Ecosystem Resilience in a Nutshell 1: What is ecosystem resilience?

Defining and assessing ecosystem resilience

This is a short guide to explain the Natural Resources Wales (NRW) definition of ecosystem resilience and how the practical difficulties of assessing it can be overcome by using their assessment framework based on the attributes of ecological resilience.

Definition of ecosystem resilience

NRW works to the definition of ecosystem resilience published in its State of Natural Resources report in 2016, which is:

"the capacity of ecosystems to deal with disturbances, either by resisting them, recovering from them, or adapting to them, whilst retaining their ability to deliver services and benefits now and in the future"

A framework approach to assessing ecosystem resilience

Assessing resilience is difficult because ecosystems are complex and dynamic, the responses to disturbances vary greatly in scale and duration, and many of the underlying mechanisms are not understood. This can be overcome by using four ecosystem attributes and their emergent properties as proxies for resilience. Resilience arises from the interplay between the attributes, rather than from any one attribute in isolation (see Figure 1). The four attributes are diversity, extent, condition and connectivity and adaptability, recovery and resistance are regarded as an emergent aspect of those attributes hence the DECCA acronym or abbreviation for this framework.

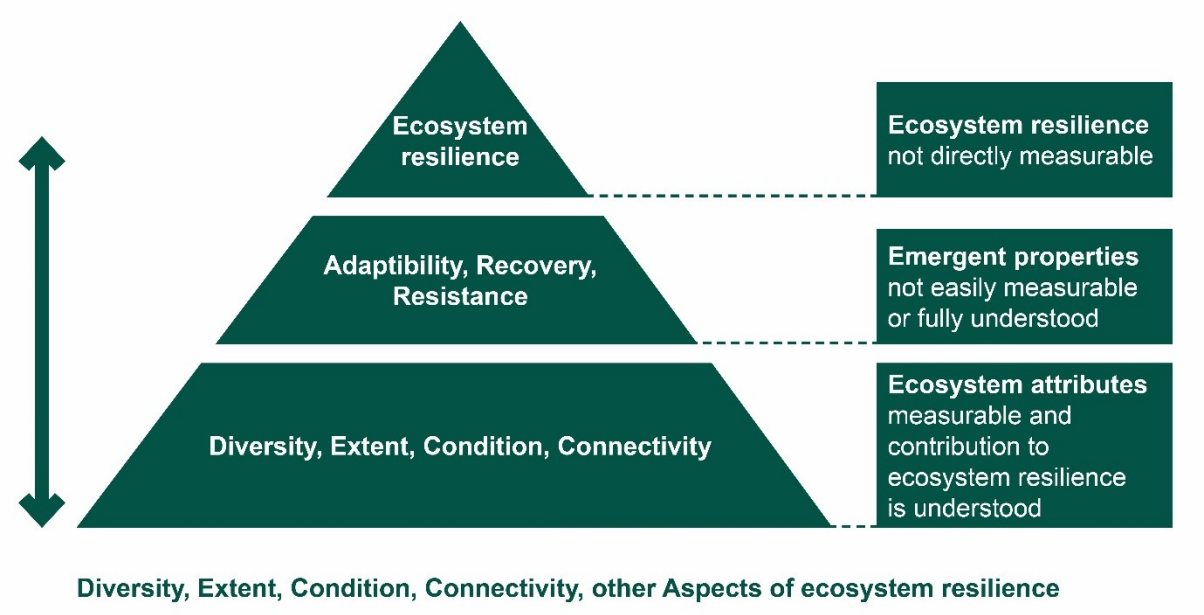

Figure 1 DECCA framework showing the relationship between the attributes and the emergent properties of resilience.

Diversity attribute

Diversity matters at every level and scale, from genes to species, and from habitats to landscapes. It supports the complexity of ecosystem functions and the cascade of interactions that deliver services and benefits, so diversity is important for enhancing the capacity of the whole system to adapt to future change.

There are three measurable components of diversity: genetic characteristics, species and habitats. These diversity assessments draw on species and habitat data because NRW does not routinely collect genetic evidence.

Extent attribute

The size of an ecosystem will affect its capacity to adapt, recover or resist disturbance. Fewer species can survive in a smaller patch, and the demography of species is altered when habitat is lost, leading to species loss and ecosystem decay.

Size also determines resilience in the face of extreme events. Smaller units are at higher risk of random extinction due to catastrophic events, for example, extreme drought, storm, major pollution incident, fire, disease outbreak.

Condition attribute

The condition of an ecosystem is investigated by collating evidence about both the biotic (biological) and abiotic (environmental) factors associated with a habitat or species. For example, biotic data could be collected about the presence, abundance, structure, function and range of habitats and species. Abiotic data relating to the status of environmental conditions relevant to the habitat or species could also be sampled, for example, water, soil and air quality.

The condition of habitats is affected by multiple and complex pressures acting both as short term “pulse” and longer term “press” types of disturbance that affect the resilience of ecological communities and their capacity to resist, persist or recover.

Connectivity attribute

Connectivity refers to the links between and within habitats, which may take the form of corridors, stepping stones or patches of the same or related vegetation types. Environmental factors such as geology, soil type or hydrological links affect sea / landscape connectivity. For any given species, connectivity is related to the relative distance that species can move to feed, breed and complete lifecycles that may need different environments. Connectivity is a major driver for spatial variation which affects diversity and the abundance of living organisms.

Adaptability, recovery and resistance to change are aspects of resilience

Ecosystem resilience is thought to be an emergent property of these four attributes, and may appear in three different ways, or aspects: adaptability, resistance, or recovery to/from disturbance. Adaptability was previously (e.g. in SoNaRR2016) listed as an attribute of resilience, but recent work has clarified the relationships of these terms, as shown in Figure 1.

DECCA, or Diversity, Extent, Condition, Connectivity and other Aspect of ecosystem resilience, is used as an acronym to refer to this framework of ecosystem resilience. DECCA can be applied to environmental processes at different scales, habitats and land uses. This recognition of interconnectivity makes an approach based on resilience different to the traditional, more reactive responses in the management of natural resources**.** These attributes have been used for decades to guide the design of networks of marine protected areas in order to contribute to the overall health and resilience of the marine environment.

Why is ecosystem resilience important?

Under the Environment (Wales) Act, Natural Resources Wales and other bodies should seek to maintain and enhance biodiversity and the resilience of ecosystems. To this end we have developed a conceptual resilience framework for Wales, and new tools to put it into practice. Resilience is core to the new, integrated approach to the environment, which is based on the flow from ecosystems, through ecosystem services and benefits, to well-being. Sustainable Management of Natural Resources (SMNR), is the means by which the Welsh environment is managed to achieve this flow, and resilience is the property of ecosystems that allows the flow to persist in the face of impacts and change.

Further reading

Garrett HM. 2020. Quantitative methods for assessing ecosystem resilience. A literature review. Natural Resources Wales Evidence Report No. 446. NRW. Dolgellau.

Garrett HM and Ayling S. 2020a. Ecosystem Resilience in a nutshell 1. What is ecosystem resilience? Briefing note unpub. NRW. Bangor.

Garrett HM and Ayling S. 2020b. Ecosystem Resilience in a nutshell 2. Mapping relative patterns of ecosystem resilience. Briefing note unpub. NRW. Bangor.

Garrett HM and Ayling S. 2020c. Ecosystem Resilience in a nutshell 3. Connectivity mapping in habitat networks. Briefing note unpub. NRW. Bangor.

Garrett HM and Ayling S. 2020d. Ecosystem Resilience in a nutshell 4. What are Resilient Ecological Networks? Briefing note unpub. NRW. Bangor.

Garrett HM, Latham J, and Ayling. 2020e. Ecosystem Resilience in a nutshell 5: Ecological thresholds, tipping points, species lag and redundancy. Briefing note unpub. NRW. Bangor.

Garrett HM and Ayling S. 2020f. Ecosystem Resilience in a nutshell 6: Mapping biodiversity hotspots and core sites for resilient ecological networks. Briefing note unpub. NRW. Bangor.

Latham J, Thomas Rh, Spode S and Lindenbaum K. 2013. Ecosystem resilience: a discussion paper on the use of the concept for natural Resources Wales. Ecosystem Understanding and Future Management Team, Living Wales Programme 2012-13.

References

Natural Resources Wales (NRW). 2016. The State of Natural Resources report 2016. *Assessment of the sustainable management of natural resources.* NRW. Bangor.