

RESILIENCE, ADAPTATION AND TRANSFORMATION IN SOCIAL-ECOLOGICAL SYSTEMS

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Resilience Theory

PERSISTENCE: "the persistence of relationships within a system"

ADAPTABILITY: "ability of systems to absorb changes of state variables, driving variables and parameters, and still persist".

TRANSFORMABILITY: "the size of a stability domain or the amount of disturbance a system could take before it shifted into alternative configuration"



Holling, C.S. 1973. Resilience and Stability of Ecological Systems. Annual Review of Ecology and Systematics 1973:4:1-23



Age (years)





Resilience Low



Sudden, abrupt change -- disturbances











Renewal and Reorganization







Hughes, T.P. 1994. **Catastrophes, Phase Shifts, and Large-Scale Degradation of a Caribbean Coral Reef.** *Science*, 265(5178): 1547-1551.

Pandolfi, John M., Jackson, Jeremy B.C., Baron, N., Bradbury, Roger H., Guzman, Hector M., Hughes, Terence P., Kappel, C.V., Micheli, F., Ogden, John C. , Possingham, H.P. and Sala, Enric. 2005. **Are U.S. coral reefs on the slippery slope to slime?**. *Science* 307(5716): 1725-1726.



Coral Dominance





Resilience Theory





Nutrient Thresholds in Everglades Marsh



Governance of Regimes/Trajectories

Maintain desired regime/trajectory

- Focus on thresholds
 - Monitoring Key Indicators
 - -Knowledge of regime shifts
- Enhance ecological resilience

Restore to more desirable regime

- Reversibility/hysteresis
- Resources and authority to experiment

Adapt to new regimes

- Active Exploration of Options
- Resources and authority to experiment
- Incentives for new solutions







Windows of Opportunity

Bio-physical Windows

- Climate Change
- Weather Events

Social Windows

- Litigation
 - Endangered species act
 - water quality laws
- Treaty expiration





Resilience may not always be a good thing....

High Resilience

- 1. Rigidity Trap
- 2. Lock-in Trap



Low/Eroded Resilience

- 1. Poverty Trap
- 2. Gilded Trap

