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Resilience, Robustness, and Marine Ecosystem-based Management

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ABSTRACT

Marine ecosystems provide essential services to humans, yet these services have been diminished, and their future sustainability endangered, by human patterns of exploitation that threaten system robustness and resilience. Marine ecosystems are complex adaptive systems composed of individual agents that interact with one another to produce collective effects, integrating scales from individual behaviors to the dynamics of whole systems. In such systems, small changes can be magnified through nonlinear interactions, facilitating regime shifts and collapses. Protection of the services these ecosystems provide must therefore maintain the adaptive capacities of these systems by preserving a balance among heterogeneity, modularity, and redundancy, tightening feedback loops to provide incentives for sound stewardship. The challenge for management is to increase incentives to individuals, and tighten reward loops, in ways that will strengthen the robustness and resilience of these systems and preserve their ability to provide ecosystem services for generations to come.

Keywords: [complex adaptive systems](#), [scale](#), [resilience](#), [robustness](#), [ecosystem management](#)

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