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Application of the Guild Concept to Environmental Impact Analysis of Terrestrial Vegetation

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The necessity for environmental impact assessments (EIA) and environmental impact statements (EIS) has become widespread since the passage of the National Environmental Policy Act of 1969 (NEPA), though the unstandardized methodology for data collection and interpretation allows different decisions and recommendations to be reached by different personnel. Ideally, more standardized and rigorous procedures would lead to a more objective evaluation of an area's ecological value.

Here, the application of the guild concept for classifying terrestrial vegetation is presented and discussed. A dichotomous key of ecological characteristics valuable for examining succession and environmental impact is provided. These characteristics were also chosen to provide clear-cut placement of plant species into a specific guild, thus eliminating much of the subjectivity of classification. The characteristics included are growth form (woody v. herbaceous), leaf persistence (evergreen v. deciduous), ability to fix nitrogen, principal mode of dispersal, type of breeding-pollination system, and life form (annual v. perennial). The guild characteristics are examined and predictions are made regarding the relative order of guild appearance during post-disturbance recolonization. By comparing pre- and post-disturbance guild inventories, the extent of degradation can be determined and particularly sensitive guilds can be examined. Overall, it is hoped that this classification scheme will better reveal the extent of damage, speed of recovery, and predictive accuracy of the EIA/EIS.

Keywords: environmental impact analysis, guilds, plants, leaf persistence, growth form, nitrogen fixing ability, mode of dispersal, breeding-pollination system, life form.

1. Introduction

The National Environmental Policy Act of 1969 (NEPA) set forth requirements aimed to improve the basis for making decisions regarding "Federal actions significantly affecting the quality of the human environment". To determine a project's potential impact upon an area better, environmental impact assessments (EIA) and environmental

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impact statements (EIS) became necessary, requiring an interdisciplinary team of personnel and the expenditure of large sums of money.

An ecologist must survey large, diverse natural communities supporting up to several thousand species and predict potential impact after extremely short periods of fieldwork. Hence, ecologists often collect only species composition data indicating at best the relative abundances of different species, i.e. abundant, common, rare, or absent. An exception is for threatened or endangered species, this being largely due to the more stringent requirements of the Endangered Species Act of 1973. Regardless, many data are left unanalyzed and at best incorporated in the appendices of an EIA/EIS. Consequently, the EIA/EIS may become a rather imprecise description of an area's ecological components; as a result, different interpretations may be arrived at by different reviewers.

Ideally, a more standard procedure would lead to more objective judgements and allow comparisons of natural areas by their relative ecological value. By favoring standardization, NEPA has created a better decision-making process and encouraged ecologists to develop methods of comparing and interpreting complex organized communities more rigorously. Using the guild concept, I propose a more concise approach to determine impact on terrestrial vegetation.

Root (1967) defined an ecological guild as "a group of species that exploit the same class of environmental resources in a similar way". Each guild consists of species possessing common ecological characteristics, regardless of taxonomic affinity. Subsequently, the concept has been applied to community structure of collards and their susceptibility to herbivorous arthropods (Root, 1973), resource partitioning in some parasitic insects (Price, 1971), foraging preferences in avian species (Karr, 1971; Willson, 1974), fugitive plant species (Platt, 1975), and reproductive groups of fishes based on preferred spawning grounds and reproductive behavior (Balon, 1975*a*, *b*).

The objectives of this paper are to describe and rationalize characteristics used to delineate guilds of terrestrial vegetation. The classification's potential usefulness in accurately assessing damage and for predicting an area's speed of recovery is then illustrated. Lastly, a methodology to interpret quantitatively the extent of disturbance, time for recovery, and changes in community structure and function is proposed.

2. The proposed classification system

I have divided terrestrial vegetation into ninety-five guilds based on growth and life form, nitrogen-fixing ability, leaf persistence, and breeding system or pollination vector (Figure 1). The logic of this classification is based primarily on the relative ability of the species to disperse, become established, and propagate at a new site (see Diamond, 1975, for a discussion on community assembly). By emphasizing dispersal, this system should be useful in predicting recolonization time. The degree of degradation of a disturbed site can be assessed by using representative species of a guild as indicators in the successional process.

In developing the proposed system, a restricted number of ecological characteristics of a species were chosen that are objective, and yet have value for environmental impact considerations. Consequently, several physiological factors important for establishment, such as root structure, seed dormancy, asexual reproduction, and tolerance to moisture, nutrients, and light were discarded because individuals may respond differently in different habitats or soils. Much of the uncertainty of classification is therefore eliminated with species fitting into only one guild.

The breakdowns into biotic and abiotic factors represent arbitrary divisions that provide a dichotomous dendrogram for placement of plant species. The system first

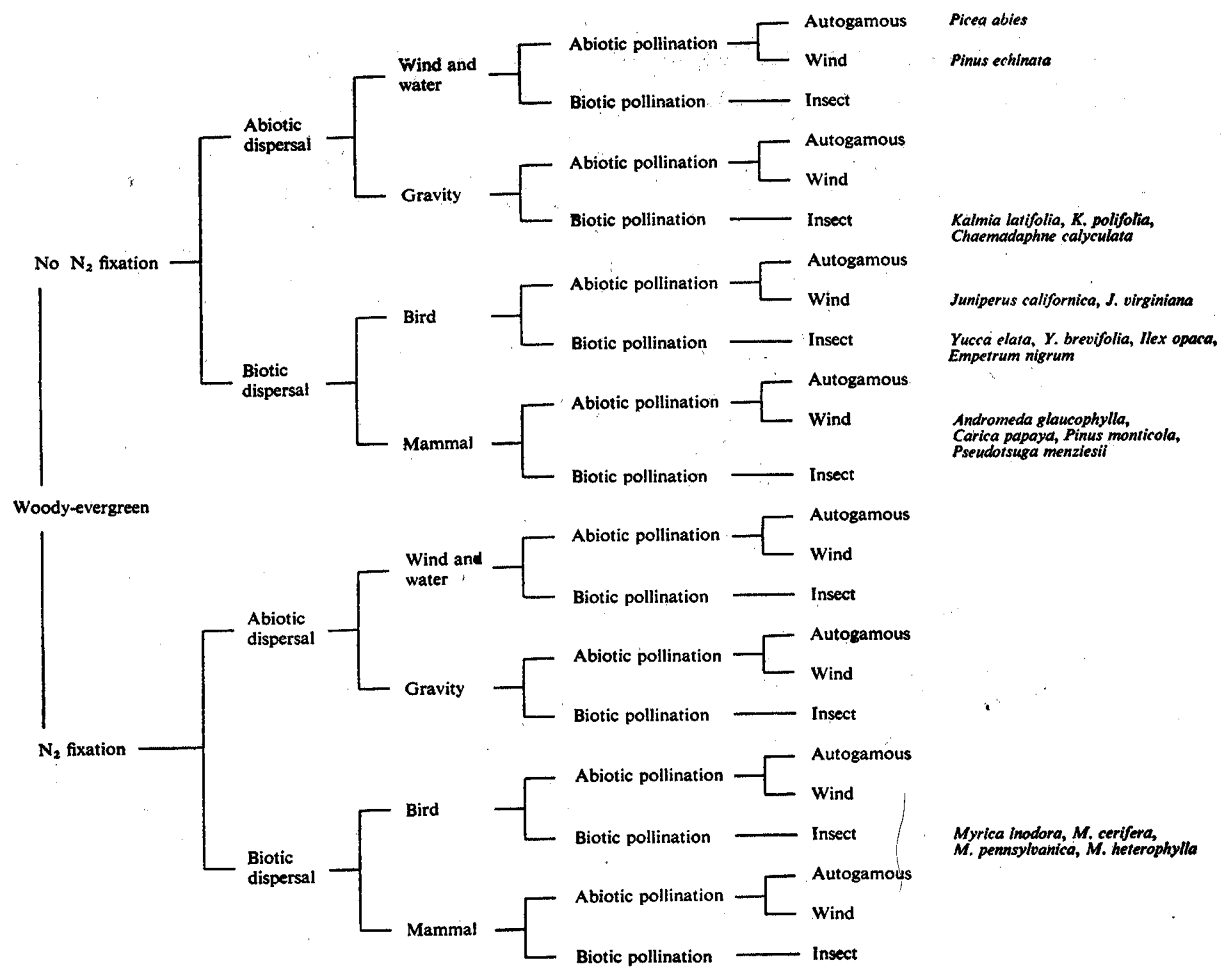

Figure 1, Part 1. Guilds of terrestrial vegetation inhabiting the United States

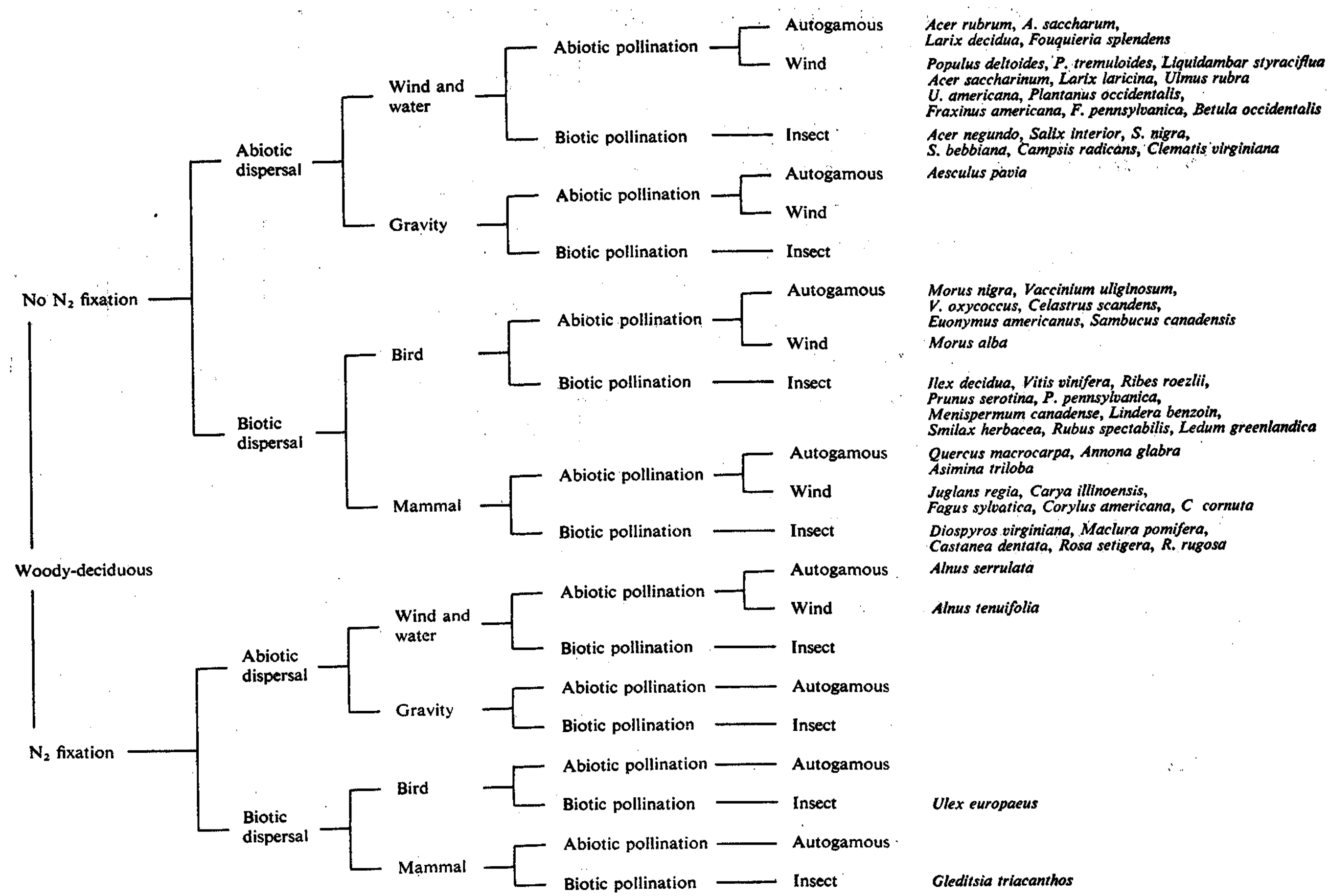

Figure 1, Part 2. Guilds of terrestrial vegetation inhabiting the United States.

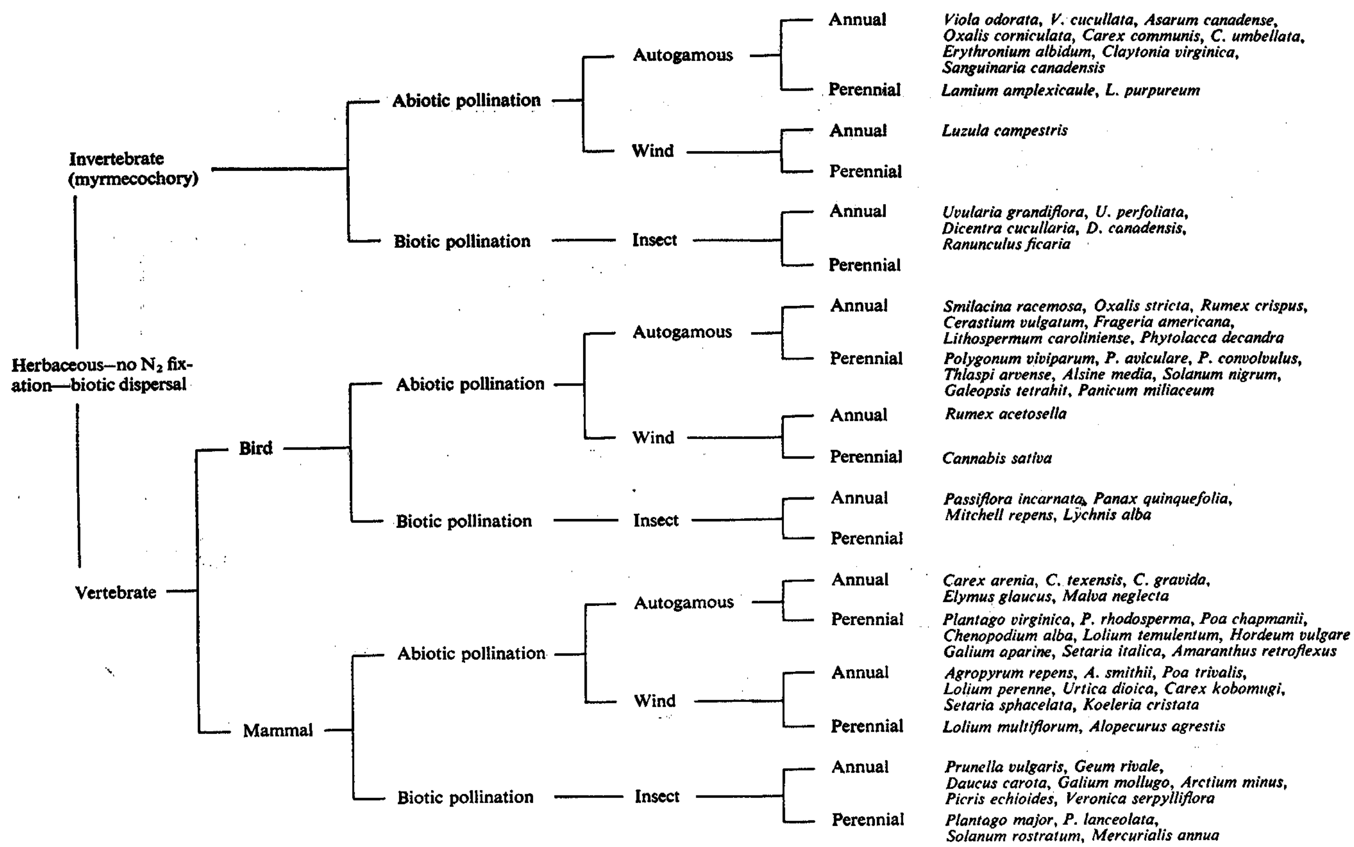

Figure 1, Part 3. Guilds of terrestrial vegetation inhabiting the United States.

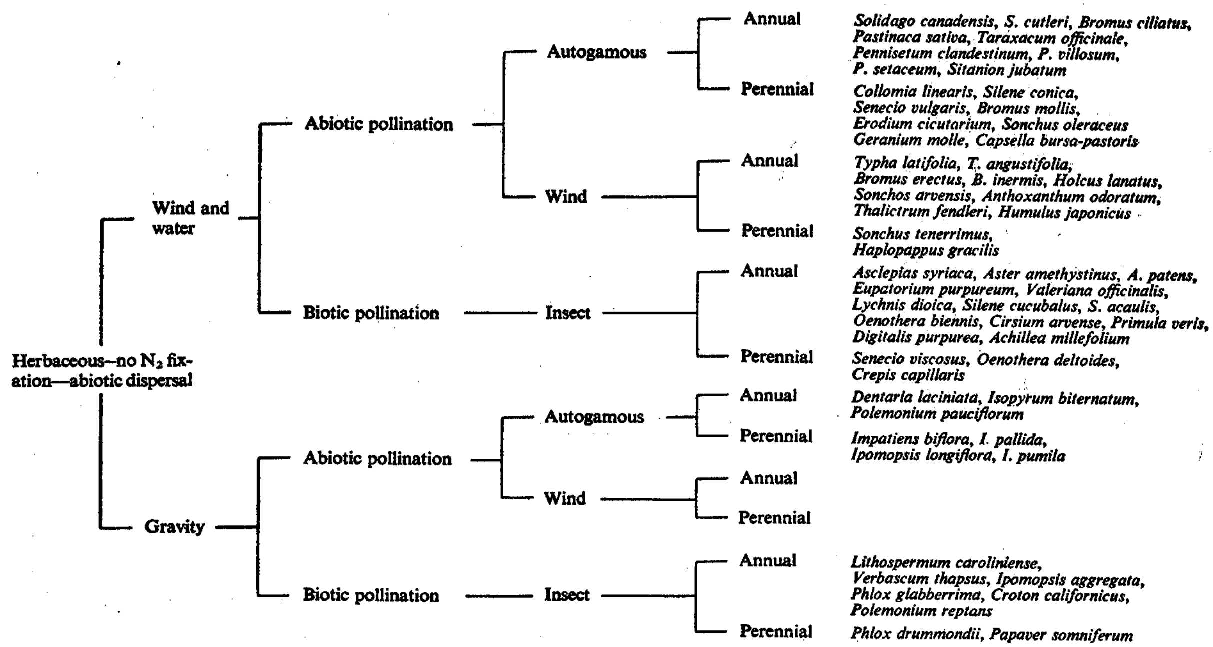

Figure 1, Part 4. Guilds of terrestrial vegetation inhabiting the United States.

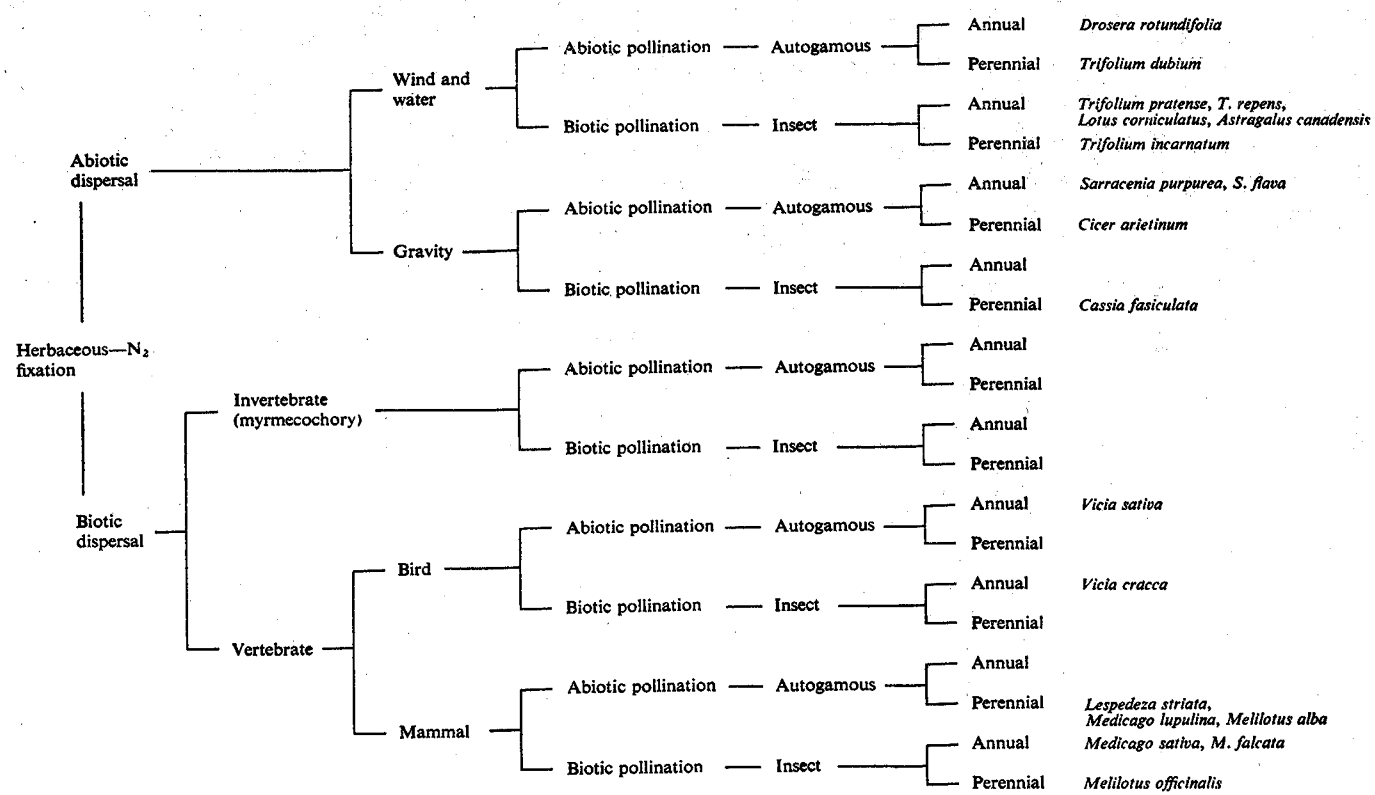

Figure 1, Part 5. Guilds of terrestrial vegetation inhabiting the United States.

divides species based on competitive ability and adaptations for establishment. These include the woody v. herbaceous, leaf persistence, and nitrogen-fixing ability categories, Dispersal is considered next as it ultimately determines which species arrive at a site. Lastly, the breeding-pollination system and life form classification are used as indicators of ability to reproduce, disseminate, and become successful in the surrounding area.

The species are first divided into woody and herbaceous plants. Apart from the gross morphological differences, the woody habit gives the advantage of combining perenniality and height. Consequently, neighbours may be shaded, flowers may be more accessible to pollinators or to the wind, and seeds may be shed over greater distances (Harper, 1977). Seeds of some woody species may colonize an area at rates similar to herbaceous species, though their reproductive contribution to the community is delayed several years until maturity. The time required to attain structural development of the woody stratum constitutes a bottleneck to later successional woody guilds depending on active transport by mammals that typically avoid areas of insufficient tree development. Consequently, species of the equivalent herbaceous guild may progress through the successional sequence more rapidly than woody guilds.

Leaf persistence (deciduous or evergreen) is another relevant growth-form characteristic of woody plants. One form is typically dominant in a given climatic region (Mooney, 1974), with the relative advantages in particular climates being due to differences in drought tolerance, nutrient retention, and length of growing season (Axelrod, 1966; Monk, 1966; Mooney, 1974; Harper, 1977; Miller, 1979). I attempted to use clear-cut examples in the system, though a few species are tardily deciduous and were placed in the evergreen category (U.S. Forest Service, 1948; Brockman, 1968).

The ability to fix nitrogen is critical where vegetation has been disturbed or removed. Nutrient losses due to leaching and erosion increase dramatically following disturbance, nitrogen being depleted in the largest quantities (Bormann *et al.*, 1969; Marks and Bormann, 1972; Likens and Bormann, 1972). Plants capable of escaping the need for soil nitrogen on disturbed sites or areas low in available nitrogen are at a competitive advantage and are often pioneer species on these soils (Stewart, 1967; Harper, 1977). Consequently, nitrogen fixers often do well on early successional sites, such as strip-mined areas, where available nitrogen is low. These plants enhance conditions for other invading plants requiring soil nitrogen. Nitrogen-fixing plants include many species of the family Leguminosae, several non-leguminous species (Stewart, 1967), and insectivorous plants (Schnell, 1976) (nitrogen-fixing ability is used to mean a lack of dependence on soil nitrogen).

Species differ in their ease and modes of dispersal. The relative effectiveness of each has implications for the relative order of arrival at a site. Generally, animal dispersal is much more effective over long distances, such as to oceanic islands, and is adaptive in a wider range of habitats (Stebbins, 1971). Wind-dispersed species are often quickest to invade and establish on disturbed sites, since the sites may be surrounded by potential colonizers. This trend is supported by data from recently strip-mined areas bearing such wind-dispersed species as *Solidago* spp., *Typha latifolia*, *Pastinaca sativa*, *Populus deltoides*, *Platanus occidentalis*, *Fraxinus* spp., and *Campsis radicans* (Wetzel, 1958; Karr, 1968).

Animal-dispersed species usually arrive at a disturbed site after wind-dispersed species because animals move preferentially into habitats having a characteristic vegetational structure and avoid travel over extremely different habitats (Baker, 1966; Stebbins, 1971). Seeds dispersed by mammals, whether it be externally or internally, may lack the ability to colonize disturbed sites promptly until some revegetation occurs. Small mammals such as the deer mouse (*Peromyscus maniculatus*) may begin to repopulate previously disturbed areas after about five years and provide dispersal via caching for species such as *Lespedeza* spp. (Howard, 1949). Most other early successional small mammals are not seed-eaters (see Severinghaus and Balbach, 1979, for seed-eating mammals) and provide dispersal only by epizoochory (external adhesion) (Wetzel, 1958). Areas strip-mined 25 years previously had not yet been invaded by the squirrel *Sciurus niger* from nearby forested areas because of insufficient tree development (Wetzel, 1958).

Alternatively, bird-dispersed species may colonize quickly over long distances through extended retention of seeds in the digestive tract (Proctor, 1968) and long migrations. Short distance dispersal occurs by regurgitating seeds of recently eaten fruits (McKey, 1975). Thus, bird-dispersed species often colonize more quickly than mammalian-dispersed species.

Dispersal by gravity includes species whose seeds have no obvious means of transport or are released ballistically. Consequently, the distance of transport is usually limited to several meters from the parent (Stebbins, 1971).

Myrmecochory, or seed dispersal by ants, is also deemed an important method of dispersal, particularly for herbs living in dense forests (Stebbins, 1971). Transport distance is relatively small and probably only slightly more than ballistically dispersed species, though myrmecochorous species enjoy the advantage of seed placement in a suitable site (van der Pijl, 1969; Culver and Beattie, 1978). Thus, the dispersal is precise and the probability of germination and establishment is enhanced.

Overall, I expect that wind-dispersed species will arrive most rapidly at a disturbed site, followed in turn by bird, mammal, ant, and finally gravity or ballistically-dispersed species.

I classified plant species by their primary mode of dispersal (for dispersal in general see Ridley, 1930; Stebbins, 1971, 1974; van der Pijl, 1969; Wood, 1974; Harper, 1977; for myrmecochory Berg, 1966; Handel, 1978; Schemske *et al.*, 1978; Culver and Beattie, 1978; for birds and mammals McAtee, 1947; Krefting and Roe, 1949; Martin, Zim and Nelson, 1951; Smith, 1975; Thompson and Willson, 1978). Species having polymorphic seeds, i.e. some members of Compositae, Leguminosae, and Cruciferae (Stebbins, 1971), some being adapted for wind or animal transport and others displaying no obvious means of dispersal, were placed in the guild having the highest dispersal potential.

A species breeding-pollination system is important in determining whether the individuals reproduce and spread in an area after arriving. Three types of breeding-pollination systems were distinguished: autogamous (self-compatible) plants, that may or may not require the aid of a pollinating vector to produce seeds (Proctor and Yeo, 1972), allogamous (self-incompatible) and dioecious wind-pollinated plants, and allogamous and dioecious insect-pollinated plants (for autogamous and allogamous species, see Fryxell, 1957; Whitehouse, 1959; Grant and Grant, 1965; Mulligan and Findlay, 1970; Mulligan, 1972; Wood, 1974; Gibbs, Milne and Carillo, 1975; de Nettancourt, 1977; Frankel and Galun, 1977; for allogamy, East, 1929, 1940; Reader, 1975; for autogamy, Uphof, 1938; Schemske *et al.*, 1978; for dioecy, Yampolsky and Yampolsky, 1922; Allen, 1940; Mather, 1940; Grant, 1975; for pollination by wind or insects, Faegri and van der Pijl, 1966; Proctor and Yeo, 1972; Stebbins, 1974; Wood, 1974; de Nettancourt, 1977).

These three systems represent a breakdown that implies a hierarchial ability to reproduce successfully on disturbed areas once establishment has occurred. Autogamy is generally regarded as an adaptive strategy for plants occupying temporary pioneer habitats (Allard, 1965; Stebbins, 1970; Frankel and Galun, 1977) because long-distance dispersal of a single propagule can lead to rapid population increases. This system is also adaptive for colonizing species because of the possible lack of predictable pollinator services (Levin, 1972). Autogamy is commonly found in annuals, while perennial species in the same or a closely related genus are often obligate outcrossers (Stebbins, 1974). Consequently, autogamous species are expected to do better than allogamous species on recently disturbed sites.

Allogamous and dioecious species, because they both need pollen from a separate plant, may be spatially isolated, and thus fail to reproduce on a heavily disturbed site. This category is divided into plants pollinated by wind and by insects, as each vector is advantageous in different conditions. Wind-pollinated flowers, which are taxonomically restricted (Faegri and van der Pijl, 1966; Stebbins, 1974), are independent of the possibly erratic and inconstant behavior of insects (Ridley, 1930; Proctor and Yeo, 1972). Optimum conditions for wind pollination are found in open, sparse vegetation or in the top layer of closed, multi-layered vegetation types (Faegri and van der Pijl, 1966). Wind-pollinated species should be reproductively successful before insect-pollinated species as insects tend to be preferentially attracted to larger densities of flowers (Platt, Hill and Clark, 1974) which may be lacking immediately after a disturbance has occurred. Vertebrate pollination was not included as a distinct class as many of the vertebrate-pollinated species (about 150 in the United States) (James, 1948; Grant and Grant, 1968; Austin, 1975) are either autogamous (Grant and Grant, 1965, 1968) or are also successfully pollinated by insects (Grant and Grant, 1968).

Lastly, the herbaceous species are divided into annual and biennials/perennials (Munz, 1968; Fernald, 1970; Britton and Brown, 1970). Perennials such as *Festuca ovina* may form long-lived genets (Cook, 1979) that need to reproduce successfully sexually in occasional years for further colonization of the site. Annuals must produce seeds every year if reproduction and colonization of the site is to continue. Non-autogamous annuals may have a short-lived existence at a site if sufficient pollen does not reach the flowers.

3. Applications

The guild concept has potential use in environmental impact analysis though it has only recently been introduced for mammals (Severinghaus and Balbach, unpublished). By assembling species into functionally similar groups based on ecology and life history requirements, one may be able to predict the impact upon the components of a community for a given project and devise methods to mitigate the impact where desired. The system should be useful in predicting recolonization time or assessing the degree of degradation of a disturbed site. Each requires a survey prior to and after the disturbance to assemble a guild inventory for both the area to be disturbed and the surrounding area (this representing potential recolonizing species).

An area's guilds are delineated by plot sampling using rectangular plots with sides in a ratio of 1 : 2. For closely-spaced herbaceous vegetation, use plots 1 m^2 in area on a scale of 1 : 2 (i.e. $0{\cdot}71 \times 1{\cdot}41$ m). For bushes, shrubs, and saplings up to 3 to 4 m tall, use 10 m^2 plots ($2{\cdot}24 \times 4{\cdot}47$ m). For forest trees over 3 to 4 m tall, use 100 m^2 plot ($7{\cdot}07 \times 14{\cdot}14$ m) sampling areas. The number of plots needed for a reliable estimate of the guild inventory is determined by using species-area and performance curves (Brower and Zar, 1977). This technique also determines the relative abundance of each guild, such that similarity indices can be used to quantify the differences of two communities or one community at different times (Huhta, 1979). The guild inventory itself gives an overview of the general community structure and stage of succession.

The extent of damage is assessed by comparing the pre- and post-disturbance guild inventory. All guilds are classified at each division of the scheme, i.e. nitrogen-fixing ability, principal mode of dispersal, etc. Each class is weighted by the expected order of arrival, this representing a relative replacement time. The magnitude of disturbance is estimated by comparing the proportionate losses among the classes of each division. As

TABLE 1. Estimated replacement time for gross habitats in Illinois. Taken from Graber and Graber (1976)

Gross habitats	Years of successional lead-in time	Years of replacement time	References
Bottomland forest			
Oak–gum–cypress	100–150	20–600	Anderson and White (1970), Shelford (1954)
Elm–ash–cottonwood by age			
5–29 years (willow–cottonwood)	35	5–29	Shelford (1954)
30–59 years (willow–cottonwood–maple)	35	30–59	Shelford (1954)
60–99 years (hackberry–gum)	35	60–99	Shelford (1954)
100+ (hackberry–gum, elm–oak–hickory, and succession to climax)	135–600	100–500†	Shelford (1954)
Upland forest by age			
10–29 years (black cherry–elm–hawthorn, elm–persimmon–sassafras)	25	10–29	Bazzaz (1968), Beckwith (1954)
30–59 years (elm–oak–hickory)	50	30–59	
60–99 years (oak–hickory)	100	60–99	Odum (1953)
100+ (oak–hickory with possible succession to maple–beech)	100+	100–500†	
Maple–beech	150–200+	35–500+ †	
Aspen	5	5–39	Essex and Gansner (1965)
Pine forest by age			
10–39 years	25	10–39	Odum (1953)
40+	25	40–100+	
Shrub areas	3	3–30	Bazzaz (1968), Beckwith (1954)
Residential habitat	..	1–100+	This paper
Marsh, natural	1,000+	600+	This paper
Marsh, man-made	3	3–100+	This paper
Prairie	10–15	10–30+	Booth (1941), Thomson (1940), Weaver (1961)
Ungrazed and fallow fields	..	1–10	This paper
Pastures	..	1–10	This paper
Hayfields	..	1–3	This paper
Small-grain fields	..	1	This paper
Row-crop fields	..	1	This paper

† Time based on sizes of largest trees in Illinois (Mohlenbrock, 1973) and growth rates for these species.

TABLE 2. Growth rates of representative tree species. This table is to be used to determine approximate ages of trees and replacement times for forests. Taken from Graber and Graber (1976)

Species	Annual growth rate†	Comment on use of growth rate	Reference and locality of reference data
Ash, green and white *Fraxinus pennsylvania* and *F. americana*	0·22		Lorenz (1962) Central Illinois
Basswood *Tilia americana*	0·22		Chittenden and Robbins (1930) Southern Michigan
Beech, American *Fagus grandifolia*	0·12		Chittenden and Robbins (1930)
Box-elder *Acer negundo*	0·24		Lorenz (1962)
Cherry, black *Prunus serotina*	0·27		Conard (1918) Central Iowa
Cottonwood *Populus deltoides*	0·60	Use this rate for 4–15 inches DBH	Williamson (1913) Mississippi Valley
	0·56	Use this rate for 16–25 inches DBH	
	0·53	Use this rate for over 25 inches DBH	Gilmore *et al.* (1973) Southern Illinois
Cypress, bald *Taxodium distichum*	0·20	Use this rate for 4–40 inches DBH	Mattoon (1915*b*) Maryland, Louisiana
	0·13	Use this rate for over 40 inches DBH	
Elm, American *Ulmus americana*	0·31	Use this rate for 4–10 inches DBH	Lorenz (1962)
	0·25	Use this rate for 10–15 inches DBH	Chittenden and Robbins (1930)
	0·19	Use this rate for over 15 inches DBH	
Elm, red *U. rubra*	0·49		Conard (1918)
Gum, sweet *Liquidambar styraciflua*	0·30		Gilmore *et al.* (1973) Southern Illinois
Hickory, shagbark *Carya ovata*	0·22		Conard (1918)
Maple, silver *Acer saccharinum*	0·45		Lorenz (1962) Conard (1918)
Maple, sugar *A. saccharum*	0·15	Use this rate for 4–14 inches DBH	Chittenden and Robbins (1930)
	0·10	Use this rate for over 14 inches DBH	
Oak, black *Quercus velutina*	0·24	Use this rate for 4–10 inches DBH	Vestal (unpublished) Southern Illinois
	0·15	Use this rate for 11–15 inches DBH	
	0·10	Use this rate for over 15 inches DBH	Gevorkiantz and Scholz (1944) Southwestern Wisconsin

Oak, bur	0·26	Use this rate for 4–10 inches DBH	Lorenz (1962)
Q. macrocarpa	0·16	Use this rate for 11–15 inches DBH	Conard (1918)
	0·11	Use this rate for over 15 inches DBH	
Oak, pin	0·34		Vestal (unpublished)
Q. palustris			Southern Illinois
Oak, post	0·17		Vestal (unpublished)
Q. stellata			Southern Illinois
Oak, red	0·152		Robbins (1921)
Q. rubra			Missouri
Oaks	0·16	Use this rate for 4–12 inches DBH	Gevorkiantz and Scholz (1944)
Quercus spp.	0·128	Use this rate for 13–18 inches DBH	
	0·104	Use this rate for over 18 inches DBH	
Pine, loblolly	0·30	Use this rate for 4–10 inches DBH	Forbes and Demmon (1929)
Pinus taeda	0·25	Use this rate for 11–15 inches DBH	Virginia, Florida, Texas
	0·20	Use this rate for over 15 inches DBH	Arnold (1973)
			Southern Illinois
Pine, shortleaf	0·29	Use this rate for 4–8 inches DBH	Mattoon (1915*a*)
P. echinata	0·25	Use this rate for 9–12 inches DBH	Western Arkansas
	0·20	Use this rate for 13–17 inches DBH	Arnold (1973)
	0·15	Use this rate for 18–20 inches DBH	Forbes and Demmon (1929)
	0·10	Use this rate for over 20 inches DBH	
Pine, white	0·23	Use this rate for 4–15 inches DBH	Lorenz (1962)
P. strobus	0·12	Use this rate for over 15 inches DBH	Dwight (1926)
			Ontario, Canada
Sassafras	0·27		Rennels (1971)
Sassafras albidum			Central Illinois
Sycamore	0·44		Vestal (unpublished)
Platanus occidentalis			Gilmore *et al.* (1973)
			Southern Illinois
Walnut, black	0·43	Use this rate for 4–15 inches DBH	Conard (1918)
Juglans nigra	0·30	Use this rate for over 15 inches DBH	Losche (1973)
			Southern Illinois
			Lorenz (1962)
			Smith (1973)
			Central Missouri
Willow, black	0·54	Use this rate for 4–20 inches DBH	Lamb (1915)
Salix nigra	0·46	Use this rate for 21–26 inches DBH	Arkansas
	0·28	Use this rate for over 26 inches DBH	

† Given in inches. This figure divided into the diameter (in inches) of a tree will give the approximate age of the tree in years.

an example, let us consider the principal mode of dispersal. The extent of damage would be significantly greater if a disproportionate number of mammal- and gravity-dispersed guilds were extirpated while few wind-dispersed guilds were lost. Alternatively, the impact of the disturbance could be substantially mitigated were the converse to occur. This analysis, carried out for each division, gives an overview of the change in number and importance of the area's guilds. Damage can be determined by the ratio of the post-disturbance weighted guild total to the weighted total before the disturbance.

Predicting recolonization time or speed of recovery is primarily useful for examining the successional sequence of guilds invading heavily disturbed or denuded sites. Thus, we may make a relative determination of when to expect impacted species to re-establish. The extent of degradation will be variable dependent on the time replacement value of the pre-disturbance community. In general, early successional guilds such as the herbaceous, wind-dispersed, autogamous plants have a fast recovery time, while a late successional guild such as the woody, mammal-dispersed, insect-pollinated plants have a long recovery period. The speed of recovery for gross habitats can be estimated by the years of replacement time (Table 1). On heavily disturbed or denuded sites, where the soil is removed or substantially altered, a successional lead-in time must be added to the replacement time (Graber and Graber, 1976). These numbers provided a more quantitative estimation for the recovery time of specific guilds in each gross habitat.

The extent and state of decay of treefalls should at least be noted qualitatively, as these localized disturbances increase community diversity via spatial coexistence of successional seres (Margalef, 1962; Platt, 1975; Thompson, 1980) exhibiting a spectrum of reproductive and dispersal strategies (Forcier, 1975). Hence, localized disturbances represent an additional time component for replacement and may also increase the number of coexisting guilds.

Special attention should be given to dominant species in the area. Dominant woody species such as maple–beech, oak–hickory, or spruce–fir in their respective provinces should be surveyed to determine age structure and abundance (see Table 2 for growth rates of several woody species).

Mitigation of impact by using procedures to facilitate speedy recovery will reduce the replacement time. Eliminating practices that scrape off the top few inches of soil may reduce the impact to potentially resprouting perennials, as well as lessen the loss of small mammals (Severinghaus, pers. comm.). This would also prevent the removal of long-lived seeds from the area's soil seed bank (Cattelino *et al.*, 1979). Avoiding soil compaction where possible would aid in re-establishment from the seed bank, as germination would be easier. On large impacted areas, it may be beneficial to leave small undisturbed habitat islands, if possible, to serve as seed and pollen sources and to promote animal activity, i.e. as dispersers and pollinators.

One problem area with this system is that it provides only a relative order of arrival. For example, I would expect the herbaceous, wind-dispersed, autogamous, annual guild to be one of the first guilds to invade an area. Alternatively, it would be difficult to predict whether the herbaceous, mammal-dispersed, autogamous annuals would precede or follow the herbaceous, bird-dispersed, insect-pollinated, perennial guild. Post-disturbance monitoring of these sites or similar refurbished areas will increase the system's predictive accuracy.

In conclusion, this system represents an ecological classification of vegetation useful for impact analysis and examining community structure. The system eliminates subjectivity and results in comparable interpretations of a site when surveyed by different personnel. Examples (Figure 1) are given from a variety of genera, families, and geographic localities to promote a better understanding of the classification for the nonspecialist. The absence of examples for several guilds does not infer that there are no species in the guild, but rather that literature was not available. The classification of additional species is an area for further field research in plant ecology.

A possible drawback of this system is the necessity of additional expenditures for post-disturbance surveys of the site to examine the extent of damage, speed of recovery, and predictive accuracy of the EIA/EIS. I believe this classification will emphasize a more scientific approach to environmental impact analysis and eliminate some of the previous major criticisms of the process (see Schindler, 1976). Consequently, the value of the EIA/EIS will be increased by the collection and analysis of data relevant to the scientific community. Only then may significant scientific benefits accompany the vast environmental expenditures by the government.

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