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Distribution and Management of Invasive Plant Populations in State Park Properties of the North Carolina Coastal Plain

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CONSERVATION ISSUES

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ABSTRACT: The North Carolina Division of Parks and Recreation manages 32,063 ha of coastal plain lands divided among 26 properties comprised of state parks, state natural areas, and a state recreation area. Of 35 invasive plant species found at 25 reporting sites, Japanese honeysuckle (Lonicera japonica) and privets (*Ligustrum* spp.) occurred most frequently, followed by sericea (*Lespedeza cuneata*), Japanese stiltgrass (*Microstegium vimineum*), alligatorweed (*Alternanthera philoxeroides*), Bermuda grass (*Cynodon dactylon*), common reed (*Phragmites australis* ssp. *australis*), silverberries (*Elaeagnus* spp.), mimosa (*Albizia julibrissin*), and wisterias (*Wisteria* spp.). Current management measures for these species and others include herbicide applications, hand pulling to intensively focused labor with equipment, or use of biological controls. These activities challenge missions, budgets, and staff time of each park unit such that early detection and rapid response are difficult. A dedicated staff position, an invasive plant management team, and the development of simple control guidelines for vines and herbs are recommended to enhance on-site efforts and provide consistency, whereas contractual assistance and collaborative efforts will be needed to control difficult or widespread populations. Regular monitoring and proactive management at sites with few to no invasive species should be given priority to avoid future problems. In addition to current challenges posed by invasive plant populations found at most sites, species introductions and spread as a function of climate change, sea level rise, and tropical storms are likely.

Index terms: plants, North Carolina Coastal Plain, state park properties

INTRODUCTION

Invasive, nonnative plant populations represent a major threat to biodiversity and a constant stewardship issue for protected area managers (Westbrooks 1998; Wilcove et al. 1998; Pimentel et al. 2005). Most units of the North Carolina state park system contain one or more species recognized as noxious or invasive according to pertinent regional references (Miller, Chambliss, and Loewenstein 2010; Smith 2012). Operations choices at each site have to be made relative to adequate protection of natural integrity versus staff time demands and funding allocations (Smith 1998). This dilemma has become more apparent to resource management personnel since 2007 with the creation and staffing of biologist positions to oversee all three regions (i.e., mountain, piedmont, and coastal plain) of the park system. Because a previous assessment of invasive plant species within state park properties was completed in 2000 (S. Manning, President, and L. Patrick, Restoration Ecologist, Invasive Plant Control, Inc., unpubl. report), our study was conceived to provide an updated status within coastal plain sites and to make informed management recommendations, founded on interim experience and documentation, that could be applied throughout the entire system.

The North Carolina Division of Parks and Recreation (DPR) manages 59 properties throughout mountain, piedmont, and coastal regions (North Carolina Division of Parks and Recreation 2013b, 2013c). The coastal plain province (North Carolina Geological Survey 1985) encompasses approximately 6,143,584 ha (Diemer and Bobyarchick 2005; State Climate Office of North Carolina 2013) and contains 26 DPR units, which occupy 32,063 ha (Figure 1, Table 1). The DPR units include 15 state parks, 10 state natural areas (i.e., each site managed as a satellite of a designated state park or recreation area), and a state recreation area differentiated by prescribed levels of public access, development, and use (North Carolina General Statutes 1987). These tracts are distributed throughout key geological subunits of the province—Cape Fear Arch, Embayed Section, Outer Banks, and Sandhills (Horton and Zullo 1991). DPR coastal areas possess nationally or state significant biological and physical elements that feature 200+ endemic and rare species documented from approximately 50 natural community types (Schafale 2012; North Carolina Natural Heritage Program, unpubl. data). Proper stewardship of each property includes exotic species control as mandated by DPR policy (P. McKnelly, former DPR Director, unpubl. report). Future management of natural lands in this portion of the state will be challenged further by anticipated effects of climate change and tropical storms (Riggs and Ames 2003;

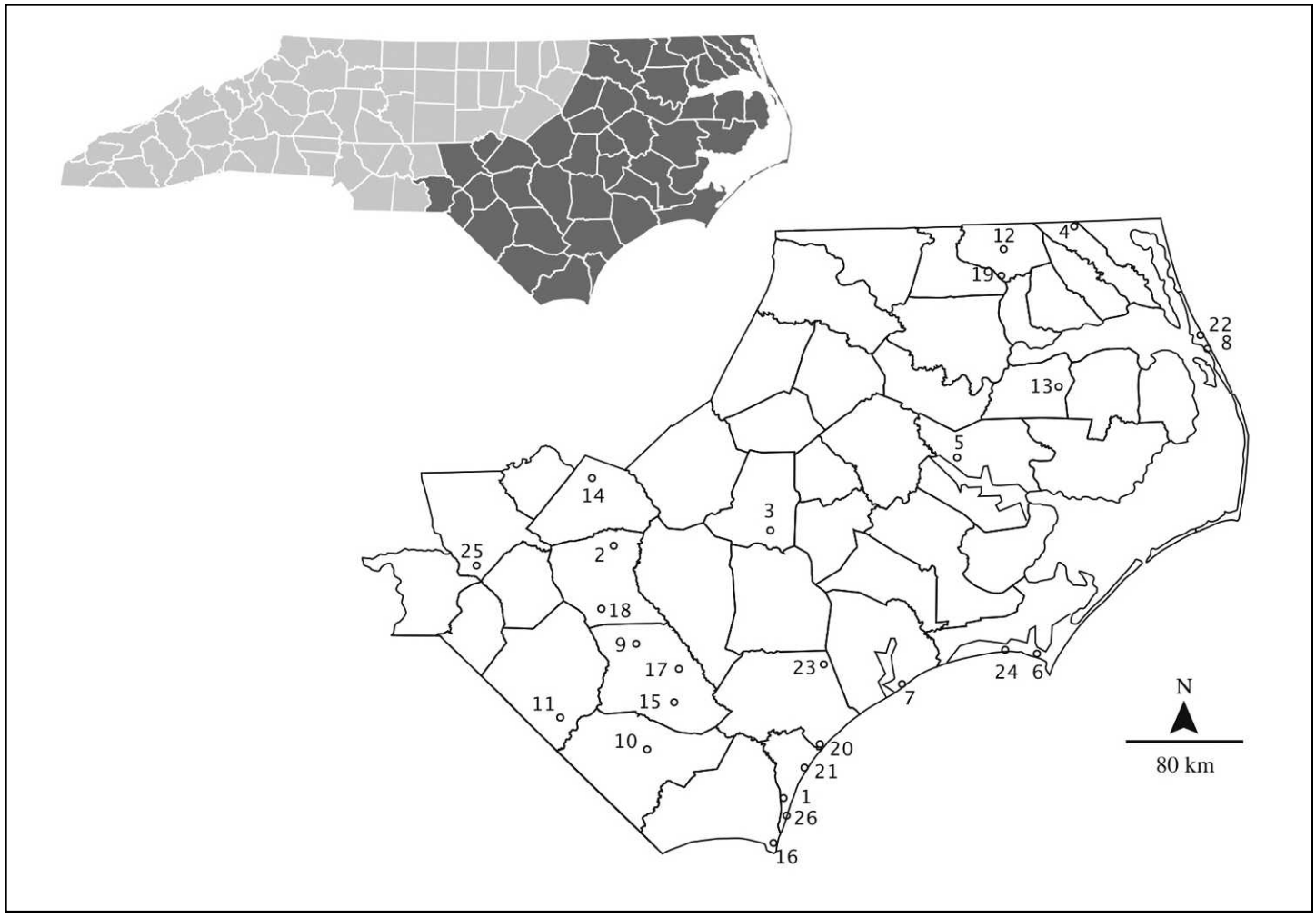

Figure 1. State park property locations within the North Carolina Coastal Plain. Numbered circles correspond to state parks, natural areas, and the state recreation area listed in Table 1.

Poulter et al. 2009).

METHODS

The term "invasive species" as used in this article follows guidelines found in Executive Order 13112 signed by President Clinton in 1999: "(1) a species that is nonnative (or alien) to the ecosystem under consideration, and (2) whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health" (Miller, Manning, and Enloe 2010). This definition is consistent with Smith (2012) for noxious weeds in North Carolina. Among various potential damages and impacts of nonnative invasive plants listed by Miller, Manning, and Enloe (2010), the following are most relevant to DPR properties: negative impacts on land management and regeneration of forests and grasslands, loss or decrease of biodiversity and wildlife habitat, alteration of ecosystem processes, impairment of recreational uses, and increased fire hazards.

A survey of invasive plant species within coastal DPR properties and associated management policies/practices was compiled by the coastal and piedmont regional biologists who visited sites listed in Table 1 (except for Chowan Swamp (#19) because of likely management transfer) to search for and verify occurrences, and to perform interviews with associated management staff and researchers. All sites were inventoried thoroughly by the biologists in collaboration with pertinent personnel. Populations were detected or verified by direct field observations, with emphasis on cover >0.4 ha for an invasive species within a given property. Unlike the 2000 system-wide assessment, undeveloped land was given equal weight with visitor use areas and access corridors. Species identifications and population locations were facilitated by pertinent references (Miller, Chambliss, and Loewenstein 2010; Smith 2012; Weakley 2012) and intra-agency communication. Botanical nomenclature followed Weakley (2012). J. Marshall Ellis and J. Taggart (authors) reviewed DPR reports, publications, and policies relative to invasive plant species occurrences and management (e.g., Smith 1998; North Carolina Division of Parks and Recreation 2007).

Table 1. State park properties of the North Carolina Coastal Plain. Areas were derived from North Carolina Division of Parks and Recreation 2013a-c, North Carolina Geological Survey 1985, and Taggart 2010.

State Parks		Area (ha)
1	Carolina Beach (New Hanover Co.)	308
2	Carvers Creek (Cumberland Co.)	1,650
3	Cliffs of the Neuse (Wayne Co.)	361
4	Dismal Swamp (Camden Co.)	5,843
5	Goose Creek (Beaufort Co.)	677
6	Fort Macon (Carteret Co.)	172
7	Hammock's Beach (Onslow Co.)	477
8	Jockey's Ridge (Dare Co.)	173
9	Jones Lake (Bladen Co.)	676
10	Lake Waccamaw (Columbus Co.)	874
11	Lumber River (Robeson Co.)	3,752
12	Merchant's Millpond (Gates Co.)	1,396
13	Pettigrew (Washington-Tyrrell Cos.)	5,768
14	Raven Rock (Harnett Co.)	1,900
15	Singletary Lake (Bladen Co.)	263
	Subtotal	24,290
State Natural Areas		
16	Bald Head Island (Brunswick Co.)	510
17	Bay Tree Lake (Bladen Co.)	247
18	Bushy Lake (Cumberland Co.)	2,568
19	Chowan Swamp (Gates Co.)	2,456
20	Lea Island (Pender Co.)	25
21	Masonboro Island (New Hanover Co.)	43
22	Run Hill (Dare Co.)	123
23	Sandy Run Savannas (Onslow-Pender Cos.)	1,214
24	Theodore Roosevelt (Carteret Co.)	107
25	Weymouth Woods (Moore Co.)	364
	Subtotal	7,657
State Recreation Area		
26	Fort Fisher (New Hanover Co.)	116
	Total Area	32,063

RESULTS

Species Distributions and Dominance

Thirty-five invasive plant genera and species were recorded from 25 DPR properties located throughout the coastal plain (see Table 2). Species per site averaged approximately eight; however, several inland (i.e., inner coastal plain) sites with relatively high numbers (e.g., Carver's Creek – 21, Weymouth Woods – 16, Raven Rock – 15, Goose Creek – 15) contrasted sharply to others that had none (i.e., Lea Island, Masonboro Island).

Species most frequently reported were Japanese honeysuckle (*Lonicera japonica* Thunberg) at 16 sites and privets (*Ligustrum* spp. L.) at 15 sites, while sericea (*Lespedeza cuneata* [Dumont-Cours.] G. Don) and Japanese siltgrass (*Microstegium vimineum* [Trinius] A. Camus) were found at 11 sites each. Alligatorweed (*Alternanthera philoxeroides* [Martius] Grisebach), Bermuda grass (*Cynodon dactylon* L. Persoon), and common reed (*Phragmites australis* [Cavanilles] Trinius ex Steudel ssp. *australis*) occurred at 10 DPR properties, followed by silverberries (*Elaeagnus* spp. L.) at nine sites, mimosa (*Albizia julibrissin* Durazzini) at eight sites, and wisterias (*Wisteria* spp. Nuttall) at eight sites.

The 2000 DPR system-wide invasive plant inventory was performed by a contractor who evaluated and subjectively ranked species by three factors—degree of invasiveness, aerial extent, and difficulty of control—largely within visitor access areas, roads, and trails. The survey established some baseline data regarding numbers of verified invasive species, but there was no mapping. However, many parks subsequently updated their respective species inventories and developed graphics prior to our survey. While most of the dominant invasive species were the same, the 2013 survey included three new properties (i.e., a state park and two natural areas) and identified over a dozen new species present among coastal plain sites.

Policy, Planning, and Priorities

Review of DPR invasive species management guidelines (Smith 1998) indicated a need for modification to reflect current conditions relative to park properties, species, and control techniques. Implementation of control measures was primarily facilitated by the fact that every park or district had staff licensed to apply herbicides. These licensures covered a variety of fields: turf and ornamentals, forestry, right-of-way, and aquatic; however, when and where to use this expertise was a critical issue.

Invasive plant control plans for several woody species were completed (J.M. Ellis, DPR Mountain Region Biologist, unpubl. rpts.) to provide prescriptions easily adapted to address similar species,

Table 2. Invasive plant species (top row) found in DPR properties (left column) of the North Carolina Coastal Plain.

	Ailanthus altissima	*Albizia julibrissin*	*Alternanthera philoxeroides*	*Arundo donax*	*Celastrus orbiculatus*	*Citrus trifoliata*	*Colocasia esculenta*	*Cynodon dactylon*	*Egeria densa*	*Elaeagnus* spp.	*Eragrostis curvula*	*Eremochloa ophiuroides*	*Hedra helix*	*Hydrilla verticillata*	*Lespedeza bicolor*	*Lespedeza cuneata*	*Ligustrum* spp.	*Lonicera japonica*	*Mahonia bealei*	*Melia azedarach*	*Microstegium vimineum*	*Miscanthus sinensis*	*Murdannia keisak*	*Myriophyllum* spp.	*Nandina domestica*	*Paspalum notatum*	*Paulownia tomentosa*	*Phragmites australis*	*Phyllostachys* spp. (bamboos)	*Pueraria montana*	*Rosa* spp.	*Schedonorus arundinaceus* ssp. *arundinaceus*	*Sorghum halepense*	*Vinca* spp.	*Wisteria* spp.	Total Species per Site
State Parks																																				
1 Carolina Beach		X											X				X	X		X						X		X								**7**
2 Carvers Creek	X	X			X			X		X	X		X		X	X	X	X		X	X	X	X		X		X			X	X		X		X	**21**
3 Cliffs of the Neuse						X											X	X			X						X		X							**6**
4 Dismal Swamp	X		X													X	X	X							X			X			X					**8**
5 Goose Creek		X	X					X					X			X	X	X		X	X					X		X			X	X	X		X	**15**
6 Fort Macon			X					X		X		X	X			X	X	X			X							X								**10**
7 Hammocks Beach								X		X						X	X			X						X		X								**7**
8 Jockeys Ridge			X					X		X	X	X						X								X		X	X							**9**
9 Jones Lake											X					X	X	X																X		**5**
10 Lake Waccamaw		X	X				X							X	X		X				X			X		X				X						**10**
11 Lumber River		X	X	X														X			X		X														**7**
12 Merchant's Millpond								X	X							X	X	X	X		X	X	X	X	X						X			X	X	**14**
13 Pettigrew	X		X			X		X					X				X	X		X	X		X	X				X			X			X		**14**
14 Raven Rock	X	X								X						X	X	X		X	X		X		X		X			X	X		X		X	**15**
15 Singletary Lake											X					X																					**2**
Natural Areas																																				
16 Bald Head Island										X								X																		**2**
17 Bay Tree Lake								X																												**1**
18 Bushy Lake								X																												**1**
19 Chowan Swamp		n	o				r	e	p	o	r	t		/		possible				management					transfer											
20 Lea Island																																				**0**

Continued

Table 2. *(Continued)*

Natural Areas	*Ailanthus altissima*	*Albizia julibrissin*	*Alternanthera philoxeroides*	*Arundo donax*	*Celastrus orbiculatus*	*Citrus trifoliata*	*Colocasia esculenta*	*Cynodon dactylon*	*Egeria densa*	*Elaeagnus* spp.	*Eragrostis curvula*	*Eremochloa ophiuroides*	*Hedra helix*	*Hydrilla verticillata*	*Lespedeza bicolor*	*Lespedeza cuneata*	*Ligustrum* spp.	*Lonicera japonica*	*Mahonia bealei*	*Melia azedarach*	*Microstegium vimineum*	*Miscanthus sinensis*	*Murdannia keisak*	*Myriophyllum* spp.	*Nandina domestica*	*Paspalum notatum*	*Paulownia tomentosa*	*Phragmites australis*	*Phyllostachys* spp. (bamboos)	*Pueraria montana*	*Rosa* spp.	*Schedonorus arundinaceus* ssp. *arundinaceus*	*Sorghum halepense*	*Vinca* spp.	*Wisteria* spp.	
	5	8	10	1	1	2	1	11	1	9	6	3	7	1	3	11	15	17	1	6	11	2	7	5	5	65	3	10	3	4	7	2	3	2	8	
Natural Areas																																				**0**
21 Masonboro Island																																				**5**
22 Run Hill			X					X			X													X				X							**14**
23 Sandy Run		X	X					X		X		X			X	X	X	X			X		X	X		X								X	**6**
24 Theodore Roosevelt			X							X			X			X	X	X										X							**16**
25 Weymouth Woods	X	X								X	X		X		X	X	X	X			X		X						X	X	X			X		
Recreation Area																																				**2**
26 Fort Fisher																		X										X								
Sites per Species	**5**	**8**	**10**	**1**	**1**	**2**	**1**	**11**	**1**	**9**	**6**	**3**	**7**	**1**	**3**	**11**	**15**	**17**	**1**	**6**	**11**	**2**	**7**	**5**	**5**	**65**	**3**	**10**	**3**	**4**	**7**	**2**	**3**	**2**	**8**	

but analogous prescriptions for invasive vines and herbs were not developed. Each plan consisted of the following sections: invasive priority, description and biology, current distribution on the site, damage and threats, goals, measureable objectives, management options, monitoring, and re-treatment. Content was derived from the best available information and techniques (e.g., Miller, Chambliss, and Loewenstein 2010; Miller, Manning, and Enloe 2010; Smith 2012) and reviewed internally with outside consultation as needed. Implementation was facilitated by the regional biologist in concert with on-site staff and any additional parties (e.g., North Carolina Division of Water Resources – Aquatic Weed Control Program, North Carolina State University Agriculture Extension Service). Staff development and education at appropriate venues (e.g., North Carolina Exotic Plant Pest Council 2013) were also available.

Priority of invasive plant control varied according to competing park time and budget demands, public concern, or growth habit. For example, discovery of an aggressive hydrilla invasion (*Hydrilla verticillata* [L.] Royle) within Lake Waccamaw State Park (i.e., part of a Carolina bay lake with several endemic aquatic species) caused local apprehension over potential impairment of recreational lake uses and impacts to listed species that resulted in control measures within one year (Barnes 2013). In contrast, less urgent invasive plant problems (e.g., an isolated colony of *Phragmites australis* within Fort Fisher State Recreation Area) persisted for years before remedial action was necessary or feasible. Invasive woody species generally received more attention compared to vines or herbs; grasses were especially difficult for personnel to identify. Sites, particularly state natural areas, with few to no invasive species received low priority for treatment or monitoring. While time and money were understandably directed toward the most heavily infested properties, such battles were often difficult and costly. Less affected sites received minimal attention and, thus, were vulnerable to invasion by populations from

adjacent properties or expansion of existing populations.

Methods and Realities of Control

Funding for chemical control was generally thought to be adequate by most park staff. Occasional use of outside assistance (e.g., volunteers, prison work crews, AmeriCorps) was helpful for large-scale problems, such as an extensive thicket of *Ligustrum sinense* Loureiro at Carolina Beach State Park. However, the primary need was for adequate staff time to implement localized control measures with necessary monitoring and follow-up treatments at sites throughout the province. This issue has always been a challenge given the diversity of responsibilities incumbent on DPR staff.

Understandably, control of invasive plant problems in coastal plain properties and throughout the state park system was generally inconsistent because of staff limitations, training/education needs, and other priorities. Discrete populations of woody species were given priority because of relative ease to identify and treat—often by mechanical removal coupled with a species-appropriate herbicide (e.g., triclopyr or glyphosate). However, enthusiasm often waned after a single large effort such that follow-up treatments were not always performed. Park staff often perceived invasive vines and herbs as either less of a threat or, where large populations occurred, too intimidating (e.g., dense thickets of *Wisteria* sp., hectares of *Microstegium vimineum*), hence they did not receive a similar level of attention. The consensus opinion of regional biologists was that control of invasive plant problems was typically beyond current capacities of DPR on-site staff, both coastal and system-wide.

The following summarizes general prescriptions and limitations for control of the top 10 invasive species found on coastal DPR properties:

- *Lonicera japonica*: small Japanese honeysuckle populations were pulled by hand, while larger areas required foliar application of glyphosate (e.g., Roundup©) and stumps were cut and painted with glyphosate or burned by propane torch. Extensive infestations were often bypassed to focus on smaller, more manageable areas.

- *Ligustrum* spp.: privet occurrences were typically large infestations that required manual labor and chain saws for removal of branches and stems followed by applications of glyphosate or triclopyr (e.g., Garlon©) to stumps or use of a propane torch. These techniques provided quick results and a sense of accomplishment among DPR sites; however, follow-up checks and treatments often were lacking or inadequate.

- *Lespedeza cuneata*: some sericea populations have been successfully controlled by mowing, followed by foliar applications of glyphosate or triclopyr before plants set seed in midsummer. Multiple treatments typically were needed to deal with the seedbank.

- *Microstegium vimineum*: mowing in early summer during flowering was desirable because of the Japanese stiltgrass annual life cycle, followed by applications of glyphosate as needed. Treatment of large infestations was generally not recommended due to current staff and herbicide/equipment limitations.

- *Alternanthera philoxeroides*: good short-term control results occurred for this widespread aquatic with use of alligatorweed flea beetles (*Agasicles hygrophila* Selman and Vogt (Coombs et al. 2004)), but the beetles did not overwinter. Triclopyr or glyphosate was used for control above the waterline, while Rodeo© (i.e., glyphosate for wetland areas) was applied in aquatic sites. Repeated herbicide applications were often required.

- *Cynodon dactylon*: when Bermuda grass became a problem and could not be removed by simply digging up turf with rhizomes, glyphosate applications in late summer were necessary. Large infestations of this grass were one of the most difficult situations to control without multiyear follow-up applications. Higher application rates and more potent herbicides (e.g., imazapyr – Arsenal©) were frequently needed.

- *Phragmites australis* ssp. *australis*: prescribed burning early in the growing season was performed on common reed, followed by thorough application of imazapyr with subsequent treatments as needed. Inconsistent follow-up treatments, and treatment outside the recommended timeframe, led to only sporadic success.

- *Elaeagnus* spp.: aggressive thickets of silverberry were cut to the ground, removed, and stumps painted with triclopyr diluted with mineral oil. When cutting was not an option, foliar applications of glyphosate were used during the growing season with follow-up treatments.

- *Albizia julibrissin*: mimosa trees were sawed down/removed and a mixture of triclopyr and mineral oil was applied to stumps, or stumps were burned by propane torch.

- *Wisteria* spp.: tangles of wisteria vines were cut and removed or foliar applications were performed where infestations were more extensive. Multiple triclopyr or glyphosate applications were needed on both stumps and leaves.

Climate Change Implications

Aside from challenges posed by extant invasive populations, there were concerns for the future in this portion of the state relative to climate change. In 2012, DPR natural resource management personnel were alerted to an isolated occurrence of cogongrass (*Cylindrica imperata* [L.] Palisot de Beauvois) planted on private property in Pender County, North Carolina, within 10 miles of Sandy Run Savannas State Natural Area (North Carolina Exotic Plant Pest Council 2013). Although the population was eradicated and no other plants were found, the occurrence raised concerns over potential invasion by this and other aggressive species currently found farther south.

According to the United States Department of Agriculture (2013), the northern portion of plant hardiness zone eight (a) includes most of the North Carolina Coastal Plain and terminates close to the Virginia state line. The next warmer subdivision reaches

its limit at the extreme northeastern corner of South Carolina, also the Brunswick County line of North Carolina. Since zones are determined by average annual minimum winter temperatures divided into 5.5 ºC zones, continued annual average temperature increases—considered likely according to the Intergovernmental Panel on Climate Change (2013) and the United States Global Change Research Program (2014)—will extend this and other zones farther north.

This warming trend will provide more hospitable conditions for invasive species that currently reach their northern limits in South Carolina or Georgia. Perhaps the biggest threat is cogongrass, known from nearby Charleston and Williamsburg Counties, South Carolina (Clemson University 2013). The proximity of these populations to protected pine savannas in North Carolina is cause for ongoing vigilance. Other southern coastal invasive species with potential for future migrations into southeastern DPR properties include camphortree (*Cinnamomum camphora* [Linnaeus] J. Presl) and coral ardisia (*Ardisia crenata* Sims) (Miller, Chambliss, and Loewenstein 2010).

In addition to higher temperatures, increased intensity of hurricanes and other tropically related weather events is considered likely (Intergovernmental Panel on Climate Change 2013; United States Global Change Research Program 2014). Such storms will facilitate spread of existing species (e.g., Chinese tallow tree (*Triadica sepifera* (L.) Small) and *Phragmites australis* ssp. *australis*) as a consequence of direct and indirect habitat alterations (e.g., tree loss, sea level rise, inland flooding, fires, disease) combined with introductions of new invasive plant propagules as storms sweep along the Atlantic coastline (Yager 2006; Hellmann et al. 2008; Howard 2012).

CONCLUSION

The invasive plant survey and review of policies/information within coastal DPR properties revealed several trends:

1. Contrasting numbers between inland and estuarine/barrier island sites were likely a function of generally larger areas among the former units versus smaller sites with varying degrees of salinity (i.e., a limiting factor for some of the aforementioned invasive species) along the immediate coast. Tracts with no reported exotics consisted of two small barrier island properties—Lea and Masonboro Islands; however, nearby populations of beach vitex (*Vitex rotundifolia* L.f.) posed a definite threat that required monitoring.

2. Nearly all coastal sites had invasive plant issues that were not being adequately addressed because of staff, training, time, or funding limitations. DPR regional biologists generally found that the actual extent of plant invasive problems at a given unit was more than perceived by on-site staff, hence early detection followed by rapid response and, in many cases, outside assistance were critical needs. While relatively small (<0.4 ha) populations can be treated by on-site staff, larger or multiple patches of particularly difficult species (e.g., *Microstegium vimineium, Wisteria chinensis*) within a given park property will require additional funding for contractual help.

3. With the exception of Weymouth Woods, state natural areas were managed as satellites of the nearest state park or recreation area and, thus, received less regular attention. Depending upon proximity to stewardship personnel and frequency of site monitoring, establishment and spread of invasive plants were often overlooked. However, in 2006 a coastal region biologist position (i.e., now centrally located in Goldsboro, North Carolina) was filled and improved this situation.

4. Future planning and monitoring for invasive plants in coastal properties need to encompass the likelihood of new introductions or spread of extant species as related to ongoing changes in climate, sea level, and tropical storm intensities.

Recommended Changes Included:

1. Addition of a full-time biologist position with primary duties concerning invasive species management would greatly aid DPR stewardship efforts. Specifically, this person would have oversight of invasive species issues at the system-wide strategic level and work in conjunction with regional biologists to implement site-specific control plans.

2. Outside assistance would be a feasible enhancement to address the most challenging invasive plant control problems observed by the regional biologists. The seasonal DPR prescribed fire crew could be trained to deal with such issues during times when burning is not possible. This would lessen the burden on site personnel and provide a more consistent manner of control. Contractual assistance with controlling extensive populations of invasive species will also be needed, while collaborative management opportunities (e.g., AmeriCorps, Youth Conservation Corps, Weed Action committees) should be pursued on a regular basis.

3. Sites with few to no invasive plant populations should pursue focused control and monitoring to avoid expansion of extant populations or new introductions. Current challenges with populations of eight or more species observed at most properties reinforce the old adage: "an ounce of prevention is worth a pound of cure."

4. Simple control plans for common invasive vines and herbs should be developed to facilitate treatment of small (<0.4 ha) populations by on-site personnel.

The 26 DPR properties were selected, acquired, and managed to protect key examples of North Carolina's coastal natural heritage. Challenges posed by removal and control of extant invasive plant populations and threats of new introductions will continue to demand staff time, funding, and acumen. A well-informed, proactive network of park personnel with dedicated stewardship funding is the best defense to maintain the natural integrity of these important sites.

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