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Modelling habitat suitability under hydrological change in aquatic habitats of northern Australia

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Abstract: River flows are important for driving the condition and persistence of many aquatic dependent species, to support habitats, and to facilitate ecosystem function. In the tropics of northern Australia, flow regimes are highly dynamic with strong seasonal trends. Within these seasonal regimes, species seek and use habitats across river channels and floodplains that best suit their needs. The habitat that is deemed suitable for species varies in location and extent across time, depending on interactions between flow regimes and landscape features. Changes in flow associated with water resource development and climate change threaten to change the quality, extent and/or location of suitable habitat for a range of flow dependent species.

Despite the ecological importance of flow, quantifying the relationships between hydrological change and ecological outcomes remains a challenge. Species interact with their physical environment differently and have diverse preferences and requirements across ranges of habitat attributes that include inundation, depth, velocity and connectivity. Species, including fish, waterbirds and other biota are recognised to form spatial relationships based upon these physical conditions. Complex landscapes and highly variable flow regimes mean that interactions between flow and geomorphology result in different hydrological and hydraulic characteristics across different settings, often making discharge alone a poor proxy for ecological outcomes in many novel settings. Improvement in our conceptual understanding indicates that ecological flow requirements have a complex relationship with geomorphology and flow dynamics through the landscape, with responses often being non-linear in relation to discharge (Theodoropoulos, 2020; Whipple, 2018). Hydrodynamic modelling provides a mechanism to explore changes in these attributes and their ecological relationships through space and time, and to enable analysis to compare differences between scenarios while considering these complex geomorphological settings.

Here we model flow habitat suitability using depth and velocity outputs from hydrodynamic (HD) models. We use species or functional groups specific habitat preference relationships informed by field data and/or literature to provide mechanistic links between hydraulic variables from HD modelling to predict habitat suitability. The form of these relationships can be used for a range of biota such as fish and waterbirds where depth and velocity are important determinants of habitat preference and suitability. Flow habitat suitability is rated on a scale of 0 (not suitable) to 1 (preferred) for each species given their specific hydraulic preferences at each grid cell, and compared between scenarios to identify the loss or gain of weighted habitat suitability between scenarios. Model results are expressed as spatial representations of suitable habitat across time at daily timesteps. The spatial resolution and domain are defined by the hydrodynamic model. We demonstrate outputs using models for the Finniss catchment from the Northern Australia Water Resource Assessment 1 (Karim et al., 2018) and discuss the methods role in the upcoming work in the Roper and Victoria catchments.

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