News and Comment

Using Coefficients of Conservatism and the Floristic Quality Index to Assess the Potential for Serious and Irreversible Damage to Plant Communities

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Coefficients of Conservatism and the Floristic Quality Index can be used to assess potential damage to plants and plant communities as a result of anthropogenic disturbances. This has benefit because it may be more powerful than an opinion and more easily understood and trusted by non-botanists and land use decision-makers.

Key Words: Coefficient of Conservatism; Floristic Quality Index; serious and irreversible damage; disturbance; plants; intolerant

In making a decision about what kinds of activities are to be permitted in a natural area, a landowner or land manager may have to decide whether or not the activity will result in "serious and irreversible damage" to a plant community. A botanist is usually invited to give advice on the matter, which often comes in the form of a professional opinion. The first consideration is what the phrase "serious and irreversible damage" really means. "Serious" may be taken to mean causing a relatively large change or harm to the individuals of the plant species present. The meaning of "irreversible" is clear. Thus the phrase refers to a large change that cannot be undone.

The second consideration might be whether or not there is anything that can be provided that would be more useful than an opinion. Of course an opinion based on a great deal of knowledge and personal experience has immense value. However, non-botanists may have some difficulty understanding this value or may perceive bias in the opinion. What can be brought to supplement it? Here I discuss an approach that I found beneficial in this context.

Different species of plants and kinds of plant communities vary in their susceptibility to damage or harm and this can be measured with Coefficients of Conservatism and the Floristic Quality Index. These metrics provide a way of assessing potential impact that might prove useful to biologists providing advice.

The concepts of Conservatism and the Floristic Quality Index

The Floristic Quality Index (FQI) of a site is based on native floristic diversity and some of the components of rarity (in the broad sense) of the native species present. It was first developed as a method of identifying natural areas and evaluating sites for protection (Swink and Wilhelm 1994, Wilhelm and Masters 1995, Bourdaghs et al. 2006) and is now widely used along with other criteria for this purpose (Bried et al. 2012). It can also be used to establish goals of restoration (Spyreas et al. 2012), to monitor the success of restoration (McIndoe et al. 2008), evaluate management practices (Smart et al. 2011), to assess human impacts on an area (Bourdaghs et al. 2006) and to evaluate ecological (community) integrity (Nichols et al. 2006).

The FQI is the square root of the number of native species present in an area multiplied by the average Coefficient of Conservatism (CoC) for the native species present. A square root enables diversity to be considered without being weighted too heavily. The coefficients are assigned for species of native vascular plants within a particular geographical area such as southern Ontario (e.g., Oldham *et al.* 1995). Higher values of the coefficients of conservatism, on the scale of 1–10, indicate species that are more "conservative" (or ecologically sensitive), including those least associated with anthropogenic disturbance, least aggressive, least able to spread, and most confined to particular natural habitats. Common Milkweed (*Asclepias syriaca*), which most people have seen along roadsides and in meadows, has a CoC of "0" while the endangered Prairie White Fringed-Orchid (*Platanthera leucophaea*), which is very sensitive to invasives and human activity leading to the drying of fens, has a CoC of "10".

Oldham et al. (1995, page 4) explain coservativism succinctly: "The native plant species of any particular area vary in their degree of tolerance to disturbance, and display varying degrees of fidelity to specific habitats. Species conservatism, – the degree of faithfulness a plant displays to a specific habitat or set of environmental conditions, – is the basis for this premise. The natural quality of an area is reflected by its richness of conservative species (Wilhelm & Ladd 1988).” Oldham et al. (1995 page 7) explain the process of ranking plant species:

> “Each native taxon was assigned a rank of 0 to 10 (“coefficient of conservatism”) based on its degree of fidelity to a range of synecological (community) parameters. Plants found in a wide variety of plant communities, including disturbed sites, were assigned ranks of 0 to 3. Taxa that typically are associated with a specific plant community, but tolerate moderate disturbance, were assigned ranks of 4 to 6. Rankings of 7 to 8 were applied to those taxa associated with a plant community in an advanced successional stage that has undergone minor disturbance. Those plants with high degrees of fidelity to a narrow range of synecological parameters were assigned a value of 9 to 10. … In order to use the method to evaluate a site, a species list is compiled, and the coefficients of all native plants are summed and divided by the total number of native plants to yield a mean coefficient for all the native plants in the assessment area. A “Natural Area Index” (also called a Floristic Quality Index) can be calculated by multiplying the mean coefficient by the square root of the total number of native species. Natural areas can be compared using their mean coefficient and/or the Natural Area Indices.”

Bried et al. (2012 page 101) note that: “the foundation of the index is the conservatism concept, which estimates a species’ ecological sensitivity or propensity to occur in areas least altered by humans. Plant species are assigned coefficients of conservatism where ruderal species receive the lowest scores, competitors and matrix species intermediate scores, and remnant dependent species the highest scores. … The concept is loosely allied with the competition-stress-disturbance model of plant ecology (Grime 1974), and therefore derives from colonization and survival strategies and adaptation to post-disturbance successional stages (Bowles and Jones 2006, Taft *et al.* 1997). Species with high conservatism values are sensitive to anthropogenic stress and therefore restricted to minimally altered natural areas …, whereas species with lower values are most likely to persist in or readily invade degraded areas (Spyreas and Matthews 2006).”

These explanations, and others, include the idea that some species and some communities are more ecologically sensitive than others. The use of the words “conservative” and “conservatism” are not only references to rarity but also representative of a number of biological features that correspond to a scale of tolerance to change.

Relation to “serious and irreversible damage”

If several native plants are eliminated from a community and many others are killed, then large change and “serious” damage has occurred. Persistence, reinvasion and purposeful restoration may enable this damage to be undone to some extent. All three possibilities are related to characteristics of CoC. Reinvasion and succession are often long processes and because the sources of plants and interactions and geological history that led to occurrence in a particular place are not necessarily going to be repeated, re-colonization is uncertain and perhaps in many cases unlikely. Likelihood is also decreased as a result of changes in climate and/or the landscape. Persistence depends on the amount of change and the ecological sensitivity of the plants. If the latter is high, then restoration will be less likely.

For simplicity, the term “restoration” will be used subsequently to include any kind of restored (with or without purpose) species or species group. If restoration is impossible or very unlikely then the damage may be “irreversible.” What makes restoration unlikely, under certain circumstances, is high ecological sensitivity. Any species with a high CoC that is intolerant to change (ecologically sensitive and occurs only in habitats least altered by humans) will be the least likely to be capable of restoration in the damaged habitat. Likewise any plant community with a relatively high FQI (based on high average CoC and high diversity) will also be less likely to be capable of restoration. Thus both CoC and FQI can be used to assess the likelihood of successful restoration. It is to be noted that successful restoration of a few species does not constitute successful recovery of a community or ecosystem.

Many factors

The greater the number of factors such as competition with invasive species, continuing destruction, substrate characteristics, etc., that influence restoration, the more difficult it is likely to be. Where water plays an important role, as ground water or surface flow does on alvars and in fens, the likelihood of successful restoration is lower because any disturbance to the habitat is likely to affect both water flow and chemical composition (in addition to other potential factors). This can be an unfortunate combination for relatively intolerant plants that require low nutrient status and well defined natural flow regimes. These other factors are accounted for, to a degree, in the biological limitations of the plants and communities in general reflected in CoC and FQI values. However, it is helpful to have some kind of damage in mind in order to be able to say that it will, or will not, be irreversible, because CoC and FQI are not necessarily indicators of the likelihood of all restoration under all circumstances of disturbance. It is also necessary to distinguish natural processes (or disturbances) that may be beneficial, from anthropogenic disturbances that are likely to be (but are not always) detrimental.

Kinds of disturbance

The most destructive changes to plant communities are often those accompanying major developments. The construction of buildings and structures causes long-term or permanent loss of habitat. There may also be very extensive damage to adjacent areas due to the construction of crane pads, crushing of vegetation and compaction of substrates by heavy equipment, as well as ruts in parking areas, working areas, storage areas and temporary roads. Construction vehicles contaminate substrates with toxic materials including oil and lubricants, introduce material from other sites, and introduce seeds and vegetative parts of competing invasive alien plants. Bulldozing, scraping, and dumping of fill alters the habitat. Although changes to water movement as a result of construction may have far-reaching effects on plants, they would not be revealed in the standard evaluations that consider only fish.

Other seemingly benign changes to land use may cause destructive damage, such as over-grazing, which includes compaction and nutrient addition, trampling, cultivation, drift of pesticide and herbicide from adjacent areas and succession as a result of loss of natural processes. Competition with invasive alien species may also be a major concern. To a degree the CoC and FQI are likely to correctly predict a response in the plant community to any of these kinds of disturbances.

Conclusions

When explaining the likelihood of serious and irreversible damage to plants and plant communities, a simple methodology may be more appreciated and more trusted than an opinion. One has to remember that non-botanists do not have the experience to understand how opinions were derived, but they do often have the last call on what happens to a botanically-significant landscape. There is an important role for Coefficients of Conservatism and the Floristic Quality Index in this regard because they are easily understood and reliable. The coefficients, which enable the index, are developed by a panel of experts, so they are trusted.

The CoC and FQI do not enable one to demonstrate an amount of damage with absolute certainty, but they do provide an objective method of applying a range of likelihood that is based on widely used concepts. In some cases their use may enable a sufficient degree of probability to be demonstrated to result in the protection of a natural area. In many cases it will be the best that can be done to support an idea that "serious and irreversible damage" to a plant community is likely.

Although now well-known and widely employed to evaluate plant communities for a variety of purposes in the United States, the coefficient and the index are not well known and rarely employed in many parts of Canada. Their use to support an opinion by predicting the likelihood of serious or irreversible damage is just one of many potential and related uses.

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