# Developing rapid response tools, control measures, and refining invasibility models for invasive pythons in the Florida everglades

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## Abstract

Recently detected hybridization between two ecologically distinct python species within the invasive Florida Everglades python population has the potential to affect more natural areas and infrastructure (i.e., water control structures, etc.) throughout the US than is currently anticipated. Moreover, current early detection and rapid response methods (specifically eDNA) do not account for the potential effect hybridization may have on positive detection of hybrid individuals. Expanded genetic analyses of pythons to include specimens from their native ranges and potential source populations (i.e., pet trade and zoos) in comparison to established invasive populations will allow biologists and managers to 1) make better management decisions to mitigate the spread of these aggressively invasive snakes throughout the southern tier of the United States, 2) increase early detection and rapid response capabilities, 3) refine habitat suitability modelling efforts, and 4) determine whether pythons in new areas are the product of subsequent releases or range expansion of established populations. Here, we present a conceptual framework being developed to advance our control and response capabilities to better manage and eradicate invasive pythons as well as halt their expansion to new areas.

Further, we showcase potential avenues for collaboration between researchers as well as managers working in the Everglades and scientists at the US Army Engineer Research and Development Center (ERDC).

## Early Detection & Rapid Response

### Scope & Objectives:

- Develop eDNA techniques to accurately detect hybrid (*P. molurus* X *P. bivittatus*), individuals.
- Build sequence library of genetic material from native range of *P. molurus* and *P. bivittatus* as well as commercial populations (i.e., zoo and pet trade).
- Develop detection methods using novel UAV technologies.

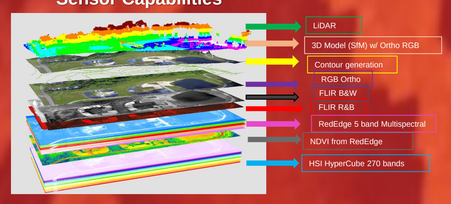
### Capabilities Developed:

- Enable detection of all three variants (*P. molurus*, *P. bivittatus*, and hybrids) from waterborne samples.
- Allow managers to identify whether new sightings within the invasive range represent novel releases or range expansions of existing invasive population.
- Facilitate assignment of newly sighted individuals to source populations (invasive, commercial, or new introduction).
- Enable and promote rapid detection over large spatial extents.

## ERDC UAS Assets

| ERDC-EL UAS Platforms | SKYCRANE G4 | HARRIS HX8 | FIREFLY6 PRO | VAPOR 55 | EL647X | SKYRAIDER R80D |
|---|---|---|---|---|---|---|
| LIFT CAPACITY | < 8 lb | < 33lb | <2lb | <24 lbs | <1lb | <4.4lb |
| SENSORS | RGB, FLIR, MicaSense, LiDAR/Hyperspec | LiDAR/Hyperspec | RGB, FLIR, MicaSense | LiDAR/RGB | Camera | HDZOOM 30x EO/IR |
| FLIGHT TIME | 12-20 MINS | 20-40 MINS | 1 HR | 1 HR | 25 MINS | 50 MINS |
| # OF SYSTEMS | 1 | 1 | 1 | 1 | 10 | 4 |
| TYPE | MULTIROTOR (X8) | MULTIROTOR (X4-DUAL TRI BLADES) | HYBRID VTOL | HELICOPTER | MULTIROTOR (X4) or (x8) | MULTIROTOR |
| APPLICATION | Surveying/Mapping | Surveying/Mapping / Agricultural/ Routes | Surveying/Mapping/ Agricultural/ Disaster Response | Surveying/Mapping | Disaster Response/ Research | ISR/Mapping/ Surveying |

**Sensor Capabilities**




**FLIR (Thermal Imagery)**


**FLIR SkyRaider R80D - Multi-mission SUAS**

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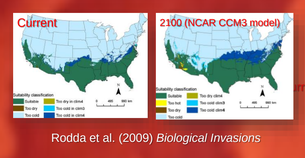
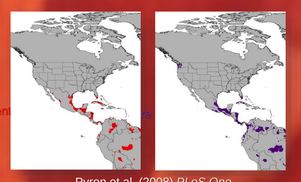
## Modeling Invasibility and Dispersal

### Scope & Objectives:

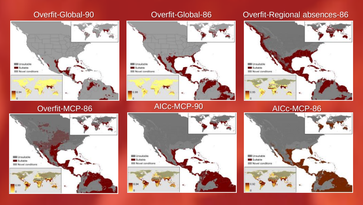
- Refine predictions of Ecological Niche Modeling efforts by incorporating potential for niche expansion due to hybrid vigor and updated environmental data from invasive and native ranges.




Rodda et al. (2009) *Biological Invasions*

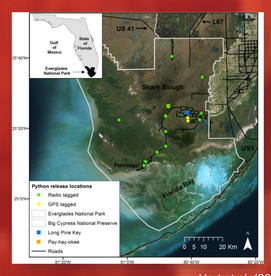


Pyron et al. (2008) *PLoS One*




Rodda et al. (2011) *PLoS One*

- Develop range expansion (dispersal) model, integrating existing knowledge of python movements and behavior within the invasive range as well as potential barriers and corridors to movements.





Hart et al. (2015) *Animal Biotelemetry*


Kirk, Nifong, and Smith, unpublished data

### Capabilities Developed:

-Increased preparedness and readiness.

-Focus resource allocation for control, containment, and eradication to most vulnerable localities.

-Identify opportunities to intercept and slow python movements across the landscape.

## Why Collaborate with ERDC?

### ERDC Mission

The U.S. Army Corps of Engineers' (USACE) Engineer Research and Development Center (ERDC) helps solve our Nation's most challenging problems in civil and military engineering, geospatial sciences, water resources, and environmental sciences for the Army, Department of Defense, civilian agencies, and our Nation's public good.


### ERDC Environmental Lab

Our researchers in the Environmental Laboratory conduct research in ecosystem science and technology, environmental resiliency, environmental sensing, ecological modeling and forecasting, risk and decision science, environmentally sustainable material, systems biology, climate change, and environmental security. We partner with other government agencies, academia, and industry to solve complex environmental systems problems. We provide solutions to environmental systems challenges worldwide, including:

- **Analytical chemistry**
- **Aquatic and wetland ecosystems**
- **Chemistry, cleanup, and remediation**
- **Dredging and dredged material management**
- **Fate and effects DM**
- **Geospatial analysis and mapping**
- **Hazardous/toxic waste assessment and cleanup**
- **Invasive and threatened/endangered species**
- **Molecular ecology**
- **Modeling and ecosystem restoration**
- **Risk assessment, sensing, and monitoring**
- **Stewardship/recreation and benefits analysis**
- **Unexploded ordnance detection and ordnance management**
- **Wetlands technology**

### Collaboration Opportunities

- Reimbursable basis
- Cooperative Research and Development Agreement (CRADA)
- Memorandum of Agreement (MOA)
- Educational Partnership Agreement (EPA)
- Intergovernmental Cooperative Agreement (ICA)
- Interagency Agreement (IAA)

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