

Interim annual report 2017

Pocomoke State Forest

Name of Principal Investigator: Beth A. Middleton, Evelyn Anemaet

Study Title: Vulnerability assessment of baldcypress swamps to climate change at the edge of the range.

Purpose of scientific study:

The project will examine carbon allocation and sequestration patterns in baldcypress swamps across the continental United States to provide insight into potential changes in carbon sequestration in response to global climate change. Specifically, above- and below-ground carbon stores and primary production will be estimated and compared in 72 sites from 12 locations across the Mississippi River Alluvial Valley, the Gulf Coast, and the Delaware-Maryland peninsula. The results will provide specific information needed to make predictions concerning carbon sequestration in baldcypress swamps in future climate scenarios. The findings will be directly applicable to models of global climate change effects on carbon sequestration. We will test the hypotheses that the rates of leaf litter and root production, carbon sequestration, and above and below ground standing crops are uniform in baldcypress swamps across the continental United States.

The objective of this study is to determine if carbon sequestration patterns differ in baldcypress swamps across the continental United States. This information will be of value in predicting potential levels of future carbon in this major wetland type of North America. Future carbon patterns can be inferred from those of baldcypress swamps experiencing a variety of climatic environments already present along the latitudinal gradient. We will test the hypotheses that the rates of leaf litter and root production, carbon sequestration, and above and below ground standing crops are uniform in baldcypress swamps across the continental United States.

For scientific studies, were any specimens collected?

Beth Middleton, Evelyn Anemaet and student workers visited the baldcypress survey sites in January (Florida, Jean Lafitte, Texas), July (Florida, Jean Lafitte), in August (Texas, Maryland, Delaware, Illinois, Tennessee, Arkansas, Mississippi and Louisiana), in September (Florida), in October (Texas), in November (Delaware, Illinois, Maryland and Tennessee) and in December (Arkansas, Florida, Louisiana, Mississippi and Texas). In July/August Beth, Evelyn and assistant workers set up the leaf litter traps (to measure above-ground production), removed old and inserted new root ingrowth bags (to measure annual below-ground production), surveyed the vegetation (to determine percent cover by species), measured the Surface Elevation Transects (SETs, to monitor elevation) and dendrometer bands (to measure tree growth), took canopy cover photos (to determine leaf area), and sampled soil and porewater. For September and October, we surveyed the sites in Florida and Texas to evaluate hurricane damage from hurricanes Harvey and Irma. In January (Florida, Jean Lafitte and Texas), November and December (all sites), we collected the leaf litter samples, downloaded water data, and

collected seeds and porewater samples. Throughout 2017 at the Wetland and Aquatic Research Center (WARC) laboratories, we continued leaf litter sample drying, sorting and weighing for samples from previous and current years, and processed root ingrowth bags to determine the above- and below-ground production. Canopy cover photos were downloaded, analyzed using Gap Light Analyzer software, and the results compiled with data from previous years. Vegetation survey data, litter and root biomass, water logger data, and SET and dendrometer band measurements were entered into spreadsheets, porewater samples were analyzed for pH and salinity, and the results compiled with sample data from previous years.

Findings and status for 2017:

Journal Articles

Middleton, B.A., and Souter, N., 2016, Functional integrity of freshwater forested wetlands, hydrologic alteration, and climate change: *Ecosystem Health and Sustainability*, v. 2, no. 1, art. e01200, 18 p., <http://dx.doi.org/10.1002/ehs2.1200>.

Middleton, B.A. 2016. Differences in impacts of Hurricane Sandy on freshwater swamps on the Delmarva Peninsula, Mid-Atlantic Coast, USA. *Ecological Engineering* 87: 62–70.
www.sciencedirect.com/science/article/pii/S0925857415302901.

Ikezaki, Y., Suyama, Y., Middleton, B.A., Tsumura, Y., Teshima, K., Tachida, H., and Kusumi, J., 2016, Inference of population structure and demographic history in *Taxodium distichum*, a coniferous tree in North America, based on amplicon sequence analysis: *American Journal of Botany*, 103:1937-1949, <http://dx.doi.org/10.3732/ajb.1600046>.

Middleton, B.A., 2016, Effects of salinity and flooding on post-hurricane regeneration potential in coastal wetland vegetation: *American Journal of Botany* 103(8):1-16, <http://dx.doi.org/10.3732/ajb.1600062>.

Middleton, B.A., 2016, Broken connections of wetland cultural knowledge [Comment]: *Ecosystem Health and Sustainability*, v. 2, no. 7, art. e01223, <http://dx.doi.org/10.1002/ehs2.1223>.

Middleton, B.A., D. Johnson, and B. Roberts. 2015. Hydrologic remediation for the Deepwater Horizon Incident drove ancillary primary production increase in coastal swamps. *Ecohydrology*: 8:838–850. Environmental Monitor: www.fondriest.com/news/oil-flushing-mississippi-river-pulse-also-boosted-coastal-wetland-production.htm www.mississippiriverdelta.org/blog/2015/03/09/latest-mississippi-river-delta-news-march-09-2015/

Lei, T. and B. A. Middleton. 2017. Drought alters resilience of seed bank regeneration in *Taxodium distichum* swamps of North America. *Ecosystems* <https://link.springer.com/article/10.1007/s10021-017-0143-y>

Middleton, B.A., J. Boudell, and N. Fisichelli. 2017. Using management to address vegetation stress related to land-use and climate change. *Restoration Ecology* 26:1–4.

Osland, M., K. Griffith, J. Larriviere, L. Feher, D. Cahoon, N. Enwright, D. Oster, J. Tirpak, M. Woodrey, R. Collini, J. Baustian, J. Breithaupt, J. Cherry, N. Cormier, C. Coronado-Molina, J. Donoghue, S. Graham, J. Harper, M. Hester, R. Howard, K. Krauss, D. Kroes, R. Lane, K. McKee, I. Mendelssohn, B. A. Middleton, J. Moon, S. Piazza, N. Rankin, F. Sklar, G. Steyer, K. Swanson, C. Swarzenski, W. Vervaeke, William, J. Willis, and K. Wilson. 2017. Assessing coastal wetland vulnerability to sea-level rise: gaps and opportunities for a regional sampling network. *PLOS One* <https://doi.org/10.1371/journal.pone.0183431>.

Middleton, B.A. 2017. Climate and land-use change in wetlands: a dedication. *Ecosystem Health and Sustainability*. Online, Nov 25, 2017, Article 1392831.

Finlayson, C.M., Davidson N.C., B. Middleton, R. McInnes, M. Everard, K. Irvine, A.A. van Dam, C.M. Finlayson, editors. 2017. Preface. *The Wetland Book. Vol. 1: Wetland structure and function, management, and methods*. Springer, Dordrecht, The Netherlands.

Middleton, B.A. 2017. Invasive plant species. *Encyclopedia of Ecology*. C. Jorgensen, ed. Elsevier, Oxford, UK.

Fidler, T., Heglund, P, Shimp, J., Blodgett, D., Guetersloh, M., Johnson, E., Keefer, M., Mangan, K., Middleton, B., Sparks, R., Speer, R., White, J., and Stanton, J. 2017. Managing the Middle Cache River to restore and sustain ecological and human values of Buttonland Swamp. A decision analysis workshop report. U.S. Fish and Wildlife Service (in review). IP-091456.

Rice, K., P. Beier, T. Breault, T., B.A. Middleton, M.A. Peck, J. Tirpak, and M. Ratnaswamy. 2017. Five-year external reviews of the eight Department of Interior Climate Science Centers: Southeast Climate Science Center: American Fisheries Society, Bethesda, Maryland, 49 p

Invited Seminars and Keynote Speeches

Middleton, Beth A. 2018. Hydrologic remediation to reduce salinity during drought in coastal freshwater forests. International Conference on Theoretical and Experimental Advance in Civil Engineering. SRM University, Kattankulathur, Tamil Nadu, India, May 12, 2018.

Middleton, Beth A. 2018. Whole river solutions to climate and land-use problems. Sigma Xi Distinguished Lecture. The Citadel, Charleston, South Carolina, February 8, 2018.

Middleton, Beth A. 2018. Wetlands and climate change. Sigma Xi Distinguished Lecture. College of Charleston, South Carolina, February 8, 2018.

Middleton, Beth A. 2017. Whole river solutions to climate and land-use problems. City College of New York, New York, November 2017.

Middleton, B.A. 2017. The wind and the salt. Trajectories of vegetation recovery following hurricanes. Sigma Xi Distinguished Lecture, Georgia Southern University, Statesboro, Georgia, November 2017.

Middleton, B.A. 2017. Wetlands and climate change. Sigma Xi Distinguished Lecture, Georgia Southern University, Statesboro, Georgia, November 2017.

Middleton, B.A. 2017. What next? Drought and flooding in the Big Thicket swamps of the Neches River. Kountze High School, Kountze, Texas, October 2017.

Middleton, Beth A. 2017. Coastal resilience to salinity intrusion, sea level rise, hurricane, drought & freshwater over-usage. US Fish and Wildlife Service, Annapolis, MD, August 2017.

Middleton, Beth A. 2017. Fostering global collaboration. SWS, San Juan, Puerto Rico, June 2017 (luncheon speaker).

Middleton, Beth A. 2017. Whole river solutions to climate and land-use problems. Departmental Retreat, Florida Atlantic University, Davie, Florida, April 2017.

Middleton, B.A. 2018. Wind and salt: coastal wetland resilience to hurricanes. University of Florida Water Institute Symposium, Gainesville, Florida. February 2018. Center Approval, Tom Doyle, 10/8/2017; IP-091371.

White, E.* , D. Kaplan, and B. Middleton. 2017. Droughts and hurricanes: stochastic weather and climate impacts on groundwater salinity in coastal baldcypress swamps. Society of Wetland Scientist, June 2017, San Juan, Puerto Rico. Center Approval, Tom Doyle, 1/16/2017, IP-084371.

Middleton, B.A. 2017. Long-term trends of climate, land-use and function in North American baldcypress swamps. US-China Workshop, Xiamen, China. Center Approval, Tom Doyle: 8/19/2016. IP-078751

Lei, T.* and B. A. Middleton. 2017. Monitoring succession in disturbed marshland vegetation in Dongting Lake. 10th Intecol Wetlands Conference, Changshu, China, September 16-21, 2016

Middleton, B.A. 2016. Marsh succession, management and climate change. 10th Intecol Wetlands Conference, Changshu, China, September 16-21, 2016

Middleton, B.A. 2015. Freshwater revives stressed tree species in tidal swamps. National Conference on Ecosystem Restoration. Coral Gables, Florida, April 18-22, 2016

Middleton, B.A. 2016. Wetlands, climate change, restoration and management. Sigma Xi Distinguished Lectureship Google Hangout. August 31, 2016

Middleton, B.A. 2016. Conservation triage for climate change and land-use impacts in wetlands. GERS-SWS Plenary Address. November 3, 2016. Pensacola, Florida

Middleton, B.A. 2016. Vegetation response to hydrologic remediation on altered floodplains. Ecological Society of America

Middleton, B.A. 2016. The wind and the salt. Louisiana State University School of the Coast. January 27, 2016

Middleton, B.A. Long-term production increase of swamp forests related to freshwater release. GOMRI, New Orleans, LA, Feb 6-9, 2017

Middleton, B.A. 2016. Long-term trends of climate, land-use and function in North American baldcypress swamps. US-China Workshop, Xiamen, China

Middleton, B.A. 2016. Reassembly of coastal freshwater swamps following hurricanes. Society of Wetland Scientists (poster). June 2016, Corpus Christi, TX. Abs.

White, E.*, D. Kaplan, and B. Middleton. 2016. Investigating the impacts of chronic low-level salinity on the productivity and resilience of coastal bald cypress (*Taxodium distichum*) swamps. Society of Wetland Scientists. (poster). June 2016, Corpus Christi, TX Abs

White, E., D. Kaplan, and B. Middleton. 2016. Investigating the impacts of chronic low-level salinity on the productivity and resilience. North Florida Marine Science Symposium, Gainesville, FL. Abs.

White, E., D. Kaplan, and B. Middleton. 2016. Investigating the impacts of chronic low-level salinity on the productivity and resilience. University of Florida Water Institute Biennial Symposium, Gainesville, FL February 16-17, 2016

Middleton, B.A. 2016. Hydrologic remediation to revive stressed freshwater species in tidal swamps. University of Florida Water Institute Biennial Symposium, Gainesville, FL February 16-17, 2016. Abs

Middleton, B.A. 2015. Conservation oblivion? TEDx Presentation, Lafayette, LA, September 12, 2015. www.youtube.com/watch?v=8O72jOgTQPw

Middleton, B.A. 2015. Webinar: Wetland restoration and management in a future of climate change. Online: www.sws.org/About-SWS/archived-webinars-for-nonmembers.html (Deliver: November 2015).

Middleton, B.A. 2015. Wetland restoration and management in a future of climate change. SWS, Providence, Rhode Island. Abs. (June 2015; Plenary).

Middleton, B. A. 2015. Climate change and wetlands panel (Heather Goldstone, science editor for WGBH and NPR panel interview with: Beth Middleton, Scott Bridgham, David Burdick, Ariana Sutton-Grier, Tim Purinton, Ambarish Karmalkar, William Moomaw). SWS, Providence, Rhode Island, June 2015. Internet slide posting: Center: Tom Doyle, 8/4/2015, IP-066193.

Middleton, B.A. 2015. Earth Day Address: Wetlands and climate change: the reconnection of people and the land. Native American Advisory Committee (NAAC), NASA Goddard Spaceflight Center, Earth Science Division for Education & Communication Colloquium, April 2015.

*Presenter