OPERATIONALIZING LANDSCAPE RESILIENCE

ENHANCING BIODIVERSITY AND ECOLOGICAL FUNCTION AT THE LANDSCAPE SCALE

AUTHORS: Erin Beller[1], April Robinson[1], Robin Grossinger[1], Letitia Grenier[1], Audrey Davenport[2], Erica Spotswood[1]
1) San Francisco Estuary Institute, Richmond, CA 94804 2) Google Ecology Program, Mountain View, CA, 94043

WEBSITE: resilientsv.sfei.org
CONTACT: Erin Beller, erin@sfei.org

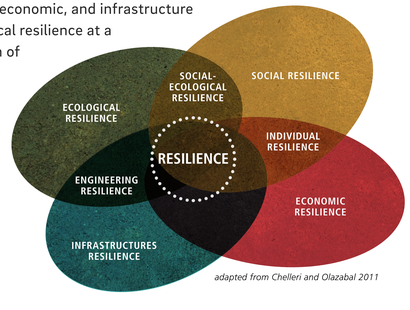
SFEI AQUATIC SCIENCE CENTER

HOW CAN WE INTEGRATE RESILIENCE SCIENCE
INTO LANDSCAPE CONSERVATION, MANAGEMENT, AND DESIGN?

The concept of resilience – with its explicit focus on creating systems that are robust enough to persist and adapt over the long run – has emerged as a key way to manage ecosystems to sustain biodiversity and ecological functions in an uncertain future. Resilience-based management has widespread appeal and potential; however, it is notoriously difficult to operationalize. How might we integrate resilience science into landscape design and ecosystem restoration? The goal of the Landscape Resilience Framework is to facilitate application of resilience principles to ecosystem management, identifying the key landscape elements that sustain biodiverse, ecologically functional landscapes in the context of climate change and other anthropogenic stressors over the coming century and beyond.

WHAT IS LANDSCAPE RESILIENCE?

The concept of resilience encompasses ecological, social, economic, and infrastructure systems (Curtin and Parker 2014). Our focus is on ecological resilience at a landscape scale, or landscape resilience, as one dimension of resilience within social-ecological systems. We define landscape resilience as the ability of a landscape to sustain desired ecological functions, robust native biodiversity, and critical landscape processes over time, under changing conditions, and despite multiple stressors and uncertainties. While social and ecological systems are inextricably linked, developing a robust understanding of the mechanisms of ecological resilience in and of themselves is an essential step in applying the broader concept (Standish et al. 2014).



adapted from Chelleri and Olazabal 2011

SEVEN PRINCIPLES OF LANDSCAPE RESILIENCE

The Landscape Resilience Framework identifies seven landscape attributes that contribute to resilience. It synthesizes empirical ecological studies and social-ecological resilience theory, and was reviewed by a team of expert advisors. Here, each principle is illustrated in a stylized Silicon Valley landscape.

01 Setting
Unique geophysical, biological, and cultural aspects of a landscape that determine potential constraints and opportunities for resilience

02 Process
Physical, biological, and chemical drivers, events, and processes that create and sustain landscapes over time

03 Connectivity
Linkages between habitats, processes, and populations that enable movement of materials and organisms

04 Diversity & Complexity
Richness in the variety, distribution, and spatial configuration of landscape features that provide a range of options for species

graphic courtesy of Bonfire

05 Redundancy
Multiple similar or overlapping elements or functions within a landscape that promote diversity and provide insurance against loss

06 Scale
The spatial extent and time frame at which landscapes operate that allows species, processes, and functions to persist

07 People
The individuals, communities, and institutions that shape and steward landscapes

04 Diversity & Complexity

The framework also details the key components within each high-level principle:

- RICHNESS OF LANDSCAPE FEATURES: Landscape-scale diversity of habitat types and connections between different habitat types; physical heterogeneity in topography, groundwater, soils
- WITHIN-HABITAT DIVERSITY AND COMPLEXITY: Site- or habitat-scale vegetative diversity (e.g., in species, structures, or height) and physical heterogeneity (e.g., in microhabitats, microtopography, and microclimates)
- DIVERSITY IN STRATEGY AND APPROACH: Response diversity and a diversity of life history strategies both within and between species
- GENETIC AND PHENOTYPIC VARIABILITY: Diversity in genes and traits within species populations

APPLYING THE FRAMEWORK IN SILICON VALLEY

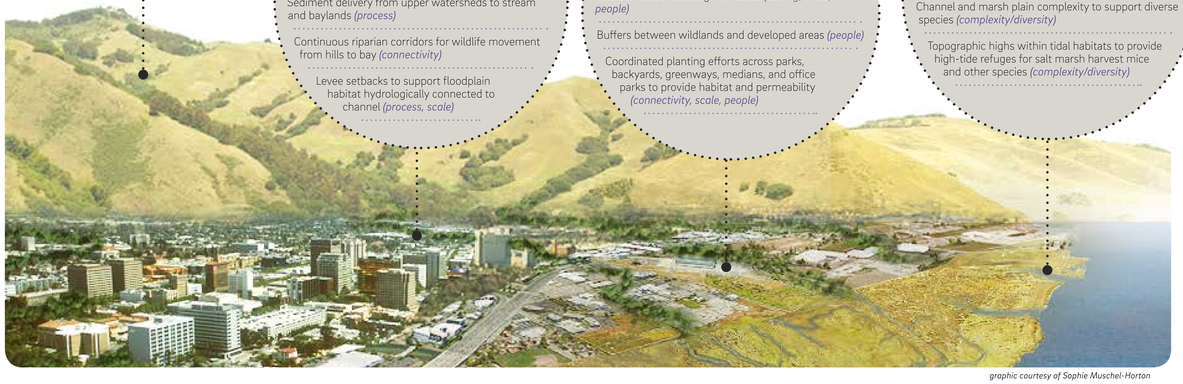
SFEI is in the process of applying the framework to specific landscapes across California. For example, we are currently working with a team of regional science advisors to use the framework to develop a vision for landscape resilience across the streams, hills, baylands, and urban areas of Silicon Valley. Example recommendations from the larger vision (Robinson et al. 2015) are highlighted below.

HILLS
- Multiple large areas of protected open space *(redundancy, scale)*
- Connectivity between ranges for large mammal movement *(connectivity)*
- Connectivity up and down ranges for habitat shifts *(connectivity, scale)*
- Drought-tolerant vegetation that could serve as future seed sources *(setting, scale)*
- Microtopography and microclimates that provide temperature and drought refuges *(setting, complexity/diversity)*

CREEKS
- Surface flow heterogeneity to support a range of species and act as a barrier to spread of invasives *(connectivity, complexity/diversity)*
- Flows that cue germination of native trees and steelhead life history support *(process)*
- Sediment delivery from upper watersheds to stream and baylands *(process)*
- Continuous riparian corridors for wildlife movement from hills to bay *(connectivity)*
- Levee setbacks to support floodplain habitat hydrologically connected to channel *(process, scale)*

VALLEY FLOOR
- A diversity of wetland habitats where supported by appropriate soils, topography, and groundwater *(setting, process, complexity/diversity)*
- Native landscaping that includes species likely to tolerate heat and drought stresses *(setting, scale, people)*
- Buffers between wildlands and developed areas *(people)*
- Coordinated planting efforts across parks, backyards, greenways, medians, and office parks to provide habitat and permeability *(connectivity, scale, people)*

BAYLANDS
- Connectivity between bayland and upland habitats for wildlife movement around Bay perimeter *(connectivity)*
- Sufficient sediment from local watersheds to support tidal marsh persistence *(process, scale)*
- Channel and marsh plain complexity to support diverse species *(complexity/diversity)*
- Topographic highs within tidal habitats to provide high-tide refuges for salt marsh harvest mice and other species *(complexity/diversity)*



graphic courtesy of Sophie Muschel-Horton

IMPLEMENTATION AND NEXT STEPS

We will be holding a workshop with our international team of resilience advisors in spring 2016 to further develop the framework. We will also be developing a quantitative, spatially explicity vision for landscape resilience in Silicon Valley based on the framework. Ultimately, we hope this vision will provide a shared foundation, aligned with other regional planning efforts, to catalyze discussions amongst scientists, planners, managers, designers, and others about specific actions that could improve landscape resilience.

ACKNOWLEDGMENTS

The Landscape Resilience Framework was developed as part of Resilient Silicon Valley, a project funded by a charitable contribution from Google's Ecology Program. For more information on Resilient Silicon Valley, please visit resilientsv.sfei.org. Thanks to our Resilience Advisory Team for their input and review of this document: Mark Anderson (The Nature Conservancy), Eric Higgs (University of Victoria), Richard Hobbs (University of Western Australia), and Katie Suding (University of Colorado).

REFERENCES

Beller EE, Robinson A, Grossinger R, et al. 2015. Landscape Resilience Framework: operationalizing resilience at the landscape scale. Publication #752, SFEI, Richmond, CA.

Chelleri L, Olazabal M. 2012. Multidisciplinary perspectives on urban resilience. Workshop report, 1st edition.

Curtin CG, Parker JP. 2014. Foundations of resilience thinking. Conservation Biology 28(4):912-923.

Robinson A, Beller E, Grossinger R, et al. 2015. Vision for a resilient Silicon Valley landscape. Publication #753, SFEI, Richmond, CA.