Communities in Crisis:

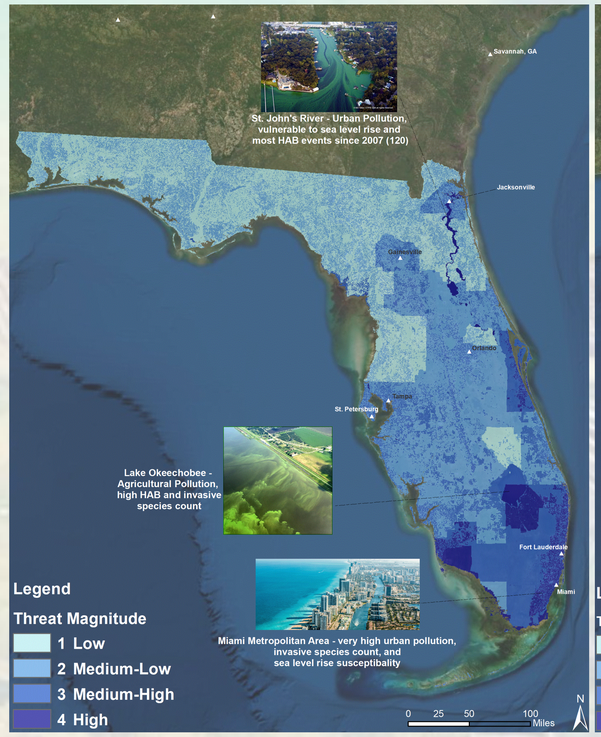
Assessing the Vulnerability of Freshwater Fish Populations in Florida

INTRODUCTION

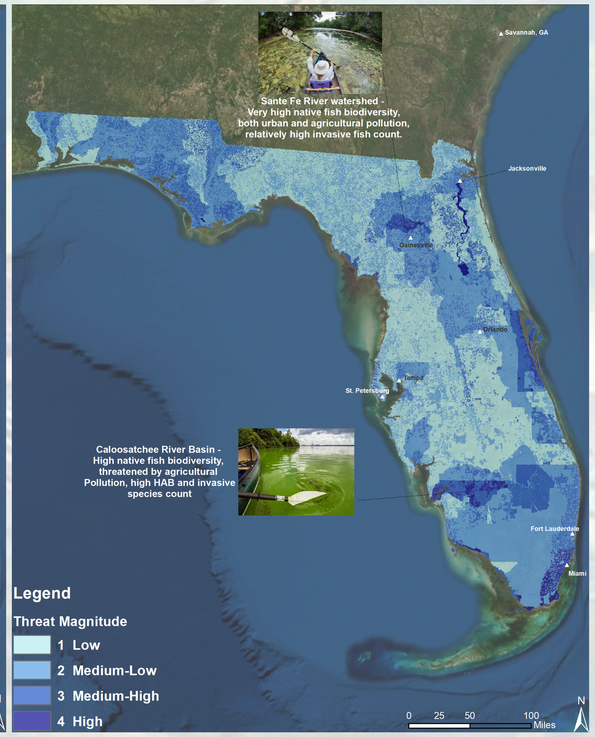
Native freshwater fishes in Florida must contend with a noteworthy amount of threats in comparison to fish species in other areas of the U.S. Among these threats are changing land use as a rapidly developing state (which leads to urban pollution), agricultural pollution from the state's 9.5 million acres of farmland[1], and harmful algae bloom (HAB) events as a result of this pollution and increasing temperatures. Additionally, as a favorable climate for many tropical species and a center of trade, Florida boasts the highest concentration of non-native species in the world, with >50 exotic freshwater fish species alone[2]. Finally, Florida as an extremely low-lying, coastal-oriented state, Florida is expected to be the U.S. state most severely impacted by sea level rise[3]. It is clear that these threats have varying distributions across the state, but it is not clear if the areas of the greatest native freshwater fish biodiversity are spatially correlated with areas of high threats. Therefore, this project is intended to both assess the vulnerability of areas in Florida to this set of diverse threats and to compare where threats are located in relation to where native fish biodiversity is located.

Clockwise from top left: Harmful Algae Bloom event in Florida's Caloosahatchee River during the summer of 2018; net filled with invasive Mayan Cichlid (*Mayaheros urophthalmus*), pesticide spraying on Florida farmland

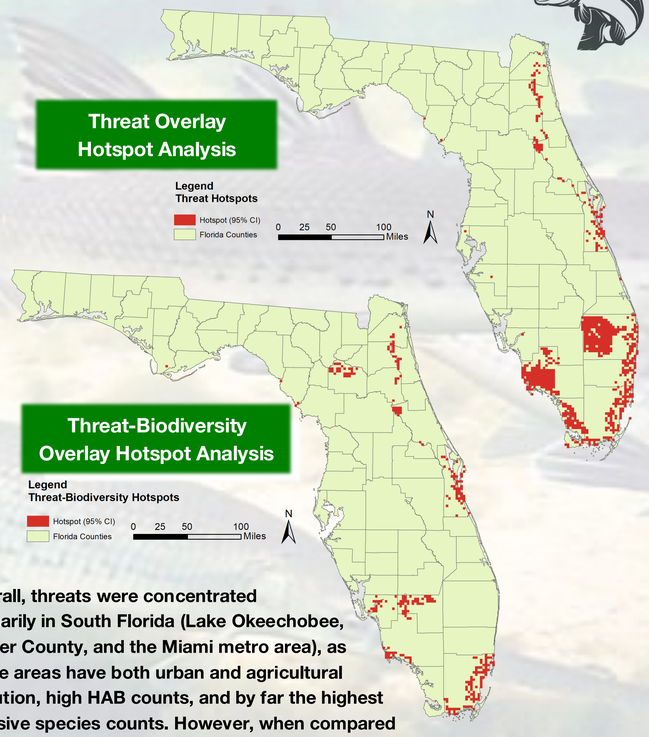
Threat Overlay



Threat-Biodiversity Overlay



FINDINGS



Overall, threats were concentrated primarily in South Florida (Lake Okeechobee, Collier County, and the Miami metro area), as these areas have both urban and agricultural pollution, high HAB counts, and by far the highest invasive species counts. However, when compared to the overlay of threats and native species diversity, South Florida appears less under threat (with the exception of the Caloosahatchee watershed) as the area generally supports less native fish diversity in comparison to North Florida. These Northern areas that have a lower concentration of threats but high diversity include the Santa Fe River basin and parts of Brevard County. The St. John's River ranks as highly threatened by both metrics (high diversity, susceptible to sea level rise, and the highest HAB count in Florida). These results are reflected in clustering analyses above, which demonstrate that statistically significant vulnerability hotspots become more evenly distributed across the state when native fish biodiversity is included as a factor.

The most significant limitation of this study were the differences in the way species counts, HAB's, and sea level rise were quantified. Due to the low spatial resolution of these data, raster overlays also exhibited a relatively low spatial resolution. Therefore, in the future, similar analyses of species vulnerability may be best conducted in vector format by water body. Despite these limitations, this analysis was successful at displaying the broad strokes of how threats to native fish biodiversity are distributed in Florida, and therefore which areas have the most significant conservation need.

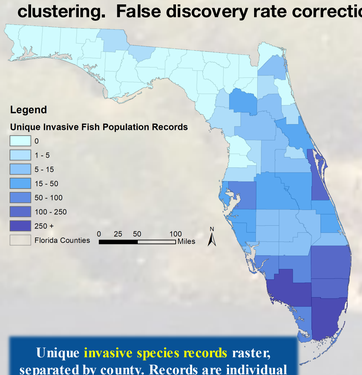
METHODOLOGY

Data for both land cover and Harmful Algae Bloom event points were downloaded from the Florida Fish and Wildlife Conservation Commission (FWC). Land cover data was reclassified into high threat (high intensity urban, agricultural, extractive), low threat (low intensity urban) and non-threat land types. HAB points were joined to Florida hydrologic data and rasterized by join count. Projected sea level rise data was downloaded via NOAA. According to the IPCC's RCP 4.5 (mid-range projection for sea level rise), global mean sea-level is likely to rise around ~.5 m from current baselines by 2100. Therefore, I used the closest available sea level rise polygon data from NOAA, which was for 2 foot (~0.6 m) mid-tide rise. These polygons were clipped to hydrologic data (which were used to set clipping geometry) in order to quantify direct impact of sea level rise on freshwater features and included in the threat raster as a Boolean constraint.

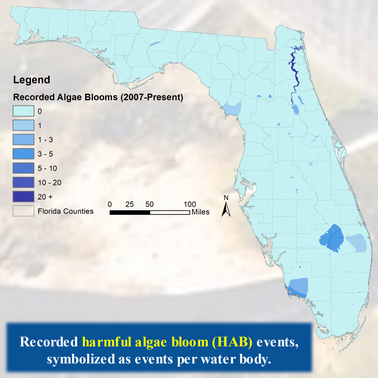
Threats from invasive species were quantified using invasive species point observations from the Early Detection and Distribution Mapping System. >50 individual species shapefiles were downloaded and iterated by feature class to select layers by location in order to obtain Florida-specific ranges, which were then appended into one shapefile and joined to county polygons in order to rasterize by invasive count. A similar method was used to create a native species diversity raster (iterating through all 865 native US freshwater species) to compare to the threat raster, except these data were polygons split by watershed. After a threat raster was created, spatial statistics (Getis Ord Gi) were used to quantify clustering. False discovery rate correction was applied to account for spatial dependency.

Threat-Biodiversity Raster Factors

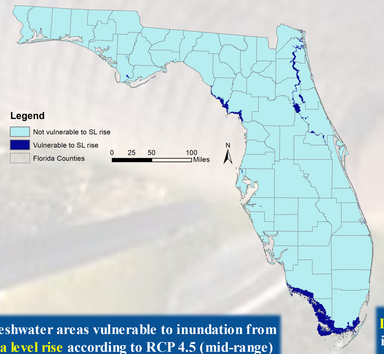
Threat	Quantification	Weight
Invasive fish populations	Invasive fish point observations by county	20
HAB events	HAB events over time by water body	20
Land use	Low /high intensity urban, extractive, agriculture classified as threats	15
Sea level rise	Boolean; inundated water bodies by 2100 based on RCP 4.5 projection	20
Native fish species richness	Unique native fish species count by watershed	25



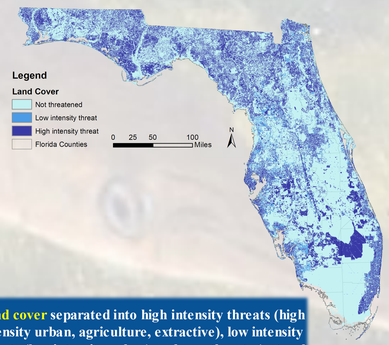
Unique **invasive species records** raster, separated by county. Records are individual observations of new invasive fish populations, not necessarily individual species.



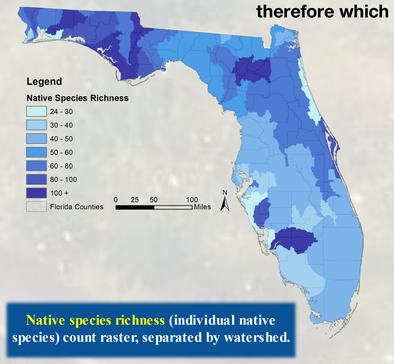
Recorded **harmful algae bloom (HAB)** events, symbolized as events per water body.



Freshwater areas vulnerable to inundation from **sea level rise** according to RCP 4.5 (mid-range) sea level rise projection.



Land cover separated into high intensity threats (high intensity urban, agriculture, extractive), low intensity threats (low intensity urban) and non-threats (natural land, miscellaneous residential, and water).



Native species richness (individual native species) count raster, separated by watershed.

Threat Overlay

Threat –Biodiversity Overlay

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Advanced GIS (GIS102)

Projection: Transverse Mercator

Coordinate System: NAD 1983 State Plane Florida FIPS 0901 (meters)

Literature Cited: (1) USDA, (2) Shafland et al. 2007, (3) Center for Climate Integrity

Data Sources: NatureServe, FWC, NOAA, EDDMAPS, ESRI

Photo Sources: Miami Herald, Towboat US, Florida Department of Health, USGS, LC3, Naples Daily News, EarthJustice

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