This thesis provides a mass conservation analysis of the Lower St. Johns River for the purpose of providing basis for future salinity transport modeling. The analysis provides an assessment of the Continuous (CG) and Discontinuous (DG) Galerkin finite element with respect to their mass conservative properties. The following thesis also presents a rigorous literature review pertaining to salinity transport in the Lower St. Johns River, from which this effort generates the data used to initialize and validate numerical simulations. The main scientific question posed and studied in this thesis is: what is the flow interaction between the river and the marshes within the coastal region of the Lower St. Johns River?

Reviewing the available data provides an initial perspective of the ecosystem. For this, salinity data is obtained and assembled for three modeling scenarios. Each scenario, High Extreme, Most Variable, and Low Extreme, is 30 days long (taken from year 1999) and represents a unique salinity record. Time-series of salinity data is examined at four stations along the Lower St. Johns River. Precipitation and evaporation data is also examined at seven stations along the entire St. Johns River to provide added insight into the salinity data.

A mass conservation analysis is conducted on the Lower St. Johns River, which is segmented into sections based on physical characteristics. Validation is performed at the four stations where data is obtained and assessed in terms of the hydrodynamics within the Lower St. Johns River. For the analysis, different model domains, including the main river channel and all components of the coastal wetlands, are applied for the purpose of interpreting the simulation results with respect to mass exchanges between the river and its marshes with the use of CG and DG finite element methods.