Unmanned aerial photographic mapping of intertidal eelgrass

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ABSTRACT
Bridging the gap between remotely sensed data and ground-based mapping techniques, aerial imagery collected by Unmanned Aerial Vehicle (UAV) is on the forefront of environmental mapping and monitoring. Providing superior spatial resolution, high flexibility for task-specific flight planning, and significantly decreased operational costs compared to manned aircraft or tasking a high resolution satellite, UAVs are revolutionizing the acquisition of aerial imagery for studying local-scale ecological phenomena. Coastal and aquatic UAV applications thus far include wetland vegetation mapping, fish nursery habitat mapping, and waterfowl monitoring. However, there currently exists no methodology in the literature to guide ecologists or community groups in the collection and processing of UAV imagery for seagrass mapping.

The goal of this research is to assess the feasibility of low-cost, “off-the-shelf” UAV photographic surveys for mapping eelgrass (*Zostera marina*) habitats in the nearshore marine environment of the Salish Sea by adapting the guidelines for benthic habitat mapping using aerial photography by Finkbeiner et al (2001). To exemplify the successes and challenges associated with the use of UAVs for eelgrass mapping, we present the methodology and results from eight aerial surveys of eelgrass meadows in the Southern Gulf Islands, British Columbia, Canada. The surveys were conducted June – July 2016, coinciding with the time of peak biomass of eelgrass in the Salish Sea. Flight times were scheduled to optimize low tides and sun angles of 30° to 45°. Other environmental conditions, particularly cloud cover and turbidity, were monitored in the field. Before the survey, a minimum of three Ground Control Points (GCPs) were distributed across the study site. Imagery was collected using a GoPro Hero 3+ Black camera mounted on a stabilizing gimbal beneath an XAircraft X650 Pro quad-copter UAV. Flights were conducted in manual mode, without the use of an autopilot system. As such, the pilot directed the UAV at an altitude of 65m along flight lines spaced 15m apart at a predetermined compass bearing to achieve 80% sidelap. Ground-based reference data was collected by underwater videography. Pix4D Mapper Pro was used to post-process the UAV imagery, resulting in photomosaics of 2cm ground resolution. Due to inconsistent photographic exposure across the mosaics, it was more practical to photointerpret each mosaic in combination with localized digital image enhancements. However, given optimal environmental conditions and fairly consistent photographic exposure, we demonstrate using the Village Bay site how advanced image analysis methods, such as Object-Based Image Analysis (OBIA), can be used to create highly detailed, multi-class thematic maps.

We were successful at producing highly detailed eelgrass maps of sites ranging from 10 to 20 ha in size, significantly improving the detail and speed of survey compared to the ground-based mapping methods previously employed at these sites. However, there are several major challenges to the adoption of UAV technology by conservation groups and academics for eelgrass mapping in the Salish Sea, namely the cost of post-processing software, as well as the regulatory framework for UAV operations. If these can be overcome, UAVs have the potential to provide a powerful tool for ecological research, conservation, and restoration of eelgrass habitats.