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A framework for using Unmanned Aerial Vehicles (UAVs) and SfM photogrammetry to detect salmonid redds

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Salmonid populations are widely distributed globally and are of both economic and ecological importance. The preservation and restoration of salmonid populations is therefore fundamental. Evidence suggests that they are in decline in many parts of the world and a primary hypothesis for this decline is the degradation of spawning habitat. Knowledge of spawning sites and their evolution through time is therefore fundamental to protect salmonid populations. Traditionally, spawning sites have been identified visually. However, this does not allow a precise quantification of the real extent of salmonid reproduction and of its evolution through time (i.e. spawning seasons). Thus, new methods to investigate spawning sites are fundamental to increase our understanding of salmonid population dynamics.
This paper develops a framework for using Unmanned Aerial Vehicles (UAVs) and SfM photogrammetry to detect salmonid redds, the nests that are the distinctive footprint of spawning, through analysis of inter-epoch Digital Elevation Models (i.e. DEMs of Difference). There are two main results.
First, SfM-derived DEMs of Difference are an effective tool to investigate spawning because of the distinctive ellipsoidal erosion-deposition pattern of salmonid redds, which discriminates them from other stream-bed elevation changes. Second, this method detects more redds (e.g. those covered by algae or biofilm) compared with classical visual observation, allowing for a better and more rigorous detection of spawning grounds. We also show that SfM photogrammetry provides additional information relevant to understanding salmonind spawning, including redd density or female lengths, without disturbance of the spawning sites.