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Robust Bayesian Design for Monitoring Submerged Shoals off the coast of Western Australia

Recently, there has been a call for more “information on the prevalence and the ecological and economic importance of deep coral-reef communities”. This was motivated by the potentially vital role these deeper reefs play in sustaining shallower reefs through, for example, a source of larval replenishment is less impacted by anthropogenic. The typical remote location and depth of these reefs mean they are often sheltered from many human and natural disturbances. While this may offer advantages around sustainability and resilience, they provide significant challenges for effective monitoring. Thus, we aim to develop a resource-efficient and effective monitoring program for deep coral-reef communities, and apply this to monitor submerged shoals off the Western coast of Australia.

To develop a monitoring program for submerged shoals, we consider coral cover as an indicator for the health of the coral community, and model historical data within a Bayesian inference framework. This is due to the rigorous uncertainty handling and the natural way prior information is included into the modelling process. Bayesian designs are then found within this framework typically by maximising the expected information to be obtained from a design based on an assumed statistical model. However, correctly specifying this model for coral cover within submerged shoals is difficult due to the lack of information about these reefs and the difficulty in appropriately describing complex ecological processes. To address this, we present an approach to find Bayesian designs robust to the specified model. This is achieved through formulating a base model from the historical data within the Generalised Additive Modelling structure, which allows the model to be flexible and thus describe a wide range of relationships between the response and the predictors. Through leveraging this flexibility in design, we can find designs that will be informative across a large class of models. This is demonstrated by finding transects to sample a submerged shoal. The performance of this design is then assessed, including the performance under a variety of alternative base models. As will be shown, our designs remain effective in capturing information on coral health, even in cases where the base model is misspecified.