Bigleaf magnolia (*Magnolia macrophylla*), Alabama

Project CAPTURE: A U.S. National Prioritization Framework for Tree Species Threatened by Climate Change

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Bristlecone fir (*Abies bracteata*), California

Introduction

Climate change and other threats will increase the likelihood that forest tree species could experience significant genetic degradation. Scientists and managers from throughout the USDA Forest Service have developed a framework for conservation priority-setting assessments of forest tree species.

The Project CAPTURE (Conservation Assessment and Prioritization of Forest Trees Under Risk of Extirpation) framework is data-driven and guided by expert opinion, and allows for the quantitative grouping of species into vulnerability classes that may require different management and conservation strategies.

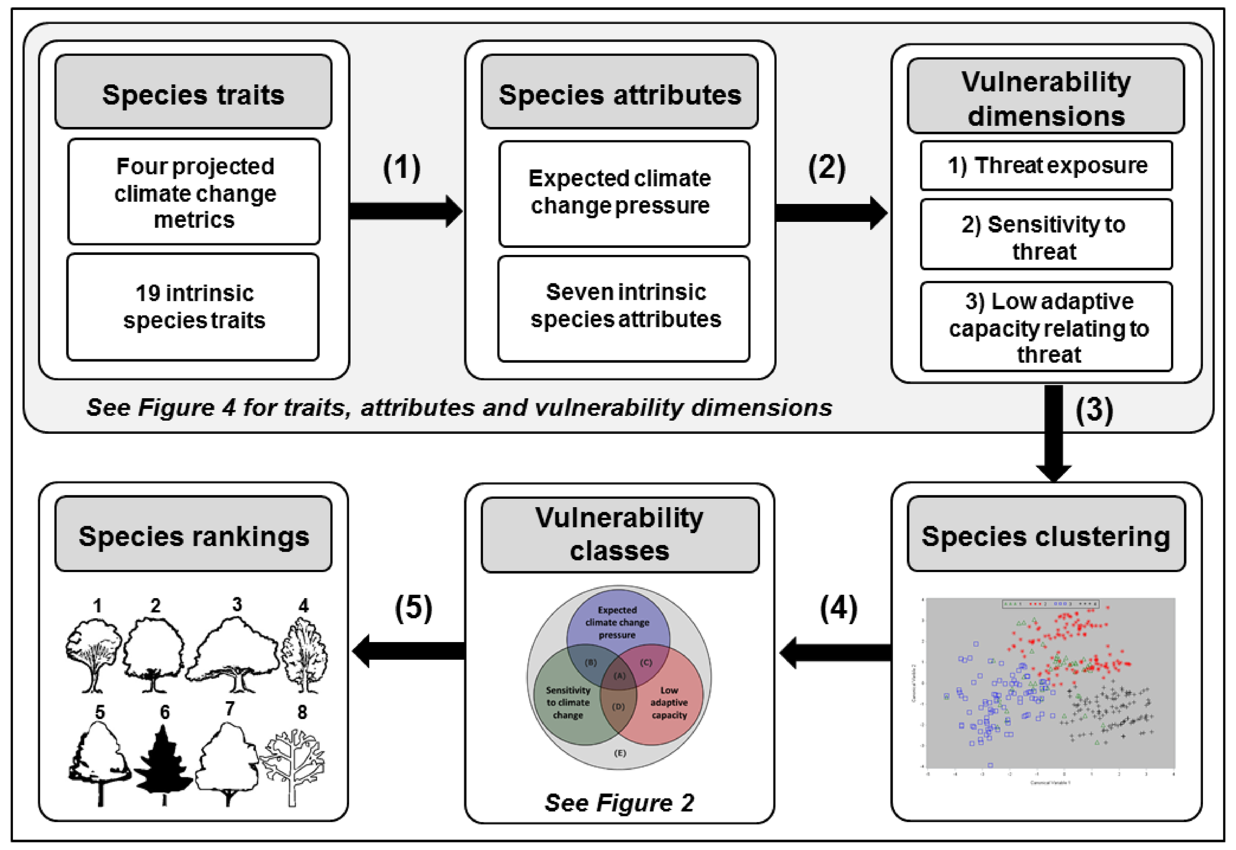
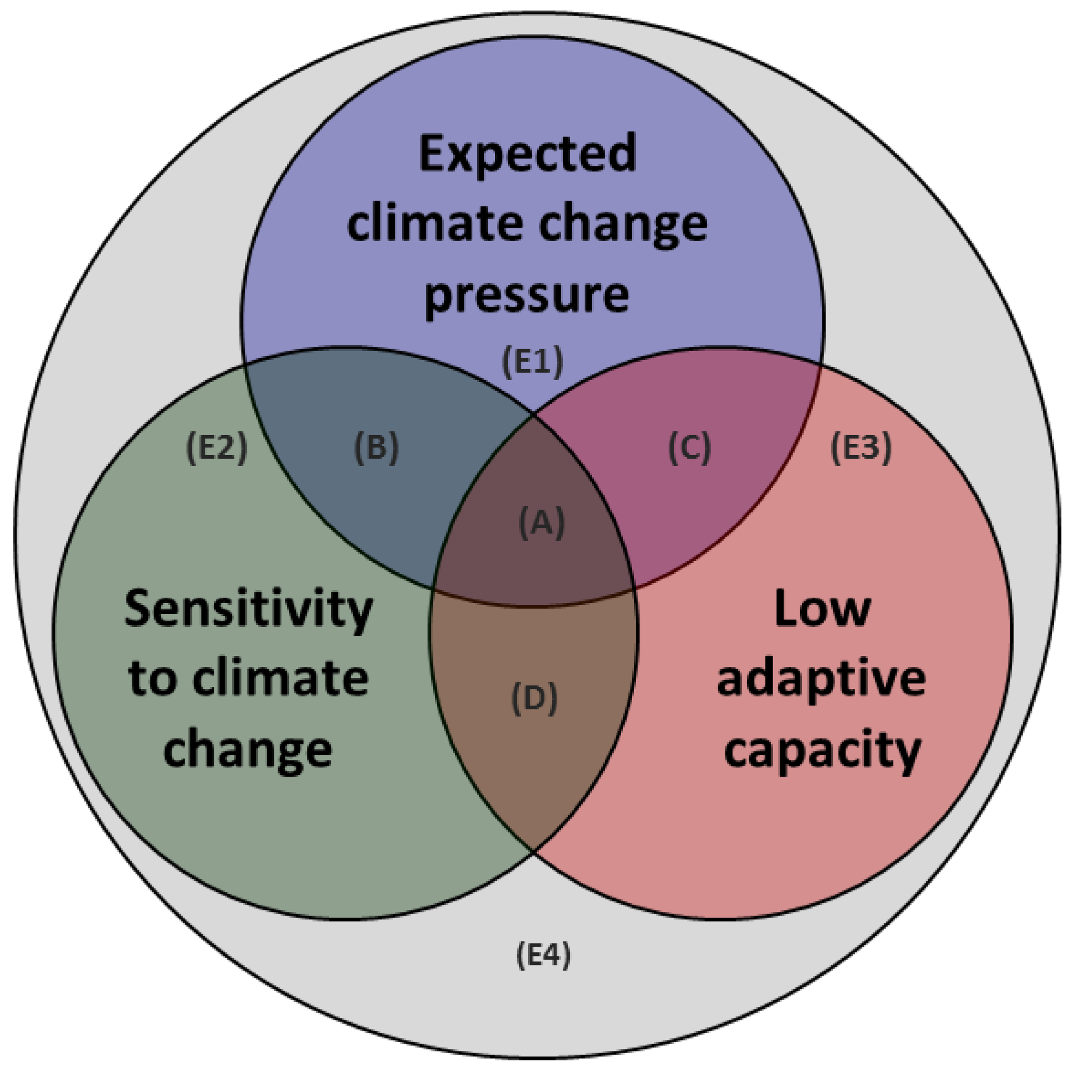


Figure 1: ***The Project CAPTURE framework, consisting of five steps (see below), categorizes species for different conservation and management actions.***

Framework

We used the Project CAPTURE framework to conduct a vulnerability assessment **(Figure 1)** for 339 forest tree species native to the contiguous United States. The assessment's five steps are described in Potter *et al*. (2017), and were guided by a survey and workshop of USDA Forest Service geneticists, ecologists, silviculturists, and forest health experts:

1) Assignment of species traits to broad species attributes (**Figure 3**);
2) Assignment of attributes to vulnerability dimensions;
3) Quantitative clustering of the 339 species using the vulnerability dimension data;
4) Association of each cluster with climate change vulnerability classes (**Figure 2**);
5) Calculation of vulnerability scores and rankings within each vulnerability class (**Table 1**).



Vulnerability Classes

A) **High vulnerability, little adaptation or persistence potential** (*immediate gene conservation*)
B) **Highly vulnerability, potential adaptation** (*management, assisted migration, etc.*)
C) **Highly vulnerability, potential persistence** (*intensified population monitoring*)
D) **Potential high future vulnerability** (*monitoring of potential threats*)
E) **Low current vulnerability** (*routine monitoring*)

Figure 2: ***Conceptual relationships among the three vulnerability dimensions (expected climate change pressure, sensitivity to climate change, and low adaptive capacity), and the description of vulnerability classes defined by those vulnerability dimensions, based on Foden et al. (2013).***

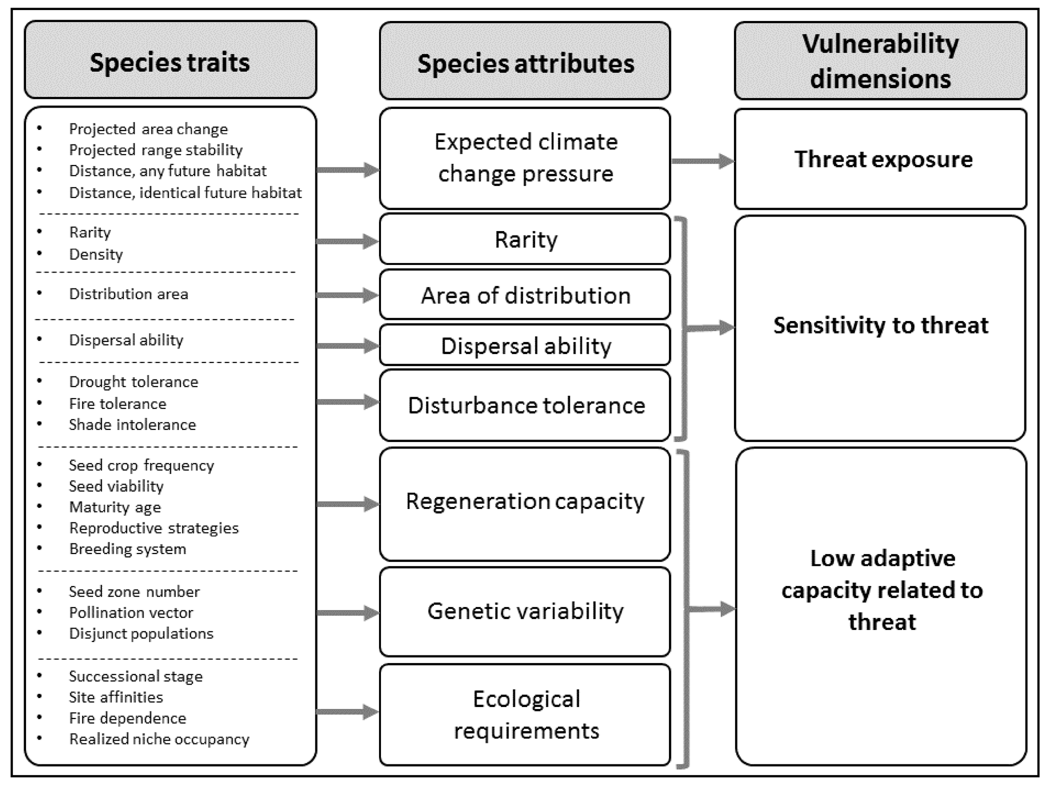
Methods

The Project CAPTURE framework incorporates eight species attributes, based on a review of ecological and life-history traits that predispose tree species to genetic degradation **(Figure 3)**. The attributes consist of 19 intrinsic and four external traits. The attributes are assigned to one of three vulnerability dimensions (**Figure 2**).

K-means clustering in SAS 9.4 is used to quantitatively group species based on each species' three vulnerability dimension scores. Each cluster is then associated with one of the vulnerability classes.

Species are given a vulnerability rating based on the mean of their three vulnerability dimension scores (on a scale of 0-100), and are ranked within their vulnerability classes (**Table 1**).

Figure 3: ***The hierarchical vulnerability assessment framework. Species traits (such as pollination vector) are aggregated into species attributes (such as genetic variability), which are then aggregated into one of the three vulnerability dimensions.***



Data

The data used in the assessment are freely available, including:

- Forest Inventory and Analysis (www.fia.fs.fed.us) **(Figure 4)**.
- Forecasts of Climate-Associated Shifts in Tree Species (ForeCASTS) (www.forestthreats.org/tools/ForeCASTS) (Potter and Hargrove 2013) **(Figure 5)**.
- Silvics of North America (www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm).
- Fire Effects Information System (FEIS) (https://www.feis-crs.org/feis/).
- Woody Plant Seed Manual (https://www.fs.usda.gov/nsl/nsl_wpsm.html).

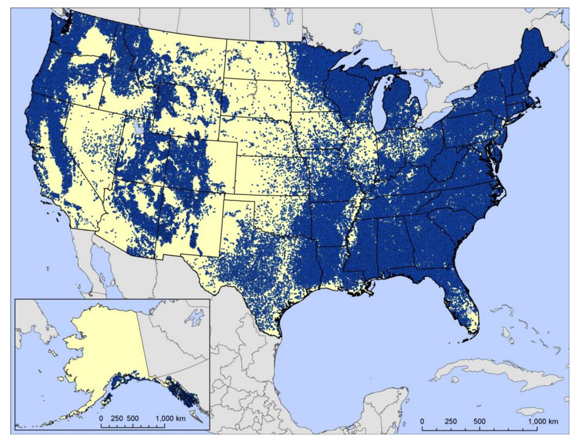


***Figure 4:* FIA plots.**

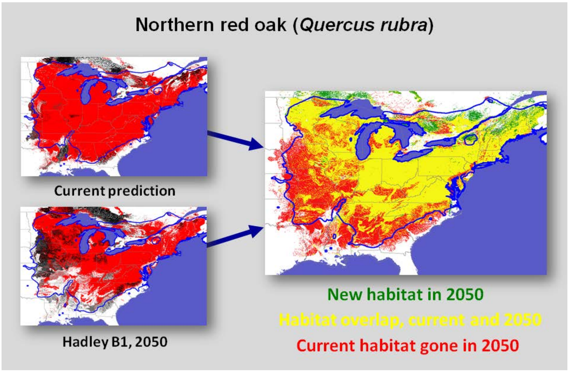


***Figure 5:* ForeCASTS climate change map.**

Results/Discussion

Table 1: ***The 20 tree species with the highest vulnerability scores.***

Rank	Species	Score
1	water locust (*Gleditsia aquatica*)	79.8
2	Texas walnut (*Juglans microcarpa*)	78.6
3	chalk maple (*Acer leucoderme*)	78.1
4	pyramid magnolia (*Magnolia pyramidata*)	77.8
5	two-wing silverbell (*Halesia diptera*)	76.0
6	butterbough (*Exothea paniculata*)	75.2
7	Ozark chinquapin (*Castanea pumila* var. *ozarkensis*)	75.2
8	Mexican palmetto (*Sabal mexicana*)	73.6
9	September elm (*Ulmus serotina*)	73.2
10	paradise-tree (*Simarouba glauca*)	71.1
11	bigleaf magnolia (*Magnolia macrophylla*)	71.1
12	Allegheny chinquapin (*Castanea pumila*)	70.1
13	Arkansas oak (*Quercus arkansana*)	69.8
14	sweet crabapple (*Malus coronaria*)	69.7
15	Ohio buckeye (*Aesculus glabra*)	69.6
16	bristlecone fir (*Abies bracteata*)	69.3
17	white basswood (*Tilia americana* var. *heterophylla*)	69.0
18	beeftree (*Guapira discolor*)	68.8
19	Florida maple (*Acer barbatum*)	68.3
20	Carolina silverbell (*Halesia carolina*)	67.7

The most vulnerable class encompassed 35 species with high scores for all three vulnerability dimensions **(Table 1)**. These will require the most immediate conservation intervention.

Project CAPTURE should be valuable for scientists and managers determining which species and populations to target for monitoring efforts and for pro-active gene conservation and management activities. An ongoing assessment effort focuses on pest and pathogen threats.

References

Foden, W.B., Butchart, S.H.M., Stuart, S.N. [and others]. 2013. Identifying the world's most climate change vulnerable species: A systematic trait-based assessment of all birds, amphibians and corals. *Plos One.* 8 (6).

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This research was supported in part through Joint Venture Agreement 13-JV-11330110-072 between the USDA Forest Service and North Carolina State University.

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