Chapter 7

TEMPORAL VARIABILITY IN SALINITY, TEMPERATURE AND SUSPENDED SEDIMENTS IN A GULF OF MAINE ESTUARY (GREAT BAY ESTUARY, NEW HAMPSHIRE)

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1. INTRODUCTION

Determining temporal and spatial variations of suspended sediments and other water column physical properties (e.g. temperature, salinity, turbidity) in estuarine systems require high-resolution observations over several scales of space and time (Uncles *et al*., 1988; Dyer, 2000; Grabemann and Krause, 2001; Schmidt and Luther, 2002). Although obtaining these types of measurements can be difficult due to time, equipment and monetary constraints, they are important for developing a fundamental scientific understanding of many estuarine processes, such as primary and secondary productivity, the transport and fate of contaminants, nutrient cycling, or sedimentation (Pritchard and Schubel, 1981; Ward *et al*., 1984; Fisher *et al*., 1988; Bilgili *et al*., 1996; Allen *et al*., 1998; Lee and Cundy, 2001; Sanford *et al*., 2001; Johnston *et al*., 2002; Verity, 2002). Accordingly, numerous studies have been conducted over the last several decades that seek to describe and quantify basic estuarine physics and sedimentological processes (see Kennedy, 1984; Nichols and Biggs, 1985; Eisma, 1993, and Dyer, 2000 for reviews). For instance, it has been long understood that the combination

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and balance of freshwater input from rivers and tidal energy controls or strongly influences net non-tidal circulation (density driven), water column stratification, and sedimentation (Pritchard, 1952; Schubel and Biggs, 1969; Biggs, 1970; Schubel, 1972; Allen *et al.*, 1980; Biggs and Cronin, 1981; Ward and Twilley, 1986; Dyer, 2000; Sanford *et al.*, 2001; Schmidt and Luther, 2002). Wind energy has also been shown to have a major impact on estuaries via wind-driven circulation, mixing of the water column, and local wave-forced resuspension of bottom sediments (Anderson, 1970; Eliot, 1978; Ward *et al.*, 1984; Ward, 1985; Blumberg and Goodrich, 1990; Sanford *et al.*, 1991; Sanford, 1994; Dyer, 2000). Furthermore, high winds (and heavy precipitation) during intense storms can dominate estuarine processes (Hayes, 1978; Hirschberg and Schubel, 1979; Althausen and Kjerfve, 1992). However, the importance of wind events and wave resuspension will vary depending on the morphology of the system (i.e. depth, length of fetch, substrate type).

Despite the significant amount of progress that has been made concerning estuarine sedimentological processes, gaps still exist in our understanding. This is largely due to the complex interactions of controlling processes and the variability that exists between estuaries, as well as within estuaries (see Wolfe, 1986 for a review). Furthermore, the relative importance of all the major controls of estuarine sedimentation strongly depends on climatic setting (and change), tidal characteristics, the geomorphology of the system, and ultimately sea level trends (Schubel and Hirshberg, 1978; Stone *et al.*, 1978; Wolfe and Kjerfve, 1986).

The objectives of the study presented here are twofold. First, to evaluate the temporal and spatial variability of suspended sediments, water clarity, and physical structure of the water column in a temperate Gulf of Maine estuary. And second, to assess the impact of two aperiodic forcings (river discharge and wind waves) on these parameters. Great Bay Estuary (GBE), New Hampshire, USA (Fig. 1) was chosen for study due to its morphology, range of controlling processes and size. The system is characterized by deep, narrow channels where tidal current velocities and turbulence are very strong, and wide, shallow flats where tidal current velocities diminish and the importance of wind-forced waves increases (Fig. 2). Also, several rivers periodically provide sufficient fresh water to increase turbidity and stratify the water column. In addition, GBE's moderate size (~ 25 km in length from Portsmouth Harbor to Great Bay) allows observations to be made over the entire system in relatively short time periods (several hours).