Using 3D Modeling to Save our Reefs: Accuracy of Reef Assessment Techniques Using Structure from Motion

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The rapidly declining health and changing distribution of coral reefs is impacting local ecologies and economies worldwide. Implementing effective conservation methods requires more accurate, efficient, and cost-effective underwater monitoring techniques. This study utilized the developing technology Structure from Motion (SfM) and compared the accuracy of six different diver trajectories, or Rapid Ecological Assessments (REAs), in a simulated reef environment. SfM offers promising capability to better document reef changes, monitor their recovery, and determine the efficacy of management actions. Current diver-based monitoring methods fail to yield sufficient scale or detail to efficiently assess changes in the health and abundance of reef ecosystems. SfM creates photo-mosaics and three-dimensional (3D) models of the seascape from a sequence of photos. We assessed the quality of metrics for each REA by comparing by-hand measurements of reef objects with measurements derived from SfM models. Of the six REAs tested, we found that the outer transect method, in which two cameras captured video on the outer edges of our reef simulation, produced the most accurate results. In contrast, the linear transect method, where one camera captured video by crossing the middle of the reef simulation, performed most poorly. Additionally, we observed that 2D measurements outperformed 3D substantially. Correlation analysis revealed that the number of cameras used and video frames taken in a trial were associated with model performance. Our findings show that SfM technology, in combination with the outer transect survey method, has the potential to quickly and reliably generate accurate models of the seafloor.