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Intertidal Ecomorphodynamic Response to Natural and Anthropogenic Influences in a Hyper-tidal Estuary

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In a 'natural' world, salt marshes and mudflats represent systems delicately balanced between hydrodynamic forces and ecological, sedimentological, and morphological responses. However, this balance may be changed as a result of anthropogenic activities such as the construction of engineering structures (e.g. causeways, dykes, culverts, shore protection), dredging, or altering landuse activities. The construction of barriers across tidal rivers and estuaries has a long history of altering the sediment dynamics and ecosystem processes in the surrounding area. The degree of alteration to the system depends in part on structure design, surrounding geology, sediment characteristics, tidal range, and basin morphology. We examine the spatial and temporal variability in the intertidal ecomorphodynamic response of the Avon River, a hyper tidal estuary in the Bay of Fundy to natural and anthropogenic influences over the last 60 years. Contemporary bathymetric (2005, 2017), low tide Lidar surveys (2007) were compared with historical surveys (1858, 1960s, and 1976) and changes in intertidal habitat examined using aerial photographs, satellite imagery and low altitude UAV imagery from 1942 to 2018 in ArcGIS. The response of the estuary can be divided into three zones of response. Within the upper two zones, dyking (1858 to 1969) exerted a significant influence on the system, decreasing accommodation space, enhancing sedimentation and inducing a shift from flood to ebb dominance as marsh accumulated seaward of the dykes. From 1969 to 1970 there was significant decrease on the order of 90% in intertidal cross sectional area within the first 1-2 km downstream of a newly installed causeway as extensive mudflats rapidly developed. Once sufficiently consolidated (1990s), these were quickly colonized by Spartina alterniflora. The influence of the causeway was moderated however by the influence of the St. Croix and Kennetcook rivers which limited sedimentation to within the first 2000 m downstream of the causeway with significant differences in tidal prism pre and post causeway. Development of intertidal mudflats was balanced by deepening of the main channel and bank erosion associated with a shifting thalweg within the second zones, establishing a dynamic equilibrium condition. This equilibrium condition was disrupted in 2012 when dredging ceased mid-estuary with marked infilling being observed within the primary channels and a shift from a steeply cliffed to ramped marsh platform. Concepts of feedback, equilibrium and self-organization are explored. The results of this study emphasize the need to examine the ecomorphodynamic response of an estuary over a wide range of temporal and spatial scales in order to develop management strategies.