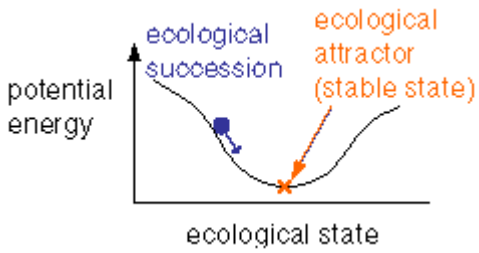
A Simple Model of Resilience

Two different defintions are commonly used in ecology. We distinguish them as engineering and ecological resilience.

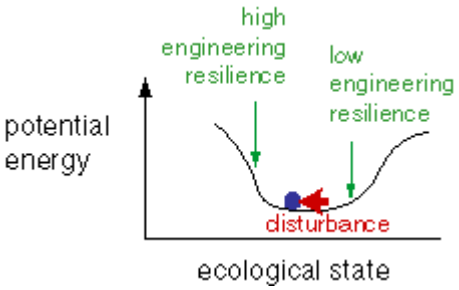
Engineering is the rate at which a system returns to a single steady or cyclic state following a perturbation. Engineering resilience assumes that behavior of a system remains within the stable domain that contains this steady state. Note that this use of resilience is that of Pimm and others.

When a system can reorganize, that is shift from one stability domain to another, a more relevant measure of ecosystem dynamics is ecological resilience. Ecological resilience is a measure of the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures.

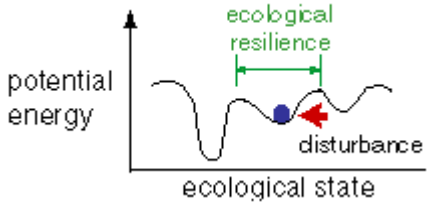
The difference between ecological and engineering resilience can be illustrated by modeling an ecological 'state' as the position of a ball on a landscape. Gravity pulls the ball downwards, and therefore pits in the surface of the landscape are stable states.



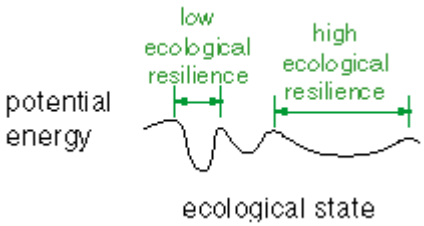
The deeper a pit the more stable it is, because increasingly strong disturbances are required to move an ecological state away from the bottom of the pit. The steepness of the sides of a stability pit corresponds to the strength of negative feedback processes maintaining an ecosystem near its stable state. Engineering resilience increases with the slope of the sides of a pit.



Ecological resilience is a measure of regional topography of a stability landscale. The ecological resilience of a state corresponds to the width of its stability pit.



Ecological resilience corresponds to the degree to which the system would have to be altered before it begins to reorganize around another set of processes.



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