MODULE 3 - RESILIENCE IN MARINE SYSTEMS: CONCEPTS AND PRACTICE

1. OBJECTIVES

The objectives of this module are:

- To understand why understanding and assessing resilience is important
- To learn about different resilience definitions, including ecosystem resilience, social-ecological system resilience and engineering resilience
- To understand which properties can contribute towards ecosystem and ecosystem service resilience
- To get an idea of how resilience can be measured or assessed in marine systems

2. INTRODUCTION

Resilience is a key property describing the persistence of certain ecosystem functions, structures, and feedbacks. It is often a sought-after feature, as resilient ecosystems are considered capable of continuously providing ecosystem services, i.e., the benefits that we derive from our oceans or other ecosystems. Identifying which factors contribute to resilience, and how close or far away an ecosystem or a social-ecological system (SES) is from a tipping point, is crucial for sustainable management of natural resources and ES. While the key factors that either contribute to resilience or erode it can be suggested based on general system knowledge and expert solicitation, the quantitative identification of tipping points is a data-intensive process.

It requires an understanding of system function and interactions, as well as long time series of data on key drivers (e.g., environmental variables, harvest pressure) and response variables (e.g., a single natural resource stock, ecosystem state), or dynamic simulation models that can recreate non-linear system dynamics. Hence, quantitative estimates of resilience are only possible for systems where extensive data and knowledge on system function are available. Qualitative, often expert-based, resilience assessments are particularly valuable within contexts where data availability is limited. These assessments evaluate the resilience of a given social-ecological system (SES) by examining both social and ecological characteristics that are understood to either enhance or undermine system resilience. Unlike data-intensive quantitative methods, qualitative approaches rely on expert judgment and stakeholder input to identify relevant drivers, interactions, and system properties.

This module will introduce the key concepts relevant to resilience, as well as provide examples of how resilience can be assessed in marine systems.

3. READING SUGGESTIONS

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

- **Folke, C.** (2006) Resilience: The emergence of a perspective for social-ecological systems analysis. Global Environmental Change 16:253-267.
- **Biggs, R., Schlüter, M., & Schoon, M. L.** (Eds.). (2015). *Principles for building resilience: Sustaining ecosystem services in social-ecological systems*. Cambridge University Press. https://doi.org/10.1017/CBO9781316014240XXX
- **Daskalov, G. M. *et al.*** (2007). Trophic cascades triggered by overfishing reveal possible mechanisms of ecosystem regime shifts. *Proceedings of the National Academy of Sciences*, *104*(25), 10518–10523.

4. EXTERNAL LINKS

- Watch: https://www.youtube.com/watch?v=khep7hHeZG8 (seven principles of resilience)
- Watch: Steve Lade: "What is resilience" ***https://www.stockholmresilience.org/research/research-videos/2020-04-16-what-is-resilience.html***