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TITLE: Managing seagrass resilience under cumulative dredging affecting light: Predicting risk using dynamic Bayesian networks

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ABSTRACT:

Abstract Coastal development is contributing to ongoing declines of ecosystems globally. Consequently, understanding the risks posed to these systems, and how they respond to successive disturbances, is paramount for their improved management. We study the cumulative impacts of maintenance dredging on seagrass ecosystems as a canonical example. Maintenance dredging causes disturbances lasting weeks to months, often repeated at yearly intervals. We present a risk?based modelling framework for time varying complex systems centred around a dynamic Bayesian network (DBN). Our approach estimates the impact of a hazard on a system's response in terms of resistance, recovery and persistence, commonly used to characterise the resilience of a system. We consider whole?of?system interactions including light reduction due to dredging (the hazard), the duration, frequency and start time of dredging, and ecosystem characteristics such as the life?history traits expressed by genera and local environmental conditions. The impact on resilience of dredging disturbances is evaluated using a validated seagrass ecosystem DBN for meadows of the genera Amphibolis (Jurien Bay, WA, Australia), Halophila (Hay Point, Qld, Australia) and Zostera (Gladstone, Qld, Australia). Although impacts varied by combinations of dredging parameters and the seagrass meadows being studied, in general, 3 months of duration or more, or repeat dredging every 3 or more years, were key thresholds beyond which resilience can be compromised. Additionally, managing light reduction to less than 50% can significantly decrease one or more of loss, recovery time and risk of local extinction, especially in the presence of cumulative stressors. Synthesis and applications . Our risk?based approach enables managers to develop thresholds by predicting the impact of different configurations of anthropogenic disturbances being managed. Many real?world maintenance dredging requirements fall within these parameters, and our results show that such dredging can be successfully managed to maintain healthy seagrass meadows in the absence of other disturbances. We evaluated opportunities for risk mitigation using time windows; periods during which the impact of dredging stress did not impair resilience.

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