

# Modeling the effects of climate change on the gopher tortoise (*Gopherus polyphemus*)

A tool for developing preemptive conservation strategies in Georgia

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## Why Gopher Tortoises?

Gopher tortoises function as ecosystem engineers and considered to be a keystone species of longleaf pine ecosystems in the southeastern U.S. (Fig 1). The gopher tortoise helps shape the community around it by directly influencing the plant and animal species assembled within the ecosystem.

The gopher tortoise is listed as “threatened” by the state of Georgia and has been identified as a high-priority species on Georgia DNR’s State Wildlife Action Plan (SWAP). Several other threatened or endangered species listed on the state’s action plan depend on the gopher tortoise for their survival.

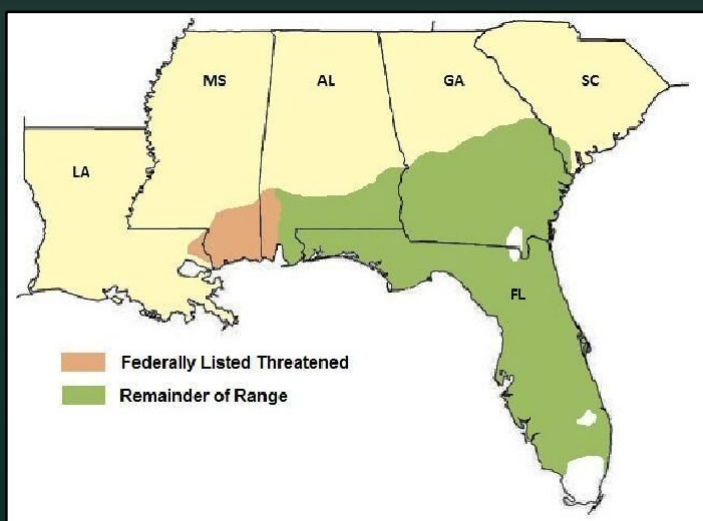


Fig 1. Gopher tortoise habitat range is limited to the southeastern United States.

## Background

Gopher tortoises have been around for nearly 60 million years and have driven the evolution of certain species.

Their presence in an ecosystem positively correlates with biodiversity levels, and may directly impact plant community assembly altogether (Richardson and Stiling, 2017; Catano and Stout, 2015).

Suitable habitats in Georgia consist of pine forests with loose soils and sparse canopy managed by controlled fires.

Studies show the gopher tortoise employs “selective” and “avoidance” behaviors when selecting their habitat (McCoy et al., 2013).

**Tortoise populations in Georgia are on the decline due to:** (1) habitat fragmentation from land development and (2) habitat degradation from lack of management (e.g., prescribed burns).

It is speculated that burn-window availability under current criteria will decline in the coming years due to climate change (Kupfer et al., 2020).

Biodiversity impacts ecosystem function, which provides the goods and services of which society depends on (Cardinale et al., 2012).



Gopher tortoise; photo by FWC Fish and Wildlife Research Institute on Flickr

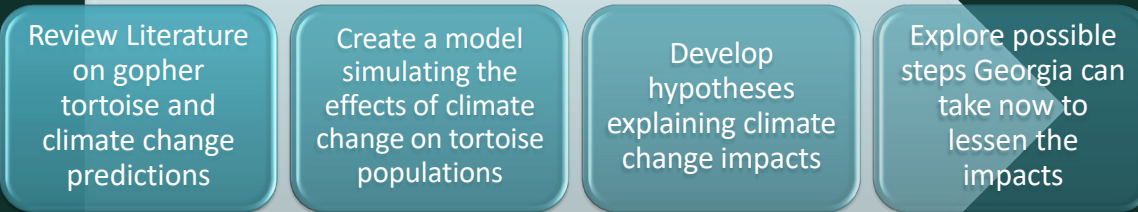
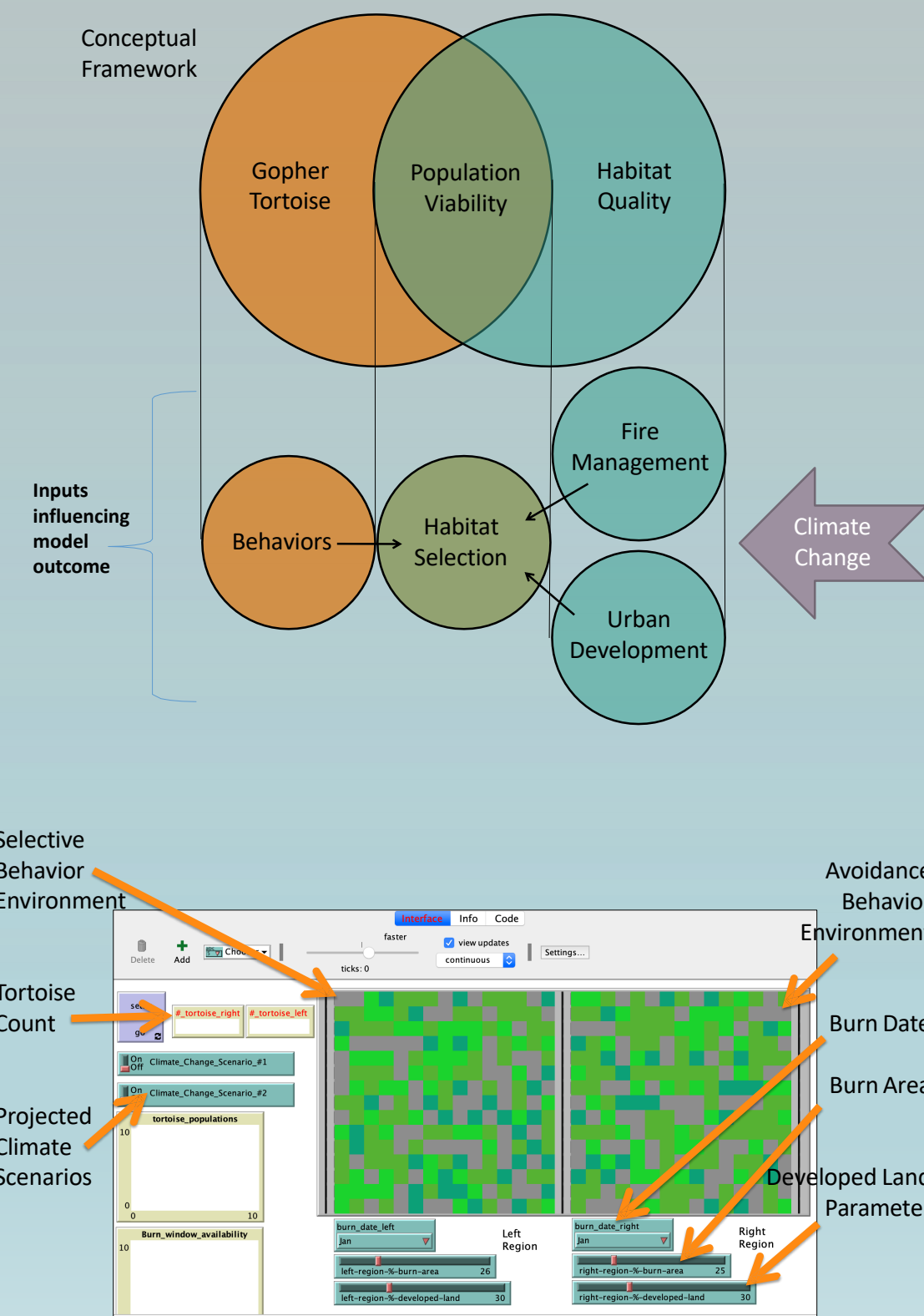
## Project Goals

The project goals for this study were collectively taken from priorities listed within the Georgia Climate Project’s *Climate Research Roadmap* \*\* and the Georgia DNR’s 2015 State Wildlife Action Plan (SWAP).

- To collect literature and write a review on known and potential affects of climate change on gopher tortoise habitat and populations
- To develop a model framework using important natural history traits of the gopher tortoise
- To use model framework to develop an agent-based model in NetLogo to simulate effects of climate change
- To develop hypotheses based on simulation analysis that may explain the effects of climate change on gopher tortoise populations
- To explore steps Georgia may take to reduce the impact of climate change-induced outcomes on gopher tortoise populations
- To create a repository for the NetLogo model to make publicly available

## NetLogo Model Framework & Interface

NetLogo is a free, agent-based modeling software



## Prospective Insights for Ecosystem Engineering

- Frequent controlled burns reduce the risk of large wildfires from occurring.
- Insights into burn-window availability better prepares fire management.
- Incorporating habitat selection behavior improves model accuracy.
- Predicting impacts on tortoise populations improves conservation strategies.
- Protecting gopher tortoise populations preserves ecosystem biodiversity.
- Effective ecosystem conservation reduces risk and protects ecosystem function.



Prescribed fires not only preserve longleaf pine forests, but also reduce the risk of larger, uncontrolled wildfires from spreading.

\*\* The Georgia Climate Project: *Climate Research Roadmap*, is an initiative outlining 40 research priorities that would most benefit Georgia policy-makers, practitioners, and scientists in enacting effective climate policy (Rudd et al, 2018).

(Q. 7) What species and ecosystems are most at risk of population declines or extirpation due to climate stresses?

References

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