PROPOSED MANAGEMENT PLAN

TOWN OF SULLIVAN'S ISLAND PROTECTED LAND

DRAFT #2A

November 2, 2011

(Draft 2 revised to eliminate scrivener comments and replace map)

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BACKGROUND

The Town of Sullivan's Island owns approximately 190 acres of beachfront land, which represents nearly all the Island oceanfront property abutting the high water mark. (Hereafter referred to as the Protected Land.) The acreage includes beach, dunes, foredune and backdune grasslands, interdunal wetlands, shrublands, early successional maritime forest and maritime hardwood depression.

In most places, the Protected Land has been in an overall state of net accretion for decades. Sullivan's Island is among a handful of barrier islands in South Carolina that have gained ground during the past centuries. Some sections of this property have accreted more than 1,500 feet seaward since the 1940s.

This property is protected by deed restrictions placed on the land in a 1991 agreement with the Lowcountry Open Land Trust that prohibits any residential or commercial development on the property. In addition, Town ordinances regulate the types and time of any vegetation cutting that is permitted.

This protected land in public ownership represents a remarkable and unique resource for the Town and surrounding Lowcountry region. It supports a great diversity of vegetation and wildlife (e.g., more than 200 species of vegetation, and birds of at least 60 species observed 5-10/2008 by consultants). (Lists of plant and bird species observed by the consultants are shown in Appendices C and D.) Thus, this protected land on Sullivan's Island represents a microcosm of the flora and fauna that can be seen in the successional ocean side habitats that occur along the South Carolina coast.

Beginning in 2007, the Town engaged consultants to assist in developing a comprehensive land management plan to enhance this natural resource of the Town. The Town recognized that it had a unique natural resource (undeveloped maritime beachfront land adjacent to a stable residential community) and had stewardship responsibilities to manage it in accordance with recognized standards of environmental management. The process included study of the land and its flora and fauna by the consultants and feedback from Town residents regarding management options. Several public meetings were held to solicit input from Town citizens. [DATES? Special Council Meetings on August 4, 2009 and December 7, 2009 minimum, plus progress reports on consultants' work were reported through Real Estate Committee of Council at every Council meeting.] To guide the consultant team in distilling the vast data from research and public input, the Town Council on December 15, 2009, approved a set of Principles for Management of this land (Appendix A).

This process resulted in a Final Draft report from the consultants dated July 16, 2010. This report formed the basis for Town Council consideration and study, which lead to this management plan. Council's consideration and study included on-site guided tours, open and advertised to the public and lead by one or more experts, which occurred on March 11, 2011 (Planning Units 1 and 3) and May 5, 2011 (Planning Units 2 and 4). These tours were accompanied by publicly advertised and open work meetings of Council held shortly after the tours, which occurred on March 12, May 6, and May 20, 2011. The work meetings were held sequentially to address Planning Units 1 and 3 (March 12), Unit 2 (May 6) and Unit 4 (May 20).

INTENT, SCOPE AND LIMITATIONS OF THE MANAGEMENT PLAN

The intent of this document is to describe, in general, non-prescriptive but controlling terms, the background, intents, objectives, and goals of the Town of Sullivan's Island (TOSI) in managing, directing and preserving, for purposes of conservation, protection and environmental education, that land which it has placed under protection with the Lowcountry Open Land Trust, as well as the land owned by the Town which is referenced by Charleston County TMS 529-09-000-68 but generally seaward of any property leased to the Charleston County School District.

This plan is intended to apply to all the lands mentioned in the above section, as well as any that in the future may accrete and otherwise be added to the aforementioned lands. It is intended to communicate the intent of the Town in the management of these lands to accomplish the objectives enumerated throughout the plan.

This plan is not expected to be so prescriptive or detailed as to constitute in and of itself a specific directive from which implementation may flow directly. Rather, it is intended to provide a clear guide to the objectives and approaches the Town intends to achieve and utilize, respectively, in its management of this land. Therefore, it is expected that the Town will engage appropriately trained professionals to translate the management plan objectives and approaches into detailed plans, which will be accessible to all Town citizens. These detailed plans would be the blueprints that the Town would cause to be executed under appropriate direction.

MANAGEMENT RECOMMENDATIONS APPLICABLE TO ALL PLANNING UNITS

Accepted good management practices should be followed in all zones.

Any species of vegetation which is both non-native and invasive should be killed and removed wherever it occurs. An example is Chinese Tallow (*botanical name here*); examples of other such species are in Appendix E. (Other species which are not categorized as *both* non-native and invasive *may* be removed, killed or reduced depending on the planning unit and circumstances.)

Town-maintained Beach Paths

(Paths providing access to the beach from locations seaward of the protected land):

a. **Emergency paths** should be cleared to a width of 20-25 feet. Additional understory may be cleared to a maximum of 10 feet on each side to permit off-path space for pedestrians to avoid emergency vehicles

b. **Non-emergency paths** should be cleared to a width of up to 10 feet. Additional understory may be cleared to a maximum of 5 feet on each side.

c. Understory clearance for Town-maintained beach paths may include removal of trees if approved by Town's urban forester or other appropriate professional engaged by the Town.

Non-Town-maintained Beach Paths

(Existing paths providing access to the beach from locations landward of the protected land, which are currently maintained by adjacent homeowners. I.e., foot paths from the beach to the transition zone which end at locations other than a current right of way; previously considered "private"):

a. Subject to the conditions below, these paths may be maintained, with approval of the Town and, where needed, OCRM and any other governmental agency with jurisdiction.

b. Previously existing paths that are not currently maintained, but whose prior existence is visible or documented, may be restored and maintained, subject to the conditions in (a.) above.

c. These paths may be cleared to a width of up to 6.5 feet. [COUNCIL QUESTION: Do other restrictions apply?] Additional understory may be cleared to maximum of 2 feet on each side; removal of trees in this area is not allowed.

Other Paths ("Nature Paths"):

a. Rationale: Currently beach paths, in addition to providing access to the beach and ocean, also provide the primary means of accessing the Protected Land. The beach paths have been maintained to permit access to the beach for pedestrians, and at 12 designated emergency paths, for emergency vehicles that are frequently dispatched to provide relief for visitors with medical or water emergencies.

   Individuals wishing to explore the off-path parts of the land are free to do so but access is impeded by lack of apparent routes and by vegetation that in some places is extremely dense because of permitted cutting by adjacent property owners and by the Town to maintain path width. As a result, most visitors only view the vegetation and wildlife that is immediately adjacent to the existing beach paths, which often is unrepresentative of that which occurs throughout the extent of this unique preserve.

b. The plan encourages the development of additional foot paths ("nature paths"), which would run in directions other than from street/transition zones to beach. These paths may run more or less parallel to the beach but in particular would have the primary purposes of 1) permitting pedestrian access for educational and recreational purposes to permit viewing of portions of the protected land that are not currently easily accessible, while protecting fragile environments; 2) connecting existing beach access paths; and 3) providing a network of trails to permit pedestrian transit on the Island via the protected land.

c. When possible, these paths should be in swales.

d. The Town will apply for outside funding, including but not limited to County Greenbelt funds, to initiate development of these nature paths.

e. Signage and other appropriate interpretive aids should be encouraged, in particular those which involve minimal intrusion and disturbance to the environment while enhancing user education [MATERIAL ADDED SINCE LAST WORKSHOP]

Punctuated Vistas:

a. When possible and consistent with the management objectives and plans for the relevant planning unit, the possibility of creating or maintaining punctuated vistas should be considered.

Transition Zones:

a. In each unit, the management plan may include a transition zone that abuts privately held properties, that would be managed differently from, and more aggressively than, the (usually much deeper) seaward balance of the accreted land.

b. The transition zone should be managed to further the following objectives when appropriate:

   i. Provision of a buffer from unwanted wildlife.

   ii. Minimization of potential fire hazard

   iii. Enhancement of public safety.

   iv. Enhancement of breezes.

   v. Enhancement of possible sight lines to the property seaward of the band.

c. Achievement of these objectives in the transition zone will be accomplished via different means depending on the characteristics of the accreted land including and seaward of the band. As examples:

   vi. Where the band has characteristics of a developing maritime forest, the undergrowth might be cleared and smaller bushes and trees that compete with more significant trees might be removed.

   vii. Where the seaward property is primarily myrtle fields, or currently cleared within the Town's ordinances, or partially cleared spaces, the band may be cleared or cut to provide an open field habitat, possibly with seeding of other grasses and/or wildflowers, with periodic mowing under the guidance of a landscape professional.

   viii. Trees that are vanguard members of a maritime forest should be spared. Trees may be pruned when it is to benefit the health of the tree.

d. Where a platted right of way exists between the protected land and the nearest seaward private properties, that right of way will be considered to be part of the desired transition zone.

e. More specific directives for transition zones are provided in the unit-specific management plans.

RECOMMENDED PLANNING UNITS

Consistent with the management Principles approved by Council (Appendix A) and the consultants' recommendations, four planning units are delineated within the protected land, as illustrated in Appendix B. The units and their general boundaries are as follows.

Planning Unit #1 – West
Extends from the western end of the Protected Land at Fort Moultrie (vicinity of station 13) and terminates at the Town-maintained beach path at the Sand Dunes Club. Unit #1 encompasses maritime forest, established shrub land, and foredune grassland along the seaward edge.

Planning Unit #2 – West Central
Extends from the Town-maintained beach path at the Sand Dunes Club to the lighthouse property (which is between station 18 and station 18½ and is outside of the protected land). Unit #2 encompasses established vegetation and pathways, as well as additional acreage of foredune grassland along the seaward edge. [QUESTION FOR COUNCIL]

Planning Unit #3 – East Central
Unit #3 includes maritime forest, grassland and foredune grassland seaward of the established shrub line. It can be divided into three sub-units:

1. Unit #3A extends from the beach path extension of Station 18 ½ Street to the extension of the western boundary line of the Town-owned property referenced by Charleston County TMS 529-09-000-68, a portion of which is leased to Charleston County School District (CCSD).

2. Unit #3B comprises the portion of the Town-owned property which is referenced by Charleston County TMS 529-09-000-68 but generally seaward of any property leased to the Charleston County School District.

3. Unit #3C extends from the eastern boundary line of the Town-owned property referenced in (2) above, to the beach path extension of Station 22.

Planning Unit #4 – East
Extends from the beach path extension of Station 22½ to the beach path extension of Station 29. Unit #4 includes manipulated shrubland and foredune grassland along its seaward edge.

MANAGEMENT PLANS BY UNIT

Planning Unit #1 - West

Location

The #1 - West planning unit extends from the western end of the Protected Land at Fort Moultrie (vicinity of station 13) and terminates at the Town-maintained beach path at the Sand Dunes Club. Unit #1 encompasses maritime forest, established shrub land, and foredune grassland along the seaward edge.

Preferred Strategy

Being the oldest and least disturbed portion of the Protected Land, the West unit supports the most developed vegetation communities (see Section 3.3 of consultants' report). Building upon the natural character of this unit, active management of the vegetation should be minimized to allow natural successional processes to drive the development of vegetation over time. Vegetation manipulation of the unit should be limited to invasive non-native species control, beach-access pathway maintenance, creation and maintenance of nature paths, and creation and management of a transition zone. Please refer to Appendix E for information on exotic species management.

Specifically, the preferred strategies are:

a. Promote progression to maritime forest

b. Protect grassland areas. (SEE NOTE BELOW)

c. Encourage restoration of wetlands

Transition zone

a. From Sta 16 eastward

b. Remove all species except desired overstory species

c. Depth: 40 ft – 100 ft

Rationale

As discussed in Section 5.6, if left alone, it is likely that the AL within the West unit will remain stable with some continued accretion over the next 40 years, though the rate of accretion is dependent on rates of sand deposition, erosion, and sea-level rise, as well as the impacts of hurricanes. Continued accretion will result in the seaward vegetation moving outward with the shoreline. The bands of seaward vegetation, including maritime grasslands and shrublands, will move outward but will remain roughly the same size and configuration as they are today. As the coastline moves seaward, the protected inland vegetation community (maritime forest) will overtake areas previously supporting grasslands and shrublands as these communities move seaward and will increase in size relative to the other communities occurring within the Fort Moultrie unit (see Section 5.6). [QUESTION FOR COUNCIL: DID COUNCIL MEAN PROTECTING THEM FROM NON-NATIVE INVASIVE SPECIES AND CUTTING, NOT TO STOP THE NATURAL SUCCESSION? IF SO, COUNCIL NEEDS TO CLARIFY THAT.]

The passive approach to management that is recommended for the Fort Moultrie unit precludes the use of land-cover targets, because land cover will be driven by natural processes (accretion, wind, salt spray, etc). Vegetation communities should be left alone to evolve with time and the changing shoreline.

Other items

Should the Town desire to build a nature center within the accreted area, it would be appropriate to do so within this unit or on Town property contiguous to it. The LOLT deed restrictions limit what type of construction may occur *within* the Protected Area. A logical location for this site would be on the west side of the entrance to the emergency access pathway at the end of station 16. There is a large patch of exotic wisteria that could be cleared in this area.

Planning Unit #2 - West Central

Location
The #2 - West Central unit extends from the public access path at the Sand Dunes Club to the western border of the lighthouse property owned by the US Coast Guard, which is located at 1815 I'On Avenue.

Preferred Strategy

a. Maintain existing hardwoods [NEED TO LIST PRIORITY TREES]
b. Convert manipulated shrubland to maritime grasslands with islands/hammocks of maritime shrubs with natural succession permitted within islands
c. Strengthen dunes when clearing shrubs
d. Overall: Active management to reduce pests

Transition zone
[NOTE FOR COUNIL: TRANSITION SPECS WERE NOT INCLUDED IN FIRST DRAFT. THIS IS FROM PHOTOS OF OUR FLIP CHART NOTES FROM WORKSHOP ON THIS UNIT.]

a. Should be managed as maritime grassland, emulating lighthouse property at similar north-south location
b. Eliminate wax myrtles while protecting trees with diameter at breast height of greater than 6 inches
c. Depth of 32-40 feet

Rationale
The #2 West Central unit should consist of maritime grassland punctuated by scattered maritime shrubland islands. Approximately 50 percent of the total land cover within this unit should be composed of maritime shrubland community, surrounded by a natural mix of maritime foredune and maritime backdune grasslands. The proportion of shrubland to grassland should increase with distance from the sea and with proximity to the Fort Moultrie and School units. Shrubland islands may vary in size and shape from single shrubs/trees to ¼ acre contiguous hammocks of random shape and may be designed such that views of the ocean are maintained from inland observation points. Ocean views may be increased by placing shrubland islands within low dune swales. Over time, larger shrubland islands may begin to develop vegetation community characteristics similar to maritime forest. This development will result in greater habitat diversity and dispersion and should not be discouraged. Naturally occurring examples of this mix of vegetation communities can be found on neighboring Dewees Island, Capers Island, and Bulls Island.

As discussed in Section 5.6 of the consultants' report, it is likely that land within this unit will continue to accrete over the next 40 years, though this is dependent on rates of sand deposition, erosion, and sea-level rise, as well as the impacts of hurricanes. Continued accretion will result in seaward expansion of vegetation. Existing maritime hardwood depression communities within the unit should be preserved to maximize habitat diversity.

Planning Unit #3 - East Central

Location

Unit #3 includes maritime forest, grassland and foredune grassland seaward of the established shrub line. It consists of three sub-units:
:

1. Unit #3A extends from the beach path extension of Station 18 ½ Street to the extension of the western boundary line of the Town-owned property referenced by Charleston County TMS 529-09-000-68, a portion of which is leased to Charleston County School District (CCSD);

2. Unit #3B comprises the portion of the Town-owned property that is referenced by Charleston County TMS 529-09-000-68 but generally seaward of any property leased to the Charleston County School District.

3. Unit #3C extends from the eastern boundary line of the Town-owned property referenced in (2) above, to the beach path extension of Station 22.

Preferred Strategy
The recommended management strategy for this unit is to conserve the existing vegetation and allow natural successional processes to drive the development of vegetation over time. Vegetation manipulation of the unit should be limited to exotic species control and beach-access pathway maintenance. Please refer to Appendix E for information on exotic species management.

Specifically, the preferred strategies for Unit 3 are to:

a. Promote progression to maritime forest

b. Protect grassland areas. [SEE NOTE ABOUT THIS IN UNIT ONE: AS IN UNIT 1, WHEN COUNCIL DISCUSSED PROTECTING GRASSLANDS, DID COUNCIL MEAN PROTECTING THEM FROM NON-NATIVE INVASIVE SPECIES AND CUTTING, NOT TO STOP THE NATURAL SUCCESSION. IF SO, COUNCIL NEEDS TO CLARIFY THAT.]

c. *[QUESTION FOR COUNCIL. This was in Zone 1 but not included here, perhaps because there may be none in this zone? SHOULD COUNCIL INCLUDE "Encourage restoration of wetlands" ADDING "where they previously occurred"?*

Transition Zone:

a. Transition zone (sub-units A and C):

   i. Site-specific strategies

   ii. Depth: 10ft–40ft with consideration of erosion issues

b. Transition zone in sub-unit B is optional, but should permit educational nature trails.

Rationale

It is likely that the Protected Land within this unit will remain fairly stable with some continued accretion over the next 40 years, though this is dependent on rates of sand deposition, erosion, and sea-level rise, as well as the impacts of hurricanes. Continued accretion will result in an increase in maritime forest cover relative to the other communities occurring within the unit. The passive approach to management of this unit precludes the use of land cover targets. Vegetation communities should be left alone to evolve with time and the changing shoreline.

The most dramatic changes that are likely to occur within this unit will be within the early successional maritime forest. The maritime forest that exists on the inland portion of the unit is fairly young. However, change will be slow, measured in tens if not hundreds of years.

Planning Unit #4 - East

Location
Unit #4 - East extends from the beach path extension of Station 22½ to the beach path extension of Station 29.

Preferred strategy

a. Maintain existing hardwoods [NEED TO LIST PRIORITY TREES]

b. Convert manipulated shrubland to maritime grasslands with islands/hammocks of maritime shrubs, with natural succession permitted within islands

c. Strengthen dunes when clearing shrubs

d. Active management to reduce pests

Transition zone

1. Depth:
    a. Stations 22 ½ - 26: Maximum of 50 feet or up to the most landward dune, whichever is less.
    b. Stations 26-29: 40 to 100 feet
2. Management strategy (Same as Unit 1):
    a. Remove all species except desired overstory species
    b. [QUESTION FOR COUNCIL: Flip chart notes said "same as Unit 1", but Unit 1 plan was developed before second site visits which led to recommendation of plans for transition zones in Units 2 and 3. Should Council revisit transition zone for Unit 4?]

Rationale

[Same as Unit 2] The unit should consist of maritime grassland punctuated by scattered maritime shrubland islands. Approximately 50 percent of the total land cover within this unit should be composed of maritime shrubland community, surrounded by a natural mix of maritime foredune and maritime backdune grasslands. The proportion of shrubland to grassland should increase with distance from the sea and with proximity to the Fort Moultrie and School units. Shrubland islands may vary in size and shape from single shrubs/trees to ¼ acre contiguous hammocks of random shape and may be designed such that views of the ocean are maintained from inland observation points. Ocean views may be increased by placing shrubland islands within low dune swales. Over time, larger shrubland islands may begin to develop vegetation community characteristics similar to maritime forest. This development will result in greater habitat diversity and dispersion and should not be discouraged. Naturally occurring examples of this mix of vegetation communities can be found on neighboring Dewees Island, Capers Island, and Bulls Island.

As discussed in Section 5.6 of the consultants' report, it is likely that land within this unit will continue to accrete over the next 40 years, though this is dependent on rates of sand deposition, erosion, and sea-level rise, as well as the impacts of hurricanes. Continued accretion will result in seaward expansion of vegetation. Existing maritime hardwood depression communities within the unit should be preserved to maximize habitat diversity.

APPENDIX A: PRINCIPLES FOR MANAGEMENT OF THE TOWN'S ACCRETED LAND

Approved by Council on December 15, 2009

1. The Town of Sullivan's Island owns the accreted land that is protected by the deed restrictions with the Lowcountry Open Land Trust. Every Town resident and property owner has a stake in the property, regardless of the location of that individual's residence or property.

2. The accreted land is protected for its aesthetic, scientific, educational, and ecological and safety value for all residents, as noted in the deed restrictions placed on this land with the Lowcountry Open Land Trust and within the Town of Sullivan's Island Codes and Ordinances. It must be recognized that this land was placed in trust for the benefit of all Sullivan's Island residents.

3. As its owner, the Town has responsibilities to be a *good steward* of the land and a *good neighbor* to the owners of properties that abut its land. The Management Plan must benefit the long term maritime eco-system and its impact on wildlife and vegetation. The Town also recognizes that scenic views and breezes inside and outside the accreted land are valuable natural resources.

4. Steward responsibilities

a. As its owner, the Town has responsibility for management of the land.

i. Responsibility for designing and implementing a management plan rests with the Town.

ii. Management plans should be based on their impact on the land as an environmental, educational and recreational resource.

iii. The Management Plan must recognize this land is part of a bio-diverse ecological process and must consider the natural succession of vegetation in this setting. Additionally, the accreted land provides a line of defense over which hazards of storm waves can be diminished and therefore provides an important shore protection function.

iv. Responsibility for funding the management of the land rests with the Town and management decisions must be independent of the sources of funding.

b. Management or modification of the accreted land should be at the sole direction and discretion of the Town after soliciting input from all Town citizens and property owners and appropriately credentialed experts in relevant fields.

c. Since there is much diversity in the accreted land from one area to another which can change over time, defined zones or management units should be identified based upon their characteristics, and a long-term plan developed for each of them. As an example, the land from Station 16 westward and in front of Fort Moultrie, and that in front of the Town owned school property, should be allowed to evolve naturally, with minimal intervention except for purposes of public safety, education, and control of invasive species.

d. Current laws governing the accreted land should remain in effect until the Town has adopted, funded, and begun implementation of the management plan to a substantial extent.

5. Neighbor responsibilities

a. The Town should do what it can to respect the neighbors to the accreted land while meeting its stewardship responsibilities.

b. The Town's management plan may include a transition or edge band that abuts privately held properties that would be managed differently from, and more aggressively than, the (usually much deeper) seaward balance of the accreted land.

i. The transition/edge band should be managed to further the following objectives when appropriate:

1. Provision of a buffer from unwanted wildlife
2. Minimization of potential fire hazard
3. Enhancement of public safety
4. Enhancement of breezes
5. Enhancement of possible sight lines to the property seaward of the band

ii. Achievement of these objectives in the transition/edge band will be accomplished via different means depending on the characteristics of the accreted land including and seaward of the band. As examples:

1. Where the band has characteristics of a developing maritime forest, the undergrowth might be cleared and smaller bushes and trees that compete with more significant trees might be removed.
2. Where the seaward property is primarily myrtle fields, or currently cleared within the Town's ordinances, or partially cleared spaces, the band may be cleared or cut to provide an open field habitat, possibly with seeding of other grasses and/or wildflowers, with periodic mowing under the guidance of a landscape professional.
3. Trees that are vanguard members of a maritime forest should be spared. Trees may be pruned when it is to benefit the health of the tree.
4. Non-native, invasive species of vines, bushes, shrubs or trees should be removed.

c. Public beach paths should be maintained based on the nature of the land they traverse, whether they are used for emergency access vehicles, and existing characteristics of the paths.

APPENDIX B: PLANNING UNITS MAP

APPENDIX C: PLANT SPECIES

Plant Species as observed by the Coastal Science & Engineering project team in the Protected Land study area (summer 2008)
(Appendix 8 in Coastal Science & Engineering Accreted Land Management Plan Final Consultant Plan dated July 2010)

Maritime Foredune Grassland

Shrub	Marsh-elder	*Iva frutescens*
Herbaceous	Sea-oats	*Uniola paniculata*
	Saltgrass	*Distchilis spicata*
	Camphorweed	*Heterotheca subaxillaris*
	Blackberry	*Rubus* sp.
	Sea side panicum	*Panicum amarum*
	Beach pea	*Strophostyles helvola*
	Fiddle-leaf morning-glory	*Ipomoea stolonifera*
	Dune sandbur	*Cenchrus tribuloides*
	Yucca	*Yucca* sp.
	Croton	*Croton glandulosus*
	Fire-wheel	*Gaillardia pulchella*
	Beach evening-primrose	*Onethera drummondii*
	Salt meadow saltgrass	*Spartina patens*

Maritime Backdune Grassland

Shrub	Earleaf green-brier	*Smilax auriculata*
	Saw green-brier	*Smilax bona-nox*
	Peppervine	*Ampelopsis arborea*
Herbaceous	Peppervine	*Ampelopsis arborea*
	Devil-joint	*Opuntia pusilla*
	Sea-oats	*Uniola paniculata*
	Camphorweed	*Heterotheca subaxillaris*
	Blackberry	*Rubus* sp.
	Seaside panicum	*Panicum amarum*
	Beach pea	*Strophostyles helvola*
	Seaside pennywort	*Hydrocotyle bonariensis*
	Dunes evening-primrose	*Onethera humifusa*
	Fire-wheel	*Gaillardia pulchella*
	Rumex	*Rumex* sp.
	Bushy bluestem	*Andropogon glomeratus*
	Earleaf green-brier	*Smilax auriculata*
	Virginia creeper	*Parthenocissus quinquefolia*
	Dogfennel	*Eupatorium capillifolium*
	Spiderwort	*Tradescantia virginiana*
	Poison ivy	*Rhus radicans*
	Indian-fig	*Opuntia ficus-indica*
	Croton	*Croton punctatus*

Manipulated Maritime Backdune Grassland

Shrub	Earleaf green-brier	*Smilax auriculata*
	Saw green-brier	*Smilax bona-nox*
	Peppervine	*Ampelopsis arborea*
	American wisteria	*Wisteria frutescens*
	Rattlebush	*Daubentonia punicea*
	Yucca	*Yucca* sp.
	Devil-joint	*Opuntia pusilla*
Herbaceous	Blackberry	*Rubus sp.*
	Earleaf green-brier	*Smilax auriculata*
	Saw green-brier	*Smilax bona-nox*
	Camphorweed	*Heterotheca subaxillaris*
	Fire-wheel	*Gaillardia pulchella*
	Spiderwort	*Tradescantia virginiana*
	Sea-oats	*Uniola paniculata*
	Peppervine	*Ampelopsis arborea*
	Devil-joint	*Opuntia pusilla*
	Rough buttonweed	*Diodea teres*
	Eastern plantain	*Plantago lanceolata*
	Saltgrass	*Distichlis spicata*
	Croton	*Croton punctatus*
	Seaside panicum	*Panicum amururan*
	Beach evening-primrose	*Onethera drummondii*

Lawns and Pathways

Herbaceous	Frog-fruits	*Phyla nodiflora*
	Beach evening-primrose	*Onethera drummondii*
	Rabbit-tobacco	*Graphalium* sp.
	Crabgrass	*Digitaria* sp.
	Rough buttonweed	*Diodea teres*
	Toadflax	*Linaria canadensis*
	Common ragweed	*Ambrosia artemisifolia*
	Bahia grass	*Paspalum notatum*
	Seaside pennywort	*Hydrocotyle bonariensis*
	Hoary plantain	*Plantago virginica*
	Flatsedge	*Cyperus* sp.
	Aloe	*Aloe vera*
	Rabbit-tobacco	*Graphalium* sp.

Maritime Interdunal Wetland

Shrub	Wax myrtle	*Morella cerifera*
	Groundsel tree	*Baccharis halmilifolia*
Herbaceous	Love grass	*Fimbristylis caroliniana*
	Frog-fruits	*Phyla nodiflora*
	Seaside pennywort	*Hydrocotyle bonariensis*
	Umbrella sedge	*Cyperus filicinus*
	Fingergrass	*Eustachys petraea*
	Common cattail	*Typha angustifolia*
	Saltmarsh bulrush	*Scirpus robustus*
	Saltgrass	*Distchlis spicata*
	Bushy bluestem	*Andropogon glomeratus*
	Arrow-leaf morning glory	*Ipomea saggittata*
	Aster	*Aster sp.*
	Soft rush	*Juncus effusus*
	Smartweed	*Polygonum* sp.
	Flatsedge	*Cyperus* sp.

Maritime Shrubland

Overstory	Wax myrtle	*Morella cerifera*
	Sugarberry	*Celtis laevigata*
	Chinese privet	*Ligustrum sinense*
	Chinese tallow	*Sapium sebiferum*
	Southern red cedar	*Juniperus silicicola*
	Carolina laurel cherry	*Prunus caroliniana*
	Red bay	*Persea borbonia*
	Hercules club	*Aralia spinosa*
	Shrub Wax myrtle	*Morella cerifera*
	Virginia creeper	*Parthenocissus quinquefolia*
	Peppervine	*Ampelopsis arborea*
	Poison ivy	*Rhus radicans*
	Alabama supple-jack	*Berchemia scandens*
	Arrow-leaf morning glory	*Ipomea saggittata*
	Groundsel tree	*Baccharis halimifolia*
	Sugarberry	*Celtis laevigata*
	Rattlebush	*Daubentonia punicea*
	Chinese tallow	*Sapium sebiferum*
	Southern red cedar	*Juniperus silicicola*
	Carolina laurel cherry	*Prunus caroliniana*
Herbaceous	Virginia creeper	*Parthenocissus quinquefolia*
	Blackberry	*Rubus sp.*
	Peppervine	*Ampelopsis arborea*
	Poison ivy	*Rhus radicans*
	Smartweed	*Polygonum sp.*

	Passion-flower	*Passiflora incarnata*
	Yucca	*Yucca sp.*
	Spiderwort	*Tradescantia virginiana*
	Seaside pennywort	*Hydrocotyle bonariensis*
	Saw green brier	*Smilax bona-nox*
	Fire-wheel	*Gaillardia pulchella*
	Beach evening-primrose	*Onethera drummondii*
	Common ragweed	*Ambrosia artemisifolia*

Manipulated Maritime Shrubland

Shrub	Groundsel tree	*Baccharis halmilifolia*
	Wax myrtle	*Morella cerifera*
	Chinese tallow	*Sapium sebiferum*
	Dog fennel	*Eupatorium capillifolium*
	Seashore mallow	*Kostelezkya virginica*
	Alabama supple-jack	*Berchemia scandens*
	Peppervine	*Ampelopsis arborea*
	Virginia creeper	*Parthenocissus quinquefolia*
	Poison ivy	*Rhus radicans*
	Blackberry	*Rubus sp.*
	Rattlebush	*Daubentonia punicea*
	Saw green-brier	*Smilax bona-nox*
	Passion-flower	*Passiflora incarnata*
	Earleaf greenbrier	*Smilax auriculata*
	Devil-joint	*Opuntia pusilla*
Herbaceous	American beauty berry	*Callicarpa americana*
	Virginia creeper	*Parthenocissus quinquefolia*
	Peppervine	*Ampelopsis arborea*
	Wood-sage	*Teucrium canadense*
	Poison ivy	*Rhus radicans*
	Alabama supple-jack	*Berchemia scandens*
	Dye bedstraw	*Galium tinctorium*
	Wood-sorrell	*Oxalis* sp.
	Smartweed	*Polygonum* sp.
	Blackberry	*Rubus* sp.
	Wild potato-vine	*Ipoemea pandurata*
	Hedge bindweed	*Calystegia sepium*
	Whitetop sedge	*Dichromena latifolia*
	Seashore mallow	*Kostelezkya virginica*
	Dogfennel	*Eupatorium capillifolium*
	Croton	*Croton punctatus*
	Camphorweed	*Heterotheca subaxillaris*
	Passion-flower	*Passiflora incarnata*
	Spiderwort	*Tradescantia virginiana*

Early Successional Maritime Forest

Overstory	Sugarberry	*Celtis laevigata*
	Wax mytrle	*Morella cerifera*
	Carolina laurel cherry	*Prunus caroliniana*
	Herculeus club	*Aralia spinosa*
	Pecan	*Carya illinoensis*
	Southern red cedar	*Juniperus silicicola*
Shrub	Wax myrtle	*Morella cerifera*
	Yaupon holly	*Ilex vomitoria*
	Carolina laurel cherry	*Prunus caroliniana*
	Southern red cedar	*Juniperus silicicola*
	Virginia creeper	*Parthenocissus quinquefolia*
	Poison ivy	*Rhus radicans*
	Japanese honeysuckle	*Lonicera japonica*
	Saw greenbrier	*Smilax bona-nox*
	Peppervine	*Ampelopsis arborea*
	Blackberry	*Rubus* sp.
	Earleaf greenbrier	*Smilax auriculata*
	Chinese privet	*Ligustrum sinense*
	Carolina willow	*Salix caroliniana*
Herbaceous	*Peppervine*	*Ampelopsis arborea*
	Poison ivy	*Rhus radicans*
	Spiderwort	*Tradescantia virginiana*
	Seaside pennywort	*Hydrocotyle bonariensis*
	Dogfennel	*Eupatorium capillifolium*
	Groundsel tree	*Baccharis halimifolia*
	Creeping cucumber	*Melothria pendula*
	Smartweed	*Polygonum* sp.
	Fireweed	*Erechtites hieracifolia*

Maritime Hardwood Depression

Overstory	Pecan	*Carya illinoensis*
	Sugarberry	*Celtis laevigata*
	Red mulberry	*Morus rubra*
	Wax myrtle	*Morella cerifera*
	Carolina willow	*Salix caroliniana*
	Chinese tallow	*Sapium sebiferum*
	Live oak	*Quercus virginiana*
	Cabbage palmetto	*Sabal palmetto*

Shrub

Wax myrtle	*Morella cerifera*
Yaupon holly	*Ilex vomitoria*
Carolina laurel cherry	*Prunus caroliniana*
Oak	*Quercus sp.*
Pecan	*Carya illinoensis*
Roundleaf green-brier	*Smilax rotundifolia*
Saw green-brier	*Smilax bona-nox*
Sugarberry	*Celtis laevigata*
Groundsel tree	*Baccharis halmifolia*
Chinese tallow	*Sapium sebiferum*
Red mulberry	*Morus rubra*
American beauty berry	*Callicarpa americana*
Peppervine	*Ampelopsis arborea*
Hedge bindweed	*Calystegia sepium*
Southern red cedar	*Juniperus silicicola*
Rattlebush	*Daubentonia punicea*
Virginia creeper	*Parthenocissus quinquefolia*
Dogfennel	*Eupatorium capillifolium*
Chinese privet	*Ligustrum sinense*
American wisteria	*Wisteria frutescens*
Seashore mallow	*Kostelezkya virginica*

Herbaceous

Sugarberry	*Celtis laevigata*
Carolina laurel cherry	*Prunus caroliniana*
Roundleaf green-brier	*Smilax rotundifolia*
Virginia creeper	*Parthenocissus quinquefolia*
Blackberry	*Rubus* sp.
Poison ivy	*Rhus radicans*
Spiderwort	*Tradescantia virginiana*
Hedge bindweed	*Calystegia sepium*
Seaside pennywort	*Hydrocotyle bonariensis*
Fireweed	*Erechtites hieracifolia*
Vetch	*Vicia* sp.
Golden rod	*Solidago* sp.
St. John's wort	*Triadenum* sp.
Creeping cucumber	*Melothria pendula*
Arrow-leaf morning-glory	*Ipomea sagittata*
Japanese honeysuckle	*Lonicera japonica*
Passion-flower	*Passiflora incarnata*
Smartweed	*Polygonum* sp.

APPENDIX D: BIRD SPECIES

Bird species as observed in the AL study area between May and October 2008 by Sabine & Waters and Jeff Mollenhauer (Audubon South Carolina)

(Appendix 9 in Coastal Science & Engineering Accreted Land Management Plan Final Consultant Plan dated July 2010)

Beach	Manipulated Areas	Maritime Forest	Dune Grassland
Black Tern	American Redstart	American Redstart	Blue Jay
Brown Pelican	Barn Swallow	Barn Swallow	Blue-gray Gnatcatcher
Caspian Tern	Blue Jay	Blue Jay	Boat-tailed Grackle
Forster's Tern	Boat-tailed Grackle	Blue-gray Gnatcatcher	Bololink
Great Black-Backed Gull	Brown Thrasher	Boat-tailed Grackle	Chimney Swift
Green Heron	Brown-headed Cowbird	Brown Pelican	Common Grackle
Herring Gull	Carolina Wren	Brown Thrasher	Common Ground-Dove
House Sparrow	Chimney Swift	Brown-headed Cowbird	Common Yellow-throat
Laughing Gull	Common Ground-Dove	Carolina Wren	Eurasian Collared Dove
Least Tern	Common Yellow-throat	Chimney Swift	House Finch
Merlin	Copper's Hawk	Common Ground-Dove	Laughing Gull
Osprey	Eurasian Collared Dove	Common Yellow-throat	Mourning Dove
Purple Martin	European Starling	Crow spp.	Northern Cardinal
Red Knot	Gray Catbird	Double-crested Cormorant	Prairie Warbler
Ring-billed Gull	Great-crested Flycatcher	Downy Woodpecker	Red-belllied Woodpecker
Royal Tern	House Finch	Eurasian Collared Dove	Royal Tern
Ruddy Turnstone	Laughing Gull	European Starling	
Sanderling	Mourning Dove	Gray Catbird	
Sandwich Tern	Northern Cardinal	Great-crested Flycatcher	
Semipalmated Sandpiper	Northern Mockingbird	Green Heron	
Willet	Northern Parula	House Finch	
Wilson's Plover	Painted Bunting	Laughing Gull	
	Rock Dove	Merlin	
	Royal Tern	Mourning Dove	
	Yellow-billed Cuckoo	Northern Cardinal	
		Northern Flicker	
		Northern Mockingbird	
		Orchard Oriole	
		Osprey	
		Painted Bunting	
		Prairie Warbler	
		Purple Martin	
		Red-eyed Vireo	
		Royal Tern	
		Short-billed Dowitcher	
		White-eyed Vireo	
		Yellow-billed Cuckoo	

APPENDIX E: INVASIVE SPECIES

(Appendix 5 from Coastal Science & Engineering Accreted Land Management Plan Final Consultant Plan dated July 2010)

Chinese Tallow Tree

Chinese tallow tree or popcorn tree (*Sapium sebiferum*) was introduced in the late 1700s for vegetable tallow production from the waxy seed coating, possibly as an alternative to expensive whale blubber for lamp fuel and candle tallow. In the early 1900s, extensive plantations were established along the Gulf coastal plain in support of a soap-making industry based on the vegetable tallow derived from the tallow tree. The kernels also produce a drying oil, Stillingia oil, which can be used in machine oils, lighting fuels, and varnishes and paints. The oil is considered poisonous and has been proven toxic to cattle. The tree produces heavy seed crops, and oil in the seed averages 20 percent by weight. The species later became popular for its brilliant fall foliage and quick shade, and was planted extensively across the Gulf coastal plain in suburban housing developments (Louisiana Invasive Plant Species: *Tridica sebifera*: (L.) Small).

Observed in the AL area, associated with maritime forest and Carolina willow woodland.

Management

Mechanical Control: Cutting of horizontal shoots result in the immediate production of small independent plants, making this method impractical unless combined with herbicide use (see below). Fire can hold the tallow at bay when tree density is low, but since tallow can suppress fuel species, fire can burn up to a stand but then go out from lack of fuel, leaving the tallow relatively unharmed. Fire control is still under research.

Biological Control: The plant apparently lacks serious biocontrols or pathogens in the United States, although a bagworm (*Eumeta* sp) from Japan appears to be a pest.

Chemical Control: Attempts at managing Chinese tallow suggest that herbicidal methods are the most effective option for control at this time. Basal bark applications are made by applying herbicide directly to the bark around the circumference of the tree from ground level up to 15 inches above the ground. Hand-held equipment (paint brush) or backpack sprayer is usually used for this application. For trees that have stems less than 6 inches in basal diameter, apply up to a 5 percent triclopyr (Garlon 4) solution mixed with spray adjuvant oil. Trees exceeding 6 inches in basal diameter can be successfully controlled with a 15-20 percent triclopyr/oil solution. Old or rough bark requires more spray than smooth young bark (Jubinsky 2002).

To control resprouting of freshly cut stumps, a 20 percent solution of triclopyr will provide control. Spray the root collar area, sides of the stump, and the outer portion of the cut surface including the cambium until thoroughly wet. No more than one-half hour should elapse between cutting and applying herbicide (Jubinsky 2002). The best time to initiate herbicidal control measures on Chinese tallow is during the spring months. During this time, either the cut stump or basal bark treatment is effective. During a normal weather year, trees begin producing seed in late August or early September. Use of the cut stump treatment during periods of the year when seeds are present is not recommended. During autumn months, restrict control measures to the basil bark method only (Jubinsky 2002).

Cattails

Cattails (*Typha latifolia*) are prolific plants that play an important role as a source of food and shelter for different marsh-dwelling animals. They can be found in damp soil or shallow water where sufficient nutrients are available. However, they can quickly dominate a wetland plant community. A 50:50 ratio of open water and vegetation is a frequent objective when managing cattail marshes in North America (Fredrickson and Reid 1987).

Observed in the AL area, associated with interdunal wetlands.

Management

Mechanical Control: The control of cattails by the manipulation of water level must be timed to the annual cycle of carbohydrate storage. Special leaf and stem cells called aerenchyma provide air passage from both living and dead leaves to the rhizomes. Removing dead leaves and submerging the shoots in early spring will strain the plant and eventually kill it. The depth of water necessary to kill the plants depends on temperature, the quantity of starch the plant stored the previous year, and the general vigor of the plants. Therefore, no minimum water depth can be prescribed, but generally, a water level maintained at 3-4 feet above the tops of existing spring shoots will retard growth. The use of water is most efficient if the water level is raised progressively, so that all plant parts remain submerged by no less than a few inches (Fredrickson and Reid 1987).

Cutting, crushing, shearing, and disking during the growing season can be used to impede starch storage. These treatments are effective if performed during a three-week window from one week before to one week after the pistillate spike is lime green and the staminate spike is dark green. However, the treatments are most effective during the 3-4 days when the spikes are so colored (Fredrickson and Reid 1987).

Deep disking can retard shoot formation and can damage the rhizomes, but the effect on plant survival is variable. The overall effect on the entire stand is minimal if water conditions are favorable for cattail survival. Control of water levels and of recruitment from the seed bank is necessary to prevent reestablishment of the cattails. Deep disking combined with continued drying and freezing in fall decreases plant survival. If the wetland can be kept sufficiently dry to repetitively disk in any two to three successive seasons, cattails can be eliminated or their stem densities severely reduced (Fredrickson and Reid 1987).

When the plants are dormant, cutting, crushing, shearing, or disking is extremely effective for severing the aerenchyma link between the rhizomes and the leaves. To reduce plant survival, however, these techniques must be combined with high water levels in spring to induce stress from anaerobic starch conversion (Fredrickson and Reid 1987).

Burning cattails is difficult during the growing season, except during extreme low-water conditions. Dry residual cattail litter provides enough fuel to carry a fire through growing plants. The fire usually does not kill the plants but can reduce starch storage. Fires in cattail marshes rarely are hot enough at ground level for heat penetration to impede rhizome function or shoot viability (Fredrickson and Reid 1987).

Most cattail marshes must be burned in winter or before significant growth has occurred in spring when fuels are dry enough to carry a fire. However, frozen or saturated soils can hamper the progress of the fire through cattail duff. When combined with high water levels in spring to smother the residual stalks, fire can be used to control cattails (Fredrickson and Reid 1987).

In wetlands with well-developed peat soils, fires during drought conditions can destroy the entire cattail plant including the rhizomes. Such fires actually burn the peat, and the ability to smother the fire by reflooding the marsh must exist before prescribing such fires. Peat fires can also eliminate the existing seed bank and, if sufficiently severe, lower the relative bottom of a marsh. Local concern with the effects of peat fires on air quality can be substantial (Fredrickson and Reid 1987).

Biological Control: There is currently no good choice to achieve biological control of cattails. Grass carp are often mentioned as a potential control method, but in reality, they prefer not to eat cattails (Lynch 2002).
Chemical Control: Herbicides, especially glyphosate, interrupt metabolic pathways and have been used successfully to kill cattails. Herbicides that are translocated to the rhizomes are most effective for cattail control. Application in mid to late summer when carbohydrates are stored enhances the effectiveness of translocated herbicides. Therefore, herbicides have little effect on seed production during the year of application. As with other techniques, the duration of the effect of herbicides depends on subsequent water-level control and recruitment from the seed bank (Fredrickson and Reid 1987).

Sesbania

Sesbania (*Sesbania exaltata*) is an erect annual herb of the legume family, which typically grows to a height of 3–10 ft. Sesbania prefers wet, highly disturbed habitats and sandy sites. It occurs in low sandy fields, sandbars of streams, alluvial ground along sloughs and borders of oxbow lakes, and along roadsides, railroads, in disturbed urban sites and agricultural areas. It may become a troublesome exotic species in wetland communities that are managed for waterfowl (Vegetation Management Guideline Sesbania 2001)

Observed in the AL area.

Management

Control of sesbania is best accomplished by creating conditions favorable for the germination of beneficial plants early in the growing season. Once established, beneficial plants can outcompete newly germinated sesbania. Therefore, control strategies should be performed early in the growing season. If early control is not possible, late disk-flood often prevents reestablishment of sesbania and creates conditions favorable for fall migrating shorebirds. This can be followed by an early drawdown during the subsequent growing season (Vegetation Management Guideline Sesbania 2001).

Mechanical Control: Spot treatment can best be accomplished by removal of the stems prior to the production of fruits. Follow-up will probably be necessary for several additional growing seasons if a seed bank is present or if reinfestation occurs (Vegetation Management Guideline Sesbania 2001).

Mowing should occur prior to seed set if possible. Mow as high as possible to preserve and promote growth of desirable plants in the understory. Burning appears to stimulate germination. Biological Control: An isolate of the fungal pathogen *Colletotrichum truncatum* was discovered on the Southern Weed Science Laboratory Experimental Research Farm and has been evaluated over the past several years for use as a bioherbicide against this weed. Various invert and vegetable oil emulsion formulations developed in this laboratory eliminated or greatly reduced free moisture requirements, and have consistently provided 85–95 percent control of weeds in field trials (Boyette et al 2003).

Chemical Control: Various herbicides have proved to be effective in controlling sesbania. One such method includes spraying 2,4-D with a boom sprayer at the rate of three/quarter pint per acre. The plants can also be wicked with Roundup or Rodeo (Vegetation Management Guideline Sesbania 2001).

Another chemical that has had success is propanil or Stam. The Stam 3+3 method (Stam is used twice at three quarts per acre) seems to work best. Blazer is another herbicide that works well against sesbania. Grandstand is a good, low-cost broad-leaf herbicide. It works best tank-mixed with about a quart of Stam (Kendig 2003).

Two herbicides registered for use will help manage broadleaf weeds and sedges. Research indicates that Permit has the potential to injure rice when applied pre-emergence. Therefore, Permit applications should be limited to postemergence. The control of sesbania taller than 8 inches or after permanent flood has been inconsistent. (Williams et al 2001).

Regiment belongs to the sulfonylurea herbicide family, which includes Londax. Regiment is slow-acting and usually takes two to three weeks to kill weeds. However, Regiment stops weed growth within a few hours of application. Because of injury potential, Regiment application to rice before the three-leaf stage is not recommended. Another strength is its ability to control alligator weed when tank-mixed with Aim (Williams et al 2001).

Chinese Privet

Chinese Privet (*Ligustrum sinense*) was introduced from China in the 1800s. It is a semi-evergreen shrub growing to 30 ft in height. Leaves are opposite in two rows and at right angles to the stem. Panicles of white flowers open from April through June followed by ovoid drupes formed as pale green and ripening to dark purple, almost black in late fall. The trunks of these shrubs usually branch near the ground and have a smooth gray appearance. Privet is shade-tolerant and forms dense thickets in bottomlands and along boundary lines. Reproduction is by root sprouts as well as seed which are spread abundantly by birds and other animals. Very few plants can grow under the dense vegetation of these shrubs (Cook 2005).
Observed in the AL area, associated with the maritime forest.

Management

The most important aspect of controlling privet is managing sprouting that often occurs subsequent to initial control. Control methods that remove or damage aboveground stems, such as mechanical cutting or prescribed burning, will likely cause sprouting. Subsequent monitoring and repeated treatments may be necessary to eliminate sprouting stems.

Mechanical Control: Seedlings can be removed by hand-pulling. When hand-pulling seedlings, the entire root system must be extracted to prevent sprouting. Established seedlings become increasingly difficult to hand-pull because of a strong root system. Mowing or cutting can reduce the spread of privet by preventing seed production. Repeated cutting may eventually eradicate privet. Cutting close to ground level and applying herbicides to the cut stumps may control larger stems (see below). Cutting stems without accompanying herbicide treatment will likely promote growth from sprouting. Even with repeated follow-up cutting, mechanical control alone may be difficult. Effectiveness of prescribed fire to control privet may vary. Fire can kill aboveground portions of Chinese privet. Due to the ability of privet to sprout following damage from fire, persistent annual burning will likely be required for local eradication (Miller 2005).

Biological Control: There are currently no biological controls for Chinese privet.

Chemical Control: Painting cut stumps with herbicides can often effectively control invasive privet. Areas where this method may be particularly desirable include sparse infestations of large stems, places where stems are concentrated, such as fence lines, or habitats where the presence of desirable native species precludes foliar application. Foliar spraying can also be effective, particularly for dense populations. Apply a glyphosate herbicide solution or Arsenal AC solution in water with a surfactant to thoroughly wet all leaves in August to December. For stems too tall for foliar sprays, apply Garlon 4 as a solution in commercially available basal oil, diesel fuel, or kerosene with a penetrant (check with herbicide distributor) to young bark as a basal spray. Alternatively, cut large stems and immediately treat stumps with Arsenal AC, or Velpar L as solutions in water with a surfactant. When safety to surrounding vegetation is a concern, immediately treat stumps and cut stems with a glyphosate herbicide or Garlon 3A as solutions in water with a surfactant (Miller 2005).

Autumn Olive

Autumn olive (*Eleagnus umbellata*) was introduced from China and Japan in 1830 and was widely planted for wildlife habitat improvement. This deciduous bush grows up to 20 ft in height, has silver undersides and produces red berries in the fall. Autumn olive prefers dryer sites and is a shade-tolerant species which forms dense stands that grow at the expense of other species (Miller 2004*).*

Observed in the AL area, adjacent to residences.

Management

The most effective control against autumn olive is early detection and detection by annually monitoring for small plants and hand-pulling to prevent seed production. Cutting and burning stimulate sprouting. Repeated

cutting over several consecutive years will reduce plant vigor and may prevent spread. The combination of cutting and the use of herbicide are the most effect means of control.

Mechanical Control: Seedlings and small plants should be hand-pulled when the soil is moist. Be sure to remove the entire plant including the roots since new plants can sprout from the root fragments. It is difficult to pull the entire root system. Larger plants should be cut off from the main stem and treated with herbicide.

Biological Control: Currently, there are no known biological control methods (Rhoads and Block 2002).

Chemical Control: Apply Arsenal AC or Vanquish as solutions in water with a surfactant to thoroughly wet all leaves in April to October (can damage trees with roots in area). For stems too tall for foliar sprays, apply a solution of Garlon 4 in commercially available basal oil, diesel fuel, or kerosene with a penetrant (check with herbicide distributor) to young bark completely around the trunk up to 16 inches above the ground. Or, cut large stems and immediately treat stumps with a solution of a glyphosate herbicide (safe to surrounding trees) or Arsenal AC or Chopper (both will damage trees with roots in treated zone) in water with a surfactant (Miller 2002).

Multiflora Rose

Multiflora rose (*Rosa multiflora*) was introduced from Asia and planted as an ornamental, as living fences for livestock containment, and for wildlife habitat. Multiflora rose is a deciduous climbing, arching, and or trailing shrub that grows 10 ft tall. Distinguishing features are the clustered white flowers with yellow anthers, pinnately compound leaves, sharp thorns and red rose hips in the fall. This species spreads by root stems, sprouts, and seed dispersal by animals. Thickets of multiflora rose forms small and large infestations which often climb trees, exclude other desired plants, and hinder site management (Miller 2004).

Management

Young plants may be pulled by hand. Mature plants can be controlled through frequent, repeated cutting or mowing. Several contact and systemic herbicides are also effective in controlling multiflora rose. Follow-up treatments are likely to be needed. Two naturally occurring biological controls affect multiflora rose to some extent: a native fungal pathogen (rose-rosette disease) that is spread by a tiny native mite and a non-native seed-infesting wasp, the European rose chalcid. Native alternatives to Multiflora rose include common blackberry (*Rubus allegheniensis*), swamp rose (*Rosa palustris*), flowering raspberry (*Rubus odoratus*), and pasture rose (*Rosa carolina*) (USFWS 2004).

Mechanical Control: Mechanical and chemical methods are currently the most widely used methods for managing multiflora rose. Frequent, repeated cutting or mowing at the rate of three to six times a year per growing season for two to four years has proven effective at achieving mortality of multiflora rose. In high-quantity natural communities, cutting of individual stems plants is preferred to mowing to minimize site disturbance.

Biological Control: Biological control is not yet available for the management of multiflora rose. However, researchers are investigating several options, including a native viral pathogen (rose-rosette disease), which is spread by a very tiny mite and a seed-infesting wasp, the European rose chalcid. An important drawback to the roserosette fungus and the European rose chalcid is their potential impact to other rose species and cultivators.

Chemical Control: Various herbicides have been used successfully in controlling multiflora rose but, because of the long-lived stores of seeds in the soil, follow-up treatments are usually necessary. Application of systemic herbicides (eg – glyphospate) to freshly cut stumps may be the most effective methods, especially if conducted late in the growing season. Plant growth regulators may be used to control the spread of multiflora rose by preventing fruit set (Bergman 2007).

Japanese Honeysuckle

Japanese honeysuckle (*Lonicera japonica*) was introduced from Japan in the 1800s and planted as an ornamental and a deer browse. It is the most commonly occurring invasive plant in the southeastern United States. Japanese honeysuckle is a semievergreen woody vine with opposite branches and leaves. It is a high climbing vine that can trail up to 80 ft. The fragrant, stalked flowers are in bloom from April to August. Fruits and seeds are produced from June to March in the form of nearly spherical green berries, which turn black as they ripen (Miller 2005).

Observed in the AL area, associated with the maritime forest, Carolina willow woodland, and max-myrtle saturated shrubland.

Management

Japanese honeysuckle produces long vegetative runners that develop roots where stem and leaf junctions come in contact with moist soil. Underground stems help establish and spread the plant locally. Long-distance dispersal is by birds and other wildlife that readily consume the fruits. Several effective methods of control are available for Japanese honeysuckle, including chemical and nonchemical, depending on the extent of the infestation and available time and labor.

Mechanical Control: Repeated pulling of the entire vine and root system may be effective for small patches. Monitor frequently and remove any new plants. Cut and remove any twining vines to prevent them from girdling and killing shrubs and other plants. Mowing large patches may be useful if repeated regularly but is most effective when combined with herbicide application. Mow at twice a year, first in mid-July and again in mid-September. Burning removes aboveground vegetation but does not kill the underground rhizomes, which will continue to sprout.

Biological Control: No biological control agents are currently available for Japanese honeysuckle.

Chemical Control: In moderate cold climates, Japanese honeysuckle leaves continue to photosynthesize long after most other plants have lost their leaves. This allows for application of herbicides when many native

species are dormant. However, for effective control with herbicides, healthy green leaves must be present at application time and temperatures must be sufficient for plant activity. Several systemic herbicides (eg – glyphosate and triclopyr) move through the plant to the roots when applied to the leaves or stems and have been used effectively on Japanese honeysuckle. Follow the label guidelines (Bravo 2006).

Kudzu

Kudzu (*Pueraria montana*) was introduced into the United States in 1876 at the Philadelphia Centennial Exposition, where it was promoted as a forage crop and an ornamental plant. It is a deciduous woody leguminous vine that grows 30–100 ft long. Distinguishing features include three-leaflet leaves, yellow-green stems with erect golden hairs, lavender pea-like flowers, and hairy flattened seedpods. Colonization is by vines rooting at nodes and by wind, animal, and water-dispersed seeds. Seed viability is generally low. Kudzu grows rapidly, forming dense mats of vegetation that overwhelm all other plant species including tall trees. Kudzu requires direct sunlight for rapid growth.

Management

With a large root system packed with starch and aggressive growth habit, eradication of kudzu requires persistent treatment. Several strategies can be employed to eradicate kudzu, including herbicides, prescribed burning, mowing, and livestock grazing. When selecting control strategy consider restraints, which may prevent broadcast applications of herbicides, use of tractors to spray, or mow, and the presence of desirable vegetation in the patch. Because kudzu can reach depths of four feet or greater, the thick mat of vines and leaves can hide gullies, ditches, logs, wells and other hazards. Carefully check the site after a prescribed burn, or in winter or early spring when the leaves have fallen to determine if obstacles to application exist.

Mechanical Control: Repeated mowing can weaken and ultimately control kudzu. Mowing is generally a good first step towards control, provided it can be done without risk to the tractor operator. Close mowing reduces the tangle of leaves and vines and treatment of re-growth is more easily accomplished. Thick mats of vines are often difficult to mow with light-duty rotary mowers. Flail mowers with horizontal blades cutting in a chopping action may operate more effectively.

Using kudzu as forage for cattle and other livestock was an early promotion with its introduction into the U.S. Kudzu hay has excellent nutritional value and is palatable to livestock. To control kudzu by grazing, it is necessary to adequately fence the entire patch and to provide sufficient additional grazing areas on which

to rotate livestock as the kudzu is grazed down. Only by repeatedly grazing the re-growth over successive growing seasons will the root reserves of starch be depleted.

Prescribed fire can be used to consume vines and leaves to permit inspection of the site and to determine the size and density of the kudzu root crowns. Burning should occur in the winter or early spring. Using spring-burns limits exposure of bare soil to winter rains, minimizing soil erosion on steep slopes. Prescribed burning is useful in promoting seed germination prior to herbicide treatment (Moorhead and Johnson 2005).

Biological Control: Efforts are being organized by the U.S. Forest Service to begin a search for biological control agents for kudzu.

Chemical Control: Apply foliar sprays of Tordon 101 as a solution in water or Tordon K as a solution in water with a surfactant to wet foliage until run-off in July to October for successive years (Tordon herbicides are restricted-use pesticides). Spray foliage of climbing vines as high as possible. When using Tordon herbicides, rainfall must occur within six days after application for needed soil activation. The soil activity of Tordon herbicides can kill or damage plants having roots within the treated area. Other options provide partial control and may be useful in specific situations. Apply Escort in water to foliage from July to September. For areas where minimal injury to other plants is desired, apply Transline as a solution in water with a surfactant to thoroughly wet all leaves and stems in July to September. A glyphosate herbicide or Garlon 4 as solutions in water with a surfactant can be used during the growing season with repeated applications. Follow product application instructions (Miller 2002).

Wisteria (Chinese and Japanese)

Wisteria (*Wisteria sinensis* and *W. floribunda*) was introduced from Asia in the early 1800s as an ornamental. Both varieties of wisteria were used on porches across the south. The climbing woody vines can reach up to 70 ft long. They are deciduous vines with showy fragrant lavender pea-like flowers in the spring. The leaves are alternate and pinnately compound. Wisteria spreads by rooting at nodes and water-dispersal of seeds that form in large, velvety leguminous pods. Wisteria forms dense growth capable of killing trees and excluding other plant species.

Observed in the AL area, associated with the maritime forest.

Management

The only practical methods currently available for control of exotic wisterias are mechanical and chemical. Cut climbing or trailing vines as close to the root collar as possible. This technique, while labor intensive, is feasible for small populations, as a pretreatment for large impenetrable infestations, or for areas where herbicide use is not desirable. Wisteria will continue to re-sprout after cutting until its root stores are exhausted. For this reason, cutting should begin early in the growing season and, if possible, sprouts cut every few weeks until autumn. Cutting will stop the growth of existing vines and prevent seed production. However, cut vines left coiled around trunks may eventually girdle trees and shrubs as they continue to grow

and increase in girth. For this reason, the vines should be removed entirely or at least cut periodically along their length.

Mechanical Control: Grubbing, removal of entire plants from the roots up, is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski, weed wrench, or similar digging tool, remove the entire plant, including all roots and runners. Juvenile plants can be hand-pulled depending on soil conditions and root development. Any portions of the root system not removed may re-sprout. All plant parts (including mature fruit) should be bagged and disposed of in a trash dumpster to prevent re-establishment (Remaley 2006).

Biological Control: No biological control agents are currently available for wisteria.

Chemical Control: Apply Tordon 101, Tordon K, or Garlon 4 as solutions in water with a surfactant to thoroughly wet foliage until run-off in July to October for successive years (Tordon herbicides are Restricted Use Pesticides). Spray foliage of climbing vines as high as possible. When using Tordon herbicides, rainfall must occur within 6 days after application for needed soil activation. The soil activity of Tordon herbicides can kill or damage plants having roots within the treated area. Other options provide partial control and may be useful in specific situations. For areas where minimal injury to other plants is desired, apply Transline as a solution in water to thoroughly wet all leaves and stems in July to August. Apply a glyphosate herbicide as a solution in water with surfactant to wet all leaves in September to October with repeated applications (Miller 2002).

Common Reed

Common reed (*Phragmites australis*) is a tall grass that inhabits wet areas like brackish and freshwater marshes, riverbanks, lakeshores, ditches and dredge spoil areas. Native and introduced forms of Phragmites occur in the United States. Researchers believe that introduced European forms are the aggressive invasive that have replaced much of our native reed. Common reed threatens by displacing native plants and forming monocultures in otherwise biologically diverse natural wetlands. It spreads by seed and strong vegetative growth and is very difficult to control once established.

Management

Control of Phragmites is difficult, time-consuming, labor intensive and costly. Cutting, burning and chemical herbicides are all used to control it under various circumstances. Researchers have recently begun investigating the potential for biological control of this plant.

Mechanical Control: This type of control (e.g., repeated mowing) may be effective at slowing the spread of established stands but is unlikely to kill the plant. Excavation of sediments may also be effective at control but if small fragments of root are left in the soil, they may lead to reestablishment. Prescribed burning after the plant has flowered, either alone or in combination with herbicide treatment, may also be effective. Burning after herbicide treatment also reduces standing dead stem and litter biomass, which may help to

encourage germination of native plants in the following growing season. Plants should not be burned in the spring or summer before flowering as this may stimulate growth.

Biological Control: At this time no means of biological control are available in the United States for treating Phragmites infestations.

Chemical Control: Glyphosate-based herbicides (e.g., Rodeo®) are the most effective control method for established populations. S. C. Department of Natural Resources has also reported good success with Habitat®. If a population can be controlled soon after it has established chances of success are much higher because the below-ground rhizome network will not be as extensive. Herbicides are best applied in late summer/early fall after the plant has flowered either as a cut stump treatment or as a foliar spray. It is often necessary to do repeated treatments for several years to prevent any surviving rhizomes from re-sprouting. When applying herbicides in or around water or wetlands, be sure to use products labeled for that purpose to avoid harm to aquatic organisms. (Saltonstall 2008)

Tree of Heaven

Tree of heaven (*Ailanthus altissima*) was introduced from Europe as an ornamental. It is a rapid growing deciduous tree, which reaches 80 feet tall, and 6 feet in diameter and forms thickets and dense stands. It tolerates dense shade and flooding. Leaves are alternate and pinnately compound. The tree flowers April to June in long clusters, some measuring 20 inches, of greenish flowers. Persistent clusters of wing-shaped fruit can be seen on the female trees through the winter into February. Ailanthus spreads by root sprouts and wind and water born seed.

Management

Because of the high seed germination rate and the vegetative reproduction, ailanthus is difficult to irradicate and requires persistent monitoring and treatment to control this species. Most effective control is usually accomplished through the use of herbicides.

Mechanical Control: Cutting or pulling stem and vegetation will usually respond by resprouting multiple suckers from stumps and broken roots. Entire plants must be removed leaving no parts of the root or root fragments. If mechanical control is attempted targeting female trees decreases the reproduction rate. Choosing to remove the plants when soil is moist and early in the growing season may produce the best mechanical result.

Biological Control: Several fungal pathogens (*Verticillium dahliae* and *Fusarium oxysporum*) have been found in dying ailanthus. These may hold some potential for development of a biological control (Swearingen 2006).

Chemical Control: For larger trees the most effective method of control can be achieved through the careful use the of herbicides Garlon 3A or Arsenal AC with stem injection. Small trees, 6 inches or less can be treated with a basal spray of Garlon 4 or Pathfinder II at recommended dilution in a wide band around the circumference of the tree. For small trees and shrubs foliar spray can be applied July through October using

Arsenal AC, Krenite S or Garlon 4 as the chemical company prescribes. Thorough wetting of the foliage is the most effective control in situations were application can be accomplished without unacceptable contact with nearby ornamental shrubs and trees (Swearingen 2006).

Alligator weed

Alligator weed (*Alternanthera philoxeroides*) is a perennial herb introduced from South America. It is one of the most difficult aquatic weeds to control. It grows in a wide range of soil and water conditions. It may be found free-floating, loosely attached, rooted, immersed, or in a dry field. It generally grows as a mat of interwoven plants. The leaves are glossy, lance-shaped, 2-5 inches long, and have a distinct midrib. The leaves are opposite and the flowers white.

Management

Mechanical Control: Successful mechanical/physical removal of this plant is extremely difficult since the plant is able to re-establish from very small pieces.

Biological Control: Biological control efforts using insect predators brought from the plant's native region have been successful in the south. Two insects that have been established are the flea beetle (*Agasicles hygrophhila*) and the stem-boring moth (*Vogtia malloi*).

Chemical Control: Alligator weed grows in different situations, each requiring particular herbicide controls. Various herbicides have proven to be successful. Glyphosate herbicides are recommended because they are biodegradable. However, glyphosate is a nonselective systemic herbicide that affects all green vegetation (Invasive Alien Plant Species of Virginia, Alligator weed). Brushoff is another herbicide suggested for terrestrial plants only (SQDNRM 2001).

Water Hyacinth

Water hyacinth (*Eichhornia crassipes*) is a member of the pickerelweed family (Pontedericeae). The plants vary in size from a few centimeters to over a meter in height. Water hyacinth can form dense mats that

interfere with navigation, recreation, irrigation, and power generation. These mats competitively exclude native submersed and floating-leaved plants, create low oxygen conditions beneath the mats, impede water flow, and create good breeding conditions for mosquitoes (Ramey 2005).

Management

Mechanical Control: Mechanical controls such as harvesting have been used in such states as Florida for many years but are ineffective for large scale control, very expensive, and can't keep pace with the rapid plant growth in large water systems (Ramey 2005).

Biological Control: Scientists believe that the best bet for a long-term solution is to introduce one or more natural enemies as biological controls. In the 1970s, two South American weevils (*Neochetina bruchi* and *N. eichorniae*) and the water-hyacinth borer (*Sameodes albiguttalis*) were released in the United States. These and other organisms are being deployed in more than 20 other countries, including Australia, Cuba, Egypt, Honduras, Indonesia, Malaysia, Mexico, Panama, South Africa, Thailand, Vietnam, and Zimbabwe. There have been many successes, but results have been variable and the weed continues to cause problems (Cordo and Center 2000).

Chemical Control: The success of herbicidal control measures has varied in effectiveness. This method of control seems to work better in controlling small infestations accessible by land or boat. The herbicides most commonly used have been 2,4-D and Glyphosate. Many plants, both aquatic and terrestrial, are susceptible to the herbicides registered for water hyacinth control, so care must be taken when applying the chemical. Instructions on application methods should be read and understood before using the chemical (Dyason 1999).

American Lotus

American Lotus (*Nelumbo lutea*) can be found in muddy, shallow waters such as lake margins or in water as deep as six feet. Its leaves may be emergent above the water or floating on it. The flowers are yellow and extremely large (typically six inches wide). American lotus leaves are circular, and do not have a "cut", as do water lily leaves.

Management

Mechanical Control: Repeated cutting of leaves has been effective in controlling American lotus. Cutting should begin before the first flower buds open in June. Care should be taken to remove the majority of the cut leaves to avoid depleting the water of oxygen as they decay (Missouri Department of Conservation 1999).

Exposing sediments to prolonged freezing and drying during the months of December, January, and February can be effective in controlling certain aquatic plants, if exposure lasts 2-4 weeks. Drain no more water than necessary to expose the unwanted plants and always leave at least eight feet of water in the deepest part of the pond to reduce the chance of a winter fish kill (Missouri Department of Conservation 1999).

Biological Control: Grass carp do not effectively control American lotus. The waxy coating (cuticle) and thick, fibrous stems of these plants make them difficult for grass carp to eat (Missouri Department of Conservation 1999).

Chemical Control: RODEO (Glyphosate) is labeled by its manufacturer, Monsanto, for use on American lotus. Refer to the product label for specific instructions. For best results, apply herbicides in early spring and early summer, when plants are growing rapidly (Missouri Department of Conservation 1999).