Testing of UAV surveys for the mapping and monitoring of freshwater pearl mussel populations in Norway

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The freshwater pearl mussel (Margaritifera margaritifera) is a red listed species and is designated as a responsibility species in Norway, with a national monitoring program in place. Given the importance of the species, and the threats the species faces, mapping the distribution of pearl mussel populations is required for their successful conservation. Observations of adult pearl mussels are usually conducted using ground-based surveying, either through observation from above the water surface, using an aquascope, or by snorkeling. These approaches are, however, very time consuming and therefore costly in project-hours. Here we test the suitability of UAVs (Unmanned Autonomous Vehicles, aka. drones) for mapping and monitoring freshwater mussel beds. The method is promising, and despite the large amount of development of UAV remote sensing applied to rivers, no research has yet been conducted on the suitability of UAVs for mapping the spatial distribution of pearl mussels. Here, we conduct UAV surveys in two rivers with high densities of mussels and quite a large range of substrate conditions. The UAV surveying is informed by a procedure developed at the Norwegian Institute for Nature Research (NINA), which includes minimizing imaging problems/limitations such as shadows and sunglint, and obtaining suitable imaging parameters (overlap and coverage) for successful orthomosaicing of imagery. In addition to UAV imaging, ground-truthing is done in selected areas via ground-based photography, with cameras either handheld, mounted on a pole overhanging the water surface, or placed immediately beneath the water surface. Images acquired in this way may be used to provide information on pearl mussel physical properties (size, shape, and color) that may be used to aid detection in UAV imagery and preprocessing of UAV photos. Spatial distributions of the pearl mussel populations are first assessed by visual investigation of orthorectified images. Positions of adult pearl mussels are registered, and spatial distributions are modelled (e.g. using point process models). Particular focus is on how the spatial distribution relates to characteristics of the pearl mussel locations such as depth, proximity to bank, and surrounding substrate type. Areas where information cannot be extracted, and potential confounding factors, are also assessed. In particular, we compare the ability to map adult pearl mussels in different riverbed material (e.g. sand vs gravel).