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

Wormsloe Fellows October 10, 2013
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I continued work on modeling minimum tidal stage that will inundate inland depressions. This minimum may differ among depressions since length, depth, and slope of drainage ditches connecting inland depressions to tide varies.

Field work during the summer suggested that tidal stages slightly above 9.2 ft[1] will have sufficient energy and height to flow inland 200 to 400 m to inundate natural depressions. To investigate how often such tidal stages may occur, I summarized a 10 year data set (October 1, 2003 thru September 30, 2013) of tidal stage from a gage at the northern end of the Isle of Hope. From tidal gage data, tidal stage at or above 9.3 ft occurred 8 to 11 months per year (Table 1), with an average of 1 to 3 days during these months. This represents ~5.5% of the entire year. But even this over-represents actual tidal influence; it is unclear how many hours each tidal influx actually impacts water quality. Field observations suggest tides are "in" for less than one hour, even though all tide water may not be pulled out by ebbing tide.

Regardless of difficulty in quantifying actual duration of tidal impact, 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.

Additional field verification is necessary since other field observations suggested that tidal influx occurred mainly during the annual highest tides near the spring and fall equinoxes.

Year	# of Months	# of Days	X Days/Month	% of Year
2003	3	9	3	---
2004	9	21	2.3	6%
2005	10	17	1.7	5%
2006	10	20	1.0	5%
2007	9	21	2.3	6%
2008	9	22	2.4	6%
2009	10	23	2.3	6%
2010	11	20	1.8	5%
2011	11	20	1.8	5%
2012	9	20	2.2	5%
2013	8	17	2.1	---

[1] Elevations are relative to a "zero" elevation, called vertical datum. There are tidal datums, which relate surface elevation of water to a tidal mean (e.g. mean high water, mean water (averages high and low tide), mean low water, etc. NOAA reports water stage relative to mean lower low water (MLLW) tidal stage. Therefore, water stage from NOAA (in MLLW vertical datum) must be converted to vertical datum to integrate with ground surface analyses (lidar used datum of NAVD 1988). In this area, the difference between MLLW and NAVD 1988 is ~4 ft.

The summaries above are based upon predicted tides. Actual tidal stage may differ, dependent upon other circumstances (e.g. strong winds). However, they provide a reasonable estimate of the temporal extent of tidal inundation.

Hydrological analyses of ground surface digital elevation model in ArcGIS 10.1 did not identify any major sinks or natural flow pathways at Wormsloe. This is not surprising; no natural cricks occur, and the region has relative flat topography. It also suggests that natural depressions are filled by more rainwater than the ground can absorb.

The DEM requires smoothing for the ditches to show consistent directional flow inland outward to tide. The trend is evident. However, there are high elevations "bumps" in the DEM that probably do not represent real world conditions. There were likely three reasons for this. First the topography is at the limits of lidar resolution, which is RMSE of 25 cm (0.82 ft or 9.8 inches) in areas with dense ground cover or dense overstory, such as Wormsloe. Secondly, there may also be errors introduced by incorrect classification of dense vegetation as a ground point. Thirdly, some high points may represent rafted materials within the ditch. Rafter materials can be up to 20 cm deep. But, tidal flow occurs under the rafted material (personal observation).

As noted earlier, a natural slope inland out toward tide exists for the drainage ditches. The fact that tides are now working against this natural slope to inundate inland depressions is curious. It also indicates that hydraulic models of water flow are necessary to accurately predict water flow essentially up-slope.