6 Self-Design vs. Designer Theories and Wetland Restoration and Creation

Arnold van der Valk

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Abstract

Wetland restoration and succession are essentially attempts to accelerate and direct succession. However, competing theories about the nature of succession exist. One theory developed by F. E. Clements postulated that all the vegetation in an area would eventually reach a final, stable stage that he called the climax. This deterministic succession theory, now called the self-design theory, has been adopted in numerous restoration/creation projects. It implies that environmental conditions are the main determinant of the vegetation that develops. An alternative theory of succession, associated with H. A. Gleason, emphasizes that the characteristics of each plant species (e.g., seed dispersal potential) and contingent environmental factors (e.g., disturbances) have a major influence on the composition of the vegetation that develops and that there is no fixed end point. This individualistic theory of succession in the restoration field is known as the designer theory. Most plant ecologists today are advocates of the designer theory.

Keywords

Climax · F. E. Clements · H. A. Gleason · Succession · Wetland vegetation

A. van der Valk (✉)
Department of Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, IA, USA
e-mail: valk@iastate.edu

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Introduction

When it comes to the restoration/creation of wetlands, it is widely assumed that it is possible to establish vegetation in them that closely resembles that of some target wetland, all else being equal. This is one of the underlying assumptions of wetland mitigation policy in the United States and elsewhere. Because wetland restoration/creation is essentially accelerated succession, the extensive literature on succession provides both theoretical concepts for designing and practical guidelines for executing restoration/creation projects. Consequently, the need to apply succession theory to aid in the design of restoration/creation projects has been frequently advocated. However, for this to be effective and successful, it is necessary to use up-to-date successional theory.

Pickett et al. (2011) compare and contrast classical and contemporary theories of succession. The classical theory, developed primarily by Frederic E. Clements in the early part of the twentieth century, was a deterministic theory that postulated that all the vegetation in a given area would eventually reach a climax. This climax vegetation would be a stable assemblage of species that was in equilibrium with the regional climate. Interactions of species on a site during succession (primarily competition) plus changes in environmental conditions caused by the plants themselves, called reactions (e.g., increased soil organic matter and available nutrients), caused changes in species composition over time until environmental conditions stabilized and the plant species were in competitive equilibrium. In the classical theory, it is the climate that is the major determinate of the type of climax vegetation that develops because only the species best adapted to this climate will ultimately survive. Nevertheless, the classical theory recognized that succession on any given site within a region was affected by site conditions (soil moisture, soil nutrients, local disturbances, herbivores, etc.), limitations on species dispersal to the site, and the performance (seed germination, seedling survival) of species that reached the site. One or more of these factors sometimes prevented the development of the expected climax vegetation.

The contemporary theory of succession, which was formulated in the last half of the twentieth century, differs from the classical theory primarily in its emphasis on the importance of contingent factors (disturbances, site conditions, vagaries of seed dispersal, etc.) for determining whether a given species is found or not on a site at a given time. In the last 60 years, numerous studies of succession have demonstrated that in a given area it is largely driven by contingent factors. Consequently, succession does not have a fixed trajectory or outcome, and many different vegetation types could potentially become established on the same site. Rather than being deterministic, succession is viewed as a probabilistic process.

Self-Design and Designer Theory

Although the terminology is different, in the wetland restoration literature two different successional theories have been proposed, self-design and designer, to guide efforts in vegetating newly restored or created wetlands (Mitsch and

Wilson 1996). One of the earliest proponents of the self-design concept was Howard T. Odum. Odum, however, called it self-organization (Odum 1988). Odum believed that if an area was "seeded" with suitable organisms that, as a result of their differential survival and interactions (feedbacks) among them, self-organization would result in development of the most energy efficient ecosystem under a given set of environmental conditions. Like the classical theory of succession, of which it is a variant, self-organization is a deterministic process with a fixed endpoint. For Odum, the climax ecosystem operates at optimal efficiency, and less energy efficient ecosystems will be replaced by more energy efficient ones. See Månsson and McGlade (1993) for a critique of Odum's concepts. One of Howard Odum's students, William J. Mitsch, applied Odum's self-organization/self-design concept to the restoration/creation of wetlands (Mitsch and Wilson 1996). As was the case with Odum, self-design involves introducing propagules of as many species as possible and letting "natural forces" choose the most appropriate species. Again, it is classical succession theory under another name.

The designer approach is described by Mitsch and Wilson as "introducing species and expecting their survival in Gleasonian zones, akin to gardening and landscape architecture." The designer theory is a variant of the contemporary theory of succession. There is no fixed endpoint, and, within the constraints imposed by environmental conditions, many different kinds of vegetation could be established in a restored or created wetland because it is possible to manipulate the species composition of the initial vegetation (e.g., using different seed mixes) and to manipulate environmental conditions to favor some species over others. In other words, it is possible to direct succession to obtain a desired vegetation type.

As pointed out by van der Valk (1998), the self-design concept has two important implications: (1) it suggests that it easy to establish vegetation – it only requires introducing suitable propagules; and (2) because of self-design, the type of vegetation that develops is inevitable and cannot be altered. Thus, according to the self-design theory, if the vegetation that develops is composed mostly of weedy species and does not resemble that in target wetlands, there is nothing that can be done to prevent this. On the other hand, the designer theory implies that the role of restoration ecologist is much more than just a sower of seeds. In order to establish to establish a particular kind of vegetation, it is necessary to have detailed knowledge of the life-history attributes of the species: how species are dispersed, under what conditions they can become established, what is their life expectancy, what are the main sources of mortality, etc. In fact, restoration ecologists have demonstrated repeatedly that it is possible to establish desired vegetation in restored and created wetlands if you understand the establishment and growth requirements of the constituent species. In short, self-design and designer restoration theories are not new. They are restatements, of the discredited classical theory and the contemporary theory of succession, respectively. Only the application of the contemporary succession theory to wetland restoration and creation projects will improve their outcomes.

Future Challenges

Improving the quality of wetland restoration and creation projects is essential if funding for them is to continue. For projects where self-design has been assumed to result in the establishment of suitable vegetation, the failure of the expected vegetation to develop has increasingly become an embarrassment to agencies and organizations funding these projects. Because the self-design assumption greatly reduces the cost of projects, convincing funding agencies to allocate the funds needed to establish suitable vegetation, not just suitable hydrology, is needed. Not only funding will be needed to establish suitable vegetation, it will also require developing sources of wetland seeds and plants of local provenance and effective techniques for successfully establishing suitable species where this has previously not been attempted. Fortunately, a great deal of work has been done on propagating wetland species and developing planting techniques in parts of the world where self-design has not been assumed (van der Valk 2009). The control of invasive species may also be needed to prevent them from dominating recently restored or created wetlands.

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