Elodea	Plants
II	*Eremochloa ophiuroides*	Centipedegrass	Plants
II	*Festuca arundinacea*	Reed fescue	Plants
II	*Glechoma hederacea*	Ground ivy	Plants
II	*Hedera helix*	English ivy	Plants
II	*Hymenachne amplexicaulis*	West Indian marshgrass	Plants
II	*Ipomoea alba*	Moon vine	Plants
II	*Ipomoea cairica*	Mile-a-Minute Vine	Plants
II	*Ipomoea quamoclit*	Cypress vine	Plants
II	*Jacquemontia tamnifolia*	Tie vine	Plants
II	*Kummerowia striata*	Japanese lespedeza	Plants
II	*Lantana camara*	West India camara	Plants
II	*Lantana montevidensis*	Weeping lantana	Plants
II	*Lespedeza bicolor*	Shrubby lespedeza	Plants

II	*Ligustrum japonicum*	Japanese privet	Plants
II	*Ligustrum lucdium*	Glossy privet	Plants
II	*Ligustrum vulgare*	Common privet	Plants
II	*Limnophila indica*	Indian marshweed	Plants
II	*Limnophila* x *ludoviciana*	Marshweed	Plants
II	*Limnophila sessiliflora*	Asian marshweed	Plants
II	*Liriope muscari*	Monkeygrass	Plants
II	*Lolium perenne*	Perennial ryegrass	Plants
II	*Lonicera japonica*	Japanese honeysuckle	Plants
II	*Ludwigia hexapetala*	Uruguay seedbox	Plants
II	*Luziola peruviana*	Peruvian water grass	Plants
II	*Macfadyena unguis-cati*	Catclaw vine	Plants
II	*Marsilea macropoda*	Big-foot Water Clover	Plants
II	*Melia azedarach*	Chinaberry	Plants
II	*Myriophyllum aquaticum*	Parrotfeather	Plants
II	*Myriophyllum spicatum*	Eurasian watermilfoil (spike milfoil)	Plants
II	*Najas minor*	Brittle naiad (brittle waternymph)	Plants
II	*Nandina domestica*	Nandina	Plants
II	*Nasturtium officinale*	Watercress	Plants
II	*Nelumbo nucifera*	Sacred lotus	Plants
II	*Nymphaea lotus*	White egyptian lotus	Plants
II	*Nelumbo nucifera*	Sacred lotus	Plants
II	*Nymphoides cristata*	Crested floating hearts	Plants
II	*Ottelia alismoides*	Duck lettuce	Plants
II	*Oxycaryum cubense*	Cuban bulrush	Plants
II	*Paederia foetida*	Stinkvine	Plants
II	*Paspalum dilatatum*	Dallis grass	Plants
II	*Paspalum notatum*	Common bahia grass	Plants
II	*Perilla frutescens*	Beefsteak plant	Plants
II	*Phleum pratense*	Timothy grass	Plants
II	*Phyllostachys aurea*	Golden bamboo	Plants
II	*Pistia stratiotes*	Water lettuce	Plants
II	*Polygonum cuspidatum*	Japanese knotweed	Plants
II	*Potamogeton crispus*	Curly pondweed	Plants
II	*Pteris multifida*	Spider brake fern	Plants
II	*Pyrus calleryana*	Bradford pear	Plants
II	*Quercus acutissima*	Sawtooth oak	Plants
II	*Ricinus communis*	Castor-bean	Plants
II	*Rosa multiflora*	Multiflora rose	Plants
II	*Rotala indica*	Indian toothcup	Plants
II	*Rottboellia cochinchinensis*	Itch grass	Plants

II	*Ruellia brittoniana*	Britton's wild petunia	Plants
II	*Rumex crispus*	Curly dock	Plants
II	*Sacciolepis indica*	Indian cupscale	Plants
II	*Sagittaria guyanensis*	Guyana arrowhead	Plants
II	*Sesbania punicea*	Brazilian rattlebox	Plants
II	*Setaria pumila ssp. pallidefusca*	Thin-spike bristle grass	Plants
II	*Solanum pseudocapsicum*	Jerusalem cherry	Plants
II	*Solanum viarum*	Tropical soda apple	Plants
II	*Sorghum halepense*	Johnson grass	Plants
II	*Tamarix africana*	African salt cedar	Plants
II	*Tamarix canariensis*	Canary island salt cedar	Plants
II	*Tamarix gallica*	French tamarisk	Plants
II	*Tamarix ramosissima*	Salt cedar	Plants
II	*Thelypteris torresiana*	Mariana maiden fern	Plants
II	*Urochloa maxima*	Guinea grass	Plants
II	*Urochloa mutica*	Para grass	Plants
II	*Verbena brasiliensis*	Brazilian verbena	Plants
II	*Vicia villosa*	Vetch	Plants
II	*Wisteria sinensis*	Chinese wisteria	Plants
II	*Youngia japonica*	Japanese hawksbeard	Plants
III	*Cipangopaludina chinensis*	Chinese mystery snail	Mollusks
III	*Cipangopaludina japonica*	Japanese mystery snail	Mollusks
III	*Phyllorhiza punctata*	Spotted jellyfish	Cnidaria
III	*Melanoides tuberculata*	Red-rimmed melania	Mollusks
III	*Cardisoma guanhumi*	Blue land crab	Crustaceans
III	*Pheidole* sp.	Exotic pheidole	Non-crustacean arthropods
III	*Drosophila suzukii*	Spotted wing drosophila	Non-crustacean arthropods
III	*Eoreuma loftini*	Mexican rice borer	Non-crustacean arthropods
III	*Balclutha rubrostriata*	Red-streaked leafhopper	Non-crustacean arthropods
III	*Xyleborus glabratus*	Redbay ambrosia beetle	Non-crustacean arthropods
III	*Heteropoda venatoria*	Caribbean huntsman spider	Non-crustacean arthropods
III	*Crossopriza lyoni*	Southeast Asian cellar spider	Non-crustacean arthropods
III	*Plexippus paykulli*	Pantropical jumping spider	Non-crustacean arthropods
III	*Astronotus ocellatus*	Oscar	Inland fishes
III	*Carassius auratus*	Goldfish	Inland fishes

III	*Archocentrus nigrofasciatus*	Convict cichlid	Inland fishes
III	*Piaractus brachypomus*	Red-bellied pacu	Inland fishes
III	*Hypsoblennius invemar*	Tessellated blenny	Marine fishes
III	*Hypostomus* sp.	Suckermouth catfish	Inland fishes
III	*Macropodus opercularis*	Paradise fish	Inland fishes
III	*Misgurnus anguillicaudatus*	Oriental weatherfish	Inland fishes
III	*Oreochromis* sp., *Sarotherodon* sp., and *Tilapia* sp.	Tilapia	Inland/marine fishes
III	*Scardinius erythrophthalmus*	Rudd	Inland fishes
III	*Xiphophorus hellerii*	Green swordtail	Inland fishes
III	*Xiphophorus maculatus*	Southern platyfish	Inland fishes
III	*Hemidactylus turcicus*	Mediterranean gecko	Reptiles and amphibians
III	*Ramphotyphlops braminus*	Flowerpot snake	Reptiles and amphibians
III	*Branta canadensis*	Canada Goose (Feral only)	Birds
III	*Cygnus olor*	Mute swan	Birds
III	*Myiopsitta monachus*	Monk parakeet	Birds
III	*Bacopa egensis*	Brazilian Water-hyssop	Plants
III	*Blyxa aubertii*	Blyxa	Plants
III	*Crotalaria brevidens* var. *intermedia*	Ethiopian rattlebox	Plants
III	*Crotalaria lanceolata*	Lanceleaf rattlebox	Plants
III	*Crotalaria retusa*	Rattleweed	Plants
III	*Crotalaria spectabilis*	Showy rattle	Plants
III	*Eucalyptus* spp.	Eucalyptus	Plants
III	*Murdannia keisak*	Asian spiderwort	Plants
III	*Securigera varia*	Crownvetch	Plants
IV	*Craspedacusta sowerbyi*	Freshwater jellyfish	Cnidaria
IV	*Perna perna*	Brown (mexihalo) mussel	Mollusks
IV	*Perna viridis*	(Asian) green mussel	Mollusks
IV	*Crassostrea gigas*	Pacific oyster	Mollusks
IV	*Crassostrea ariakensis*	Asian oyster	Mollusks
IV	Achatina sp., Archachtina sp., and *Limicolaria* sp.	Giant African land snails	Mollusks
IV	*Eriocheir sinensis*	Chinese mitten crab	Crustaceans
IV	*Carcinus maenas*	Green crab	Crustaceans
IV	*Orconectes rusticus*	Rusty crawfish	Crustaceans
IV	*Orconectes virilis*	Virile crawfish	Crustaceans
IV	*Orconectes immunis*	Papershell crawfish	Crustaceans
IV	*Agrilus planipennis*	Emerald ash borer	Non-crustacean arthropods

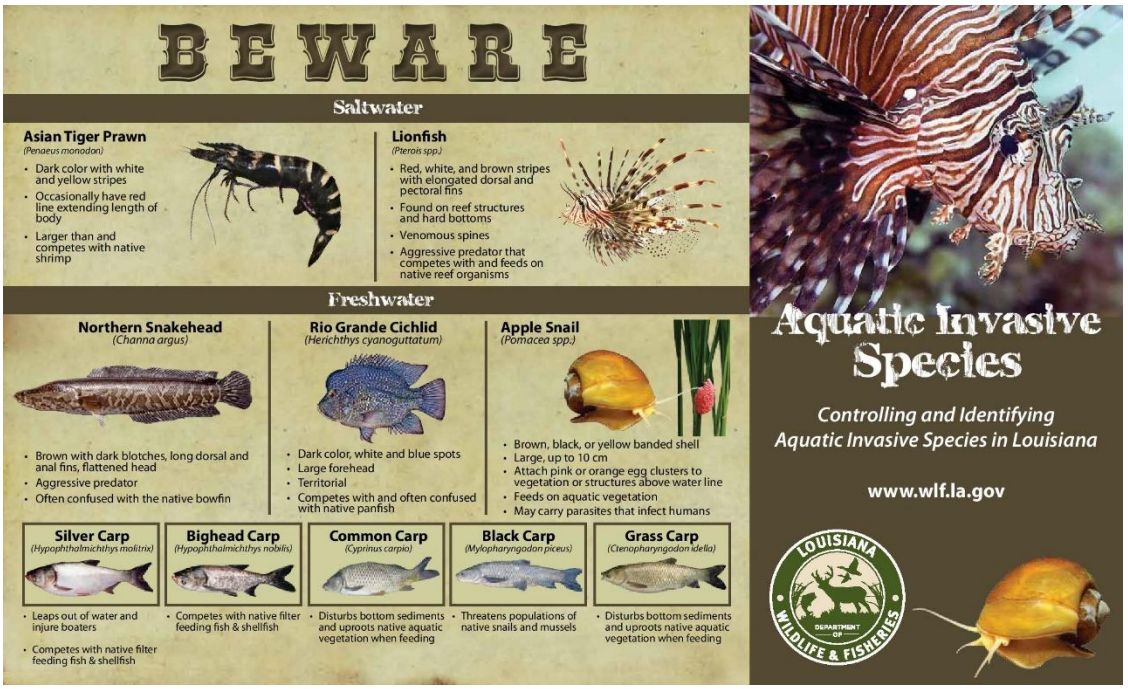
IV	*Anoplophora glabripennis*	Asian longhorn beetle	Non-crustacean arthropods
IV	*Apis mellifera scutellata*	Africanized honeybee	Non-crustacean arthropods
IV	*Lymantria dispar*	Gypsy moth	Non-crustacean arthropods
IV	Channidae family	Snakehead family	Inland fishes
IV	Clariidae family	Walking catfish	Inland fishes
IV	*Electrophorus* spp.	Freshwater electric eel	Inland fishes
IV	Synbranchidae family	Asian swamp eel	Inland fishes
IV	Trichomycteridae family	Pencil catfish	Inland fishes
IV	*Tinca tinca*	Tench	Inland fishes
IV	*Osteopilus septentrionalis*	Cuban treefrog	Reptiles and amphibians
IV	*Salvator merianae*	Argentine giant tegu	Reptiles and amphibians
IV	*Boa constrictor*	Boa constrictor	Reptiles and amphibians
IV	*Python molurus*	Burmese python	Reptiles and amphibians
IV	*Python* sp.	Pythons	Reptiles and amphibians
IV	*Boiga irregularis*	Brown tree snake	Reptiles and amphibians
IV	*Casuarina* spp.	Australian pine	Plants
IV	*Cylindrospermopsis raciborskii*	Cylindro blue green algae	Plants
IV	*Eichhornia azurea*	Rooting water hyacinth	Plants
IV	*Hygrophila polysperma*	Indian swampweed	Plants
IV	*Ipomoea aquatica*	Water spinach	Plants
IV	*Lagarosiphon major* and *L. muscoides*	African elodea	Plants
IV	*Lygodium microphyllum*	Old world climbing fern	Plants
IV	*Lythrum salicaria*	Purple loosestrife	Plants
IV	*Marsilea minuta* and *M. mutica*	Water clovers	Plants
IV	*Melaleuca quinquenervia*	Punktree	Plants
IV	*Monochoria hastata* and *M. vaginalis*	False pickerelweeds	Plants
IV	*Najas marina*	Marine naiad	Plants
IV	*Nymphoides indica*	Little floating hearts	Plants
IV	*Nymphoides peltata*	Yellow floating heart	Plants
IV	*Rotala rotundifolia*	Roundleaf toothcup	Plants
IV	*Schinus terebinthifolius*	Brazilian peppertree	Plants
IV	*Solanum tampicense*	Aquatic soda apple	Plants

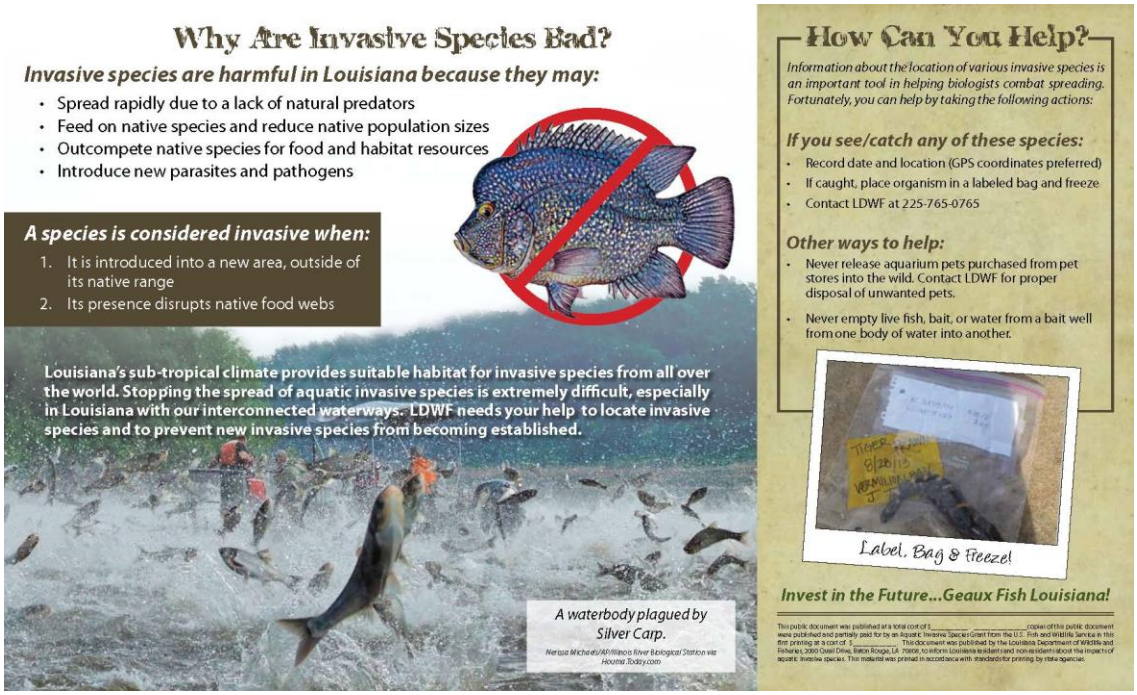
IV	*Trapa natans*	Water chestnut	Plants

Appendix 5: BREC NRM Health and Safety Plan

Still in development.

Appendix 6: LDWF Aquatic Invasive Fact Sheet





Source: http://www.wlf.louisiana.gov/sites/default/files/pdf/page/37779-fisheries-brochures/aquaticinvasivespecies.pdf

Appendix 7: Additional Sources of Information on Invasive Species

1. *Laws and Regulations*
    - *U.S. Fish and Wildlife Service Invasive Species (www.fws.gov/invasives/laws.html)*
    - *UDSA Louisiana regulations (*http://www.invasivespeciesinfo.gov/laws/la.shtml*)*
    - *Lacey Act Information (www.fws.gov/le/pdffiles/Lacey.pdf)*
2. *General Invasive Species Information*
    - *Louisiana Invasive Species (http://is.cbr.tulane.edu/index.html)*
    - *USDA National Invasive Species Information Center (NISIC) (*https://www.invasivespeciesinfo.gov/*)*
    - *USDA NISIC State of Louisiana (*https://www.invasivespeciesinfo.gov/us/louisiana*)*
    - *LSU AgCenter Invasive Species (*https://www.lsuagcenter.com/topics/environment/invasive%20species)
    - *LSU AgCenter Invasive Species in Louisiana Forests (*https://www.lsuagcenter.com/portals/communications/publications/agmag/archive/2006/spring/invasive-species-in-louisiana-forests*)*
    - *Invasive species distribution and mapping (http://www.eddmaps.org)*
    - *Invasive species reporting (http://pest.ceris.purdue.edu/state.php?code=LA)*
    - *Southeast Exotic Pest Plant Council (http://www.se-eppc.org/index.cfm)*
    - *Aquatic Nuisance Species Taskforce (http://www.anstaskforce.gov/default.php)*
    - *USDA Animal and Plant Health Inspection Service (APHIS) (http://www.aphis.usda.gov/wps/portal/aphis/home/)*
    - *USGS Nonindigenous Aquatic Species (NAS) (http://nas.er.usgs.gov/)*
    - *ISSG Global Invasive Species Database (http://www.issg.org/)*