Title: Searching for answers: Selective Brazilian peppertree control in mangrove communities.

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Need for Research/Outreach. Brazilian peppertree (*Schinus terebinthifolius*) is one of the most invasive trees in Florida. It occupies hundreds of thousands of acres throughout peninsular Florida and has transformed countless landscapes into dense monotypic peppertree stands. In the southwestern Everglades, Brazilian peppertree has invaded virtually every type of mangrove community and may be negatively impacting white (*Laguncularia racemosa*), red (*Rhizophora mangle*), black (*Avicennia germinans*), and button (*Conocarpus erectus*) mangroves. Peppertree control strategies are extremely limited within mangrove communities for several reasons. One of the primary reasons is an historic negative perception of herbicide use around mangroves, which largely originated during the Vietnam War, where Agent Orange was used as a defoliant. Additionally, many infestations are in areas that are extremely difficult to access with ground crews. Finally, herbicides currently used for Brazilian peppertree control such as triclopyr and imazapyr have been observed to severely injure or kill mangrove species.

While these issues make the problem seem almost impossible, it is very important to pursue solutions to the peppertree problem as it continues to increase. Over the last few years, there have been several new herbicide active ingredients registered for aquatic plant management in Florida. However, there is little research that has examined their potential usefulness on a myriad of invasive plants including Brazilian peppertree. These chemistries need to be evaluated for both efficacy on target invasive plants such as peppertree and on non-target native plants such as mangroves.

Objectives. Given the lack of data on selective Brazilian peppertree control in mangrove ecosystems, our objectives are to evaluate several new herbicide chemistries for Brazilian peppertree control and mangrove tolerance. We believe this research is of great importance to Florida, given the critical role mangroves play in Florida's coastal ecosystems.

Methods. The sensitive nature of invasive plant control within mangroves is an important aspect of this proposed work. Therefore, we propose a four-tiered research approach. Initially we will conduct an efficacy screen on Brazilian peppertree with several herbicides and herbicide tank mixes that have shown promise for other aquatic and terrestrial invasive plants (tier 1). We will then advance any promising herbicides and/or herbicide combinations and evaluate their impact on the four key mangrove species in dose response mesocosm studies (tier 2). Following this, the most promising treatments will be tested on larger plots in the field using aerial and ground application techniques (tier 3). Finally, sequential treatments will be applied in the field studies to assess the most cost-effective long-term strategy for managing Brazilian peppertree in mangrove communities (tier 4). This approach will minimize wasted efforts (too little control of peppertree, too much mangrove injury) as we continuously move towards operational treatments. Table 1 lists proposed treatments to be tested.

Table 1. Newer herbicide active ingredients proposed for screening on Brazilian peppertree and mangrove species in Florida.

Product	Active ingredient	Mode of action	Potential Foliar Treatment Rate
Tradewind	Bispyribac	ALS inhibitor	2 oz/A
Clearcast	Imazamox	ALS inhibitor	32-64 oz/A
Galleon	Penoxsulam	ALS inhibitor	5.6-11.2 fl oz/A
Oasis	Topramezone	HPPD inhibitor	16 fl oz/A
Stingray	Carfentrazone	PPO inhibitor	1-4 oz/A
Clipper	Flumioxazin	PPO inhibitor	4-12 oz/A

Additionally, we will compare these new herbicides to several herbicide treatments used widely for invasive plant control (Table 2). Some of these have been documented to injure or kill mangroves. However, they will provide a useful metric for comparison with newer aquatic herbicides. Additionally, not all of them have aquatic registrations.

Table 2. Commonly used invasive plant treatments which will serve as comparisons for Brazilian peppertree control and mangrove tolerance.

Product	Active ingredient	Mode of action	Potential Foliar Treatment Rate
Rodeo	Glyphosate	EPSP inhibitor	3 qt/A
Escort	Metsulfuron	ALS inhibitor	4 oz/A
Milestone	Aminopyralid	Auxin mimic	7 fl oz/A
Habitat	Imazapyr	ALS inhibitor	2 qt/A
Garlon 3A	Triclopyr amine	Auxin mimic	3 qt/A
Method	Aminocyclopyrachlor	Auxin mimic	16 oz/A

Tier 3 and 4 field studies will be conducted at multiple locations to assess treatment effects across diverse field conditions. Individual and community responses will be quantified to better assess treatment outcomes. These may include large scale field plots for aerial treatment and ground crew treatments. Potential sites include Everglades National Park, Cape Canaveral, and sites managed by SFWMD and SWFWMD. Partnerships will be critical in these field efforts to find good sites which can also be used for educational and outreach efforts.

For all studies, appropriate statistical analyses will be conducted to compare reductions in cover and density of target and non-target species, and total target mortality for herbicide treatments versus the appropriate untreated controls.

Deliverables. Results from this research will be used to identify the best possible treatments for both limited-area and large-scale Brazilian peppertree control in mangrove communities. We will develop a new guide to inform treatment of and restoration after Brazilian peppertree management in mangrove communities.

Schedule.

September 2015 to January 2016: Peppertree and mangrove propagation (Fort Lauderdale REC).

February 2016 to September 2016: Peppertree and mangrove herbicide dose response studies.

October 2016 to December 2016: Field trial site selection and baseline data collection.

February 2017: Aerial and ground peppertree treatments.

March 2017 to January 2018: Field data collection.

February 2019: Retreatment protocols initiated.

March 2019 to December 2019: Field data collection of retreatment protocols, final data analysis.

Budget. See following page and official FWC budget form attached.

Budget.

	2015	2016	2017	2018	2019
Personnel expenses					
a. Salaries	$28,010.52	$28,850.83	$29,716.35	$30,607.84	$31,526.07
b. Fringe	$ 6,013.74	$ 6,194.15	$ 6,379.97	$ 6,571.37	$ 6,768.51
Supplies	$ 6,925.00	$ 6,925.00	$ 6,925.00	$ 6,925.00	$ 6,925.00
Equipment	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Travel	$13,200.00	$13,200.00	$13,200.00	$13,200.00	$13,200.00
contractual	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Miscellaneous	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Subtotal Expenses	$54,149.26	$55,169.98	$56,221.32	$57,304.21	$58,419.58
Overhead/IDC	$ 5,414.93	$ 5,517.00	$ 5,622.13	$ 5,730.42	$ 5,841.96
Total Budget	$59,564.29	$60,686.98	$61,843.45	$63,034.63	$64,261.54