Why Aren't Common Toads and Frogs Breeding in Natural Areas at Wormsloe?

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My initial field project focused on species diversity of amphibians (toads, frogs, salamanders) and reptiles (snakes, lizards, turtles) at Wormsloe compared to other Georgia Sea Islands. However, low capture rates for most species and lack of tadpoles of more common species shifted the project focus. The below average rainfall the past several years undoubtedly contributed to these initial results. However, the lack of tadpoles for two abundant toads personally observed breeding was more puzzling. It turns out that the anthropogenic ditches and canals connecting inland freshwater ponds to tide resulted in occasional tidal influence. Toads and frogs do not tolerate brackish (i.e. slight salt) water, so the lack of egg-laying despite observed copulation indicated that the brackish water was limiting successful breeding.

Therefore, my research focus shifted to identifying depressions and canals from lidar data, measuring salinity, modeling tidal stage that would cause saltwater flux 250 m to 400 m inland, and comparing Wormsloe to other nearby conservation areas with similar land-use history. Comparison sites include Skidaway Island State Park, UGA Marine Extension/SKIO lands, and Rose Dhu Island.

As noted above, Savannah (and all of Georgia) received below average rainfall for several years before this study began in spring 2011. Above average rainfall occurred in 2013. Unfortunately, no surficial USGS or other water stage gages exist for the region – only precipitation measurements.

Over summer 2013, field visits were made in June and August. Inland depressions on Wormsloe had more water than observed since spring 2011, although the water was still slightly brackish (3 to 5 ppt compared to 30 ppt for nearby tidal marsh). The brackish water indicates that tidal influx influences inland depressions even in some years of higher rainfall. However, since this was the first year of above average rainfall after several years of below average, surficial aquifer levels need to be replenished by rainfall soaking into the ground before depressions may hold enough surface water to prevent tidal influx.

In June 2013, Southern toad tadpoles occurred only in the artificial water lily pond behind the Big House. This occurs most years; of significance, no other species of tadpoles have been observed in this lily pond. Southern toad metamorphs (e.g. recently metamorphed tadpoles) were seen up to 400 m from this artificial pond, which is within range for natural dispersion from natal ponds. Neither egg masses nor tadpoles were seen in any of the natural depressions.

However, Southern leopard frog tadpoles and metamorphs occurred in natural depressions at both Skidaway Island State Park and Rose Dhu Island.

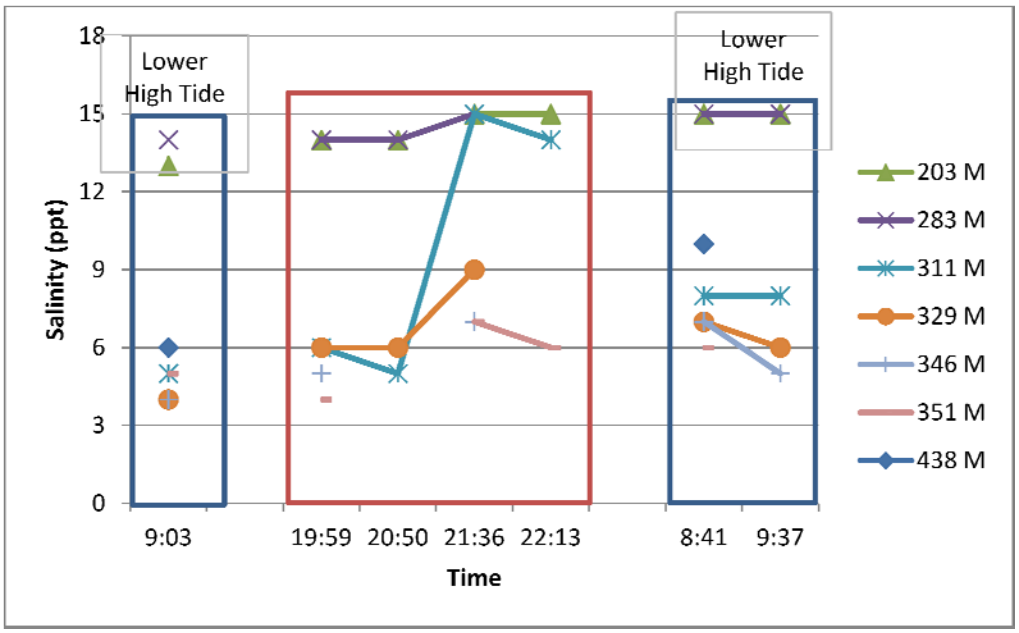
In August, hylid (treefrog) tadpoles and metamorphs occurred at two ponds on MarEx lands. Most interestingly, tens of thousands of hylid tadpoles occurred in a depression that had never had surficial water since 2011, was dry in June but in August had <20 cm of water and covered less than ~500 sq ft. On a single pond at Skidaway Island State Park, 50 to 100 metamorphs of Southern leopard frog occurred around a single depression of less than 200 sq ft. On Rose Dhu Island, a single depression also had hundreds of Southern leopard frog metamorphs, but no indication of Southern toads or hylids. Still, inland depressions at Wormsloe with 15 to 30 cm of water covering larger areas had no evident tadpoles or metamorphs.

Bathtub models of tidal influence, which simply fill in water depth based upon difference of tidal water stage versus ground elevation, do not work for Wormsloe for several reasons. First, while lidar does provide a high resolution digital elevation model, the resolution of 18 to 25 cm may still miss fine scale variations. Second, there are classification errors caused by dense vegetation overhanging canals, resulting in higher ground elevation than actually exists. Overall, the net result of bathtub models of tidal flow show that upstream (uptide) areas fill with water before the actual tidal flow path along ditches/canals occurs. Therefore, actual field measurements were necessary to actually determine tidal influx into historically freshwater inland depressions.

Salinity and water depth changes were measured during August monthly high tides. Measurements were made at fixed points (identified by plastic poles). Daily low high tides[1] of 8.9 ft and 9.2 ft did not cause obvious flow or increase in stage or salinity more than ~280 m from tidal marsh and did not reach the depression ~320 m (see figures next page). However, high high tide of 9.6 ft 12 hours later did cause obvious water flow, increased surface water depth, and increased salinity up to 450 m along tidal flow path (i.e. ditches). Sites closest to marsh had little changes in salinity (uniformly high), but up to 30 cm changes in water depth. Sites further inland had more changes in salinity but less in water depth; those sites furthest inland had lower changes in salinity (uniformly low) and depth. However, the fact that sites up to 450 m inland with 9 to 13 cm of surface water had brackish water (6 to 10 ppt depending upon preceding tidal stage) supports the hypothesis that tidal influx limits amphibian breeding. These field measurements suggest that tidal stages above 9.2 ft are necessary for tidal influx to reach some inland depressions. Stages above 9.2 ft do not occur every month.

[1] Tidal stage from gage on Isle of Hope, referenced to Fort Pulaski. Stage is in ft above mean low water level.

Changes in salinity at fixed points thru time along canal leading to inland depression. Plots are coded by distance from tidal marsh. For example the green-triangle plot is 203 meters inland from tidal marsh. There was no obvious flow during morning lower high tides, so fewer measurements were made.



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