1. Introduction

The technology of airborne remote sensing encompasses a broad class of airborne platforms and a wide suite of remote sensing instruments. Usable platforms range from airships (Hamley, 1994; Windischbauer and Hans, 1994), UAVs (Unmanned Airborne Vehicles, Miller et al., 1999; Petrie, 2001), and helicopters (Gade et al., 1998; Matthews et al., 1997; Schaepman et al., 1997), to standard and high-altitude aircraft (see for example, Carder et al., 1993; Harding et al., 1994, Miller and Cruise, 1995; Mumby et al., 1998). Similarly, the airborne instruments deployed on aircraft vary from analog cameras (Sheppard et al., 1995), digital CCD (Charged Coupled Device) cameras (Howland, 1980; Miller et al., 1997), and analog and digital video cameras, to digital optical systems. In principle, any air-based platform that contains a measurement and recording device can be a remote sensing system for Earth observations. As a consequence, there are numerous, almost countless, airborne remote sensing systems available from commercial, state, and federal organizations world wide. Hence, a complete treatise on airborne remote sensing is far beyond the scope of this chapter. Here, we provide a brief overview of key elements that potential users of airborne remote sensing of coastal environments should consider. We limit our discussion to aircraft platforms that employ digital optical imaging systems and focus on issues that compare and contrast the use of airborne systems with the optical satellite systems described in Brown et al. (Chapter 2).

2. Elements of Airborne Remote Sensing

The wide spread use of airborne remote sensing is due in large-part to the availability of low cost aircraft and imaging systems and the operational characteristics of the aircraft. The major benefit of airborne remote sensing, compared to satellite-based systems, is that the user can define the deployment and operational characteristics of the remote sensing system. In general, an airborne system can provide considerably higher spatial resolution data (e.g., less than a meter to tens of meters). The system can be deployed when atmospheric (i.e., cloud-free), environmental, and solar conditions are acceptable to study specific phenomenon. For example, in some areas, such as the Pacific Northwest of the U.S., airborne remote sensing is the only way to reliably obtain coastal zone imagery. The deployment can also be coordinated with a field program to acquire \textit{in situ} measurements for instrument calibration or algorithm development or validation. These advantages are particularly important in coastal aquatic environments where many processes occur over time and space scales that cannot be adequately sampled by most satellite instruments (Miller et al., 2003). Airborne remote sensing
enables specific coastal events to be studied, for example, such as a particular phase of a tidal cycle or an extreme low-water event in Puget Sound, WA (Fig. 1). In this image obtained by the Airborne Thematic Mapper (5 m resolution) a normally submerged sea grass bed on a tidal flat can be examined. This grass bed is only exposed several days each year at Mean Lower Low Water. Clouds are a persistent feature in this region and often obscure the view of satellite instruments. The flexibility of user-defined deployments provides a capability to study ephemeral coastal events such as algal blooms or human-induced spills. These events can be imaged over a period of hours or days as they evolve in a manner impossible for most satellite-based systems.

There are however, several additional factors that must be considered to evaluate the utility of airborne remote sensing for a given application. These factors include geometric accuracy, radiometric calibration, and total spatial coverage. As discussed below, these factors can reduce the effectiveness of airborne remote sensing for certain coastal applications.

Figure 1. Near-infrared (830 nm) image acquired 30 July, 2000 using the Airborne Thematic Mapper over exposed sea grass beds of Puget Sound, WA. The flexibility of an aircraft system to respond to clear sky conditions enabled the capture of this unique image.

2.1 AIRCRAFT AS REMOTE SENSING PLATFORMS

In the early 19th century, as commercial aircraft came into common usage, it was obvious that they were an ideal platform to observe a variety of geographic features. The introduction of aerial mapping cameras in the 1920’s, pioneered by Sherman Fairchild, led quickly to the use of airborne mapping by the U.S. Coast and Geodetic Survey for charting coastlines. Further development of aerial photography was spawned by World War II and the high altitude reconnaissance of the subsequent Cold War period. These