

## Clarification of the 3R's for the purpose of identifying recovery criteria

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**R**epresentation, **R**esiliency, and **R**edundancy comprise key characteristics that collectively contribute to a species' ability to be securely self-sustaining over the long term. When combined across populations, they measure the health of the species as a whole. The more we can identify and break down the constituent elements contributing to resiliency, representation and redundancy, the better we can understand what contributes to, and is necessary for, the long-term health of a population.

**Representation** contributes to the adaptability and evolutionary capacity of a species over time, to accommodate long term issues like climate change. The breadth of genetic ecological, demographic, and behavioral diversity across a species' range may contribute to its capacity to adapt over time. Measures of genetic and life history variability among populations, distribution of populations across a range of ecologically diverse locations or niches, etc., are useful proxies to measure. Consider needs for establishing or re-establishing populations in unoccupied habitat that may be necessary or suitable for species adjustment to climate change or other stressors, including the need to replace former populations in no longer represented ecosystems.

**Resiliency** speaks to an individual population's ability to tolerate environmental and demographic stochasticity, such as fluctuations in temperature or genetic drift. It is often measured in terms of population size and growth rate, but in fact is dependent on a number of traits, both demographic and environmental. These include, among others: age or stage class distribution, genetic heterogeneity, birth rates, annual survivorship, sex ratios, etc., and the quality and extent of habitat, the degree of disease, competition, etc. Meta-population dynamics and distribution can also contribute to population resiliency in some species.

**Redundancy** contributes to the ability of population types to withstand catastrophic events (hurricanes, wildfires, etc.). The number and distribution of populations of *each* representative type contribute to the retention of various representative types despite catastrophic events by ensuring that the loss of a population doesn't lead to the loss of representation.

The 3R's are interconnected and overlapping. For example populations must be resilient in order to contribute to redundancy or representation. Likewise, redundant populations within a representative genotype or ecological setting contribute to the maintenance of the representation contributing to the species' adaptive and evolutionary capacity.

Likewise, as with all things biological, evaluation of the 3R's for any species must be considered in the context of the species' life history and ecology. Representation for a narrowly endemic species might look quite different than for a wide-ranging generalist. Similarly, measures of population resilience might be quite different for a short-lived rapidly breeding species versus a long-lived species that delays reproductive maturity for 10 or 20 years.