The Focal-Species Approach and Landscape Restoration: a Critique

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Abstract: *In many parts of the world there is an urgent need for landscape restoration to conserve biodiversity. Landscape restoration is not straightforward, however, because many issues and processes must be understood for effective action to take place. In an attempt to guide restoration efforts for biodiversity conservation, Lambeck (1997, 1999) developed a taxon-based surrogate scheme called the focal-species approach. The focal-species approach involves the identification of a suite of species targeted for the management of threatening processes and vegetation-restoration efforts. Together, their "requirements for persistence define the attributes that must be present if [the landscape] is to meet the needs of the remaining biota" (Lambeck 1999). Some of our concerns with the focal-species approach include the following. First, the underlying theoretical basis of the focal-species approach is problematic. As part of a taxon-based surrogate scheme, a suite of focal species is presumed to act collectively as a surrogate for other elements of the biota. But taxon-based surrogate schemes have had limited success everywhere they have been applied. Second, the focal-species approach may be unsuitable for practical implementation, primarily because of the lack of data to guide the selection of a set of focal species in the majority of landscapes. We argue that restoration strategies should be based on appropriate theory, realistic assessment of available information, and an achievable outcome for the land managers who own or control the majority of land in the most significantly affected landscapes. Given the potential limitations of the focal-species approach, a mix of different strategies should be adopted in any given landscape and between different landscapes to spread risk of failure of any one approach. We believe that it is important to raise awareness about the potential limitations of the focal-species approach and to ensure that land managers do not assume it will inevitably lead to the conservation of all biota in a landscape.*

El Planteamiento de Especie Focal y Restauración de Paisaje: una Crítica

Resumen: *En muchas partes del mundo hay una urgente necesidad de restaurar paisajes para conservar la biodiversidad. Sin embargo, la restauración de paisajes no es sencilla porque hay muchos asuntos y procesos que deben ser comprendidos para que se lleven a cabo acciones efectivas. En un intento de guiar los esfuerzos de restauración para conservar la biodiversidad, Lambeck (1997, 1999) desarrolló una estrategia sustituta basada en un taxón denominado el planteamiento de la especie focal. El planteamiento de la especie focal involucra la identificación de un conjunto de especies para el manejo de los procesos amenazadores y los esfuerzos de restauración de la vegetación. Juntos sus "requerimientos para persistir definen los atributos que deben estar presentes para que (el paisaje) satisfaga las necesidades de la biota remanente" (Lambeck 1999). Algunas de nuestras preocupaciones con el planteamiento de especie focal incluyen las siguientes. En primer lugar, la base teórica que sustenta al planteamiento de la especie focal es problemática. Como parte de una estrategia sustituta basada en un taxón, se piensa que un conjunto de especies focales actúa como un*

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sustituto de otros elementos de la biota. Sin embargo, las estrategias sustitutas basadas en un taxón tienen éxito limitado en donde han sido aplicadas. En segundo lugar, el planteamiento de especie focal puede ser no ser adecuado para su instrumentación práctica, principalmente por la falta de datos para guiar la selección de un conjunto de especies focales en la mayoría de los paisajes. Sostenemos que las estrategias de restauración deben basarse en la teoría apropiada, valoraciones realistas de la información disponible y resultados alcanzables para quienes poseen o controlan la mayor parte de los paisajes significativamente más afectados. En virtud de las potenciales limitaciones del planteamiento de la especie focal, se debe adoptar una mezcla de distintas estrategias en cualquier paisaje y entre diferentes paisajes para distribuir el riesgo de fracasar de algún planteamiento en particular. Pensamos que es importante destacar las limitaciones potenciales del planteamiento de la especie focal y asegurar que los administradores de tierras no asuman que esto inevitablemente conducirá a la conservación de toda la biota en un paisaje.

Introduction

Extensive land degradation and associated environmental problems have occurred in many parts of the world. A conspicuous example is the widespread loss of native vegetation over much of the agricultural zone of Australia, which has led to many problems associated with land degradation. The remaining indigenous species in the agricultural zone of Australia must contend with the cumulative and interacting effects of habitat loss, grazing pressure, introduced competitors and predators, logging, firewood collection, and other altered environmental conditions. These environmental problems mean that major efforts are required to conserve remaining areas of native vegetation (Benson 1999) and to restore the biodiversity values of landscapes (Saunders et al. 1993). But developing sound and practical strategies to restore degraded landscapes is not a straightforward task. Many issues and processes must be individually and collectively understood for effective action to take place. It can be difficult to determine which areas to restore, what species and/or vegetation communities to target in restoration programs, and what threatening processes need to be mitigated.

Lambeck (1997, 1999) proposed the focal-species approach in an effort to provide a more scientific basis for landscape restoration. He defined focal species as taxa targeted for management through vegetation-restoration efforts because they are the ones most influenced by threatening processes. For example, focal species might be the most area-sensitive, dispersal-limited, resource-limited, and ecological process–limited taxa in a landscape (Lambeck 1999). The idea is to manage a landscape for a suite of focal species, each of which is thought to be sensitive to a particular threatening process. Lambeck (1997) claimed that "because the most demanding species are selected, a landscape designed and managed to meet their needs will encompass the needs of all other species."

The focal-species approach is an appealing way to focus restoration efforts by defining specific goals and objectives to conserve given sets of taxa in particular landscapes through a relatively transparent and repeatable framework (Lambeck 1999). It provides a systematic procedure that encourages the exploration of data and priority setting that aims to benefit at least a subset of the biodiversity in an area. The focal-species approach is now being applied in the Australian states of Western Australia, New South Wales, and Queensland. It has also been cited as a tool that can aid landscape restoration in other parts of the world (Noss et al. 1997; Miller et al. 1999; Noss 1999; Foreman et al. 2000).

Despite the merits of the focal-species approach and the enthusiasm for its implementation, we believe that its theoretical and practical underpinnings are not well established. We urge caution in the uncritical adoption of the approach, because using the focal-species approach to restore landscapes may lead land managers to assume incorrectly that all other elements of the biota have been conserved.

The Focal-Species Approach

The first step in applying the focal-species approach is to identify a set of threatening processes. Each threatening process is assigned a focal species, which is the species whose "requirements for persistence define the attributes that must be present if [the landscape] is to meet the needs of the remaining biota" (Lambeck 1999). Hence, the focal-species approach is essentially a taxon-based surrogate scheme. These schemes are not new: others include umbrella species, flagship species, and indicator species. Although the focal-species approach builds on the idea of umbrella species (Lambeck 1997; Caro & O'Doherty 1999), it differs in two respects. First, the taxa identified as focal species are identified on the basis of threatening processes. Second, the focal-species approach involves the selection of a suite of taxa rather than a single species.

Problems with the Focal-Species Approach

Failure of Taxon-Based Surrogate Schemes

The fundamental assumption of all taxon-based surrogate schemes, including the focal-species approach, is that if resource management or restoration efforts are targeted at a group of species, the needs of other taxa also will be met (Lambeck 1999). A number of workers have raised concerns about the conceptual, theoretical, and practical basis of taxon-based surrogate schemes (e.g., Landres 1983; Simberloff 1998; Andelman & Fagan 2000; Lindenmayer et al. 2000). Some of the problems that afflict taxon-based surrogate schemes are outlined below.

Taxon-based surrogate schemes assume that the response of particular species will be indicative of the response of many other species in the same or a different assemblage or group. This assumption is not valid, because the effects of landscape change and habitat fragmentation can vary among species (e.g., Robinson et al. 1992) and among groups of species (e.g., Gascon et al. 1999). Members of the same guild may not respond in the same way to a given type of disturbance, even when they are closely related (Landres et al. 1988; Morrison et al. 1992). Similarly, Swedish studies of red-listed species in semiprotected areas called "key woodland habitats" have found limited patterns of co-occurrence among vascular plants, fungi, lichens, and beetles (Gustafsson et al. 1999; Jonsson & Jonsell 1999). Many other studies have produced similar results (e.g., Prendergast et al. 1993). Andelman and Fagan (2000) examined the efficacy of indicator species, flagship species, umbrella species, and other taxon-based surrogate schemes. They found that none captured more species or protected habitat better than species selected at random.

Several workers suggest that taxon-based surrogate schemes would be useful indicators in a management regime (Milledge et al. 1991), but any species that is made the specific target of conservation by particular management actions is no longer an independent yardstick of those actions (Landres et al. 1988).

Causal relationships have never been demonstrated between the response of a purported taxon-based biodiversity surrogate and the ecosystem conditions for which it is supposed to be indicative (Lindenmayer et al. 2000). Such a lack of understanding can lead to the selection of the wrong biodiversity surrogate (Hilty & Merenlender 2000), with negative effects on the system targeted for management or a highly inaccurate reflection of the condition of that system. An example is a bivalve mollusc (*Velesunio ambiguus*) and its recommended use as an indicator of the presence of heavy metals in Australian river systems (Walker 1981). Subsequent work found that the uptake of heavy metals by *V. ambiguus* did not reflect the extent of pollution. This makes it an unreliable and thus entirely unsuitable indicator of river conditions (Millington & Walker 1983).

Problems in Identifying Species Most Affected by Threatening Processes and Their Interactions

A fundamental requirement of the focal-species approach is the identification of key threatening processes and the taxon most threatened by each process. Determining the causes of the decline of a given species can be a complex task (Caughley & Gunn 1995). Even if all the important threatening processes could be unequivocally determined, a subsequent major task would be to identify the species most sensitive to each process. Identifying these species is also hampered by biases in the taxonomic record. Although most vascular plants and vertebrate species are known to science, the majority of invertebrates remain undescribed. Given that invertebrates constitute the majority of animal species (Oliver & Beattie 1996), such a taxonomic bias means most threatened species will usually be unrepresented in the focal-species approach. This could be highly problematic because in many cases numerous important invertebrate taxa will remain in an area when vertebrates have been lost (Burgman & Lindenmayer 1998). There is also the potential for cultural and social bias in the selection of focal species toward charismatic megafauna such as large carnivores (Linnell et al. 2000).

Problems persist even if the focal-species approach is confined to well-known vertebrates. For example, identifying the most dispersal-limited species in a landscape will be almost impossible because dispersal is difficult to study and poorly understood for most taxa. Moreover, like other ecological phenomena, patterns of dispersal interact in unpredictable ways with factors such as patch size and matrix conditions (Gustafson & Gardner 1996). Identifying the most resource-limited or ecological process–limited species in a landscape will also be extremely difficult, even for well-known groups such as avifauna in the Northern Hemisphere. (See Newton [1998] for an example of the difficulties of determining the limiting effects of tree hollows on birds.)

Because data on the most dispersal-limited or resource-limited species will be lacking for most landscapes, the focal-species approach will often have to target the most area-limited taxa. This may fail because (1) area may not be the key factor influencing distribution patterns or the underlying cause of decline for some species (e.g., predation or within-fragment habitat structure could be more important) or (2) remnant area may interact with other factors to promote the decline of a species.

Another assumption of the focal-species approach is that threatening processes are independent (Cale 1999). Threatening processes rarely act in isolation (e.g., Ambuel & Temple 1983), and the decline and extinction of many species is caused by multiple factors (Simberloff 1988; Caughley & Gunn 1995). For example, patch size alone was a poor predictor of species richness and composition in an Australian study of the effects of remnant size and grazing pressure on indigenous herbs (Prober & Thiele 1995). Some large, intensively grazed remnants had considerably higher proportions of exotic species and fewer native taxa than much smaller remnants that were lightly grazed. Cascading fragmentation effects below hypothesized threshold levels of landscape cover (Andrén 1994; Zuidema et al. 1996) further illustrate the complexity created by interacting and/or cumulative threatening processes. Interacting and cumulative effects could theoretically be taken into account in the focal-species approach, but in reality they will be extremely difficult to quantify for most species in the majority of landscapes.

Even if it were feasible to identify all the interacting threatening processes and the species most sensitive to each one, it is possible that virtually every taxon in a landscape could turn out to be a focal species. This is because of (1) the wide range of threatening processes in a landscape; (2) the myriad possible combinations of interactions between different threatening processes; (3) differences in the spatial and temporal scales at which threatening processes operate (Lindenmayer 2000); and (4) the possibility that each species may have specific responses to each one of these processes (and their interactions). Such an outcome would essentially render the focal-species approach unworkable.

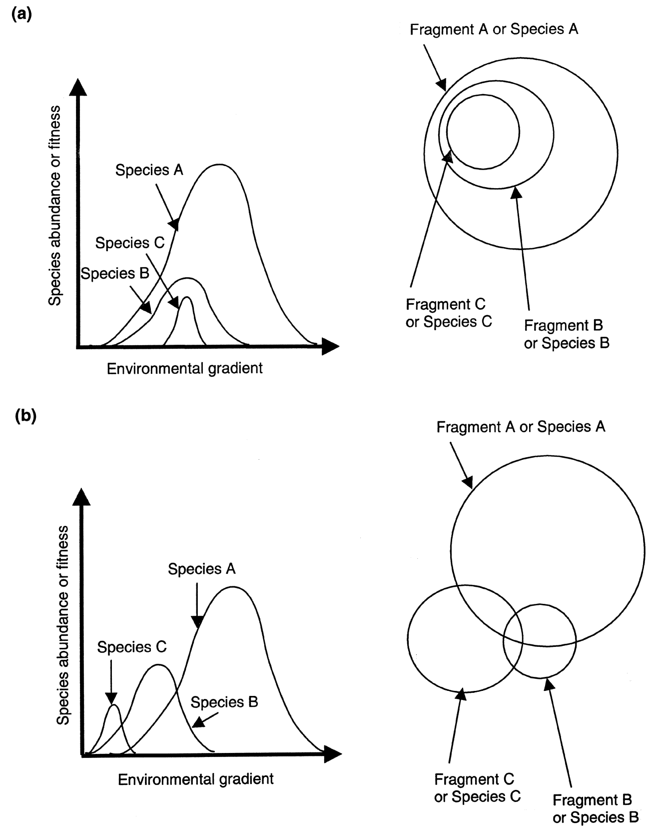

Figure 1. The principle of nested-subset theory (adapted from Patterson 1987) in relation to niche requirements and habitat fragmentation. (a) Nested-niche requirements may lead to nested-species assemblages. (b) Alternatively, species may not have overlapping niche requirements, which would lead to non-nested species assemblages.

Problems with the Implicit Assumption of Nestedness

The focal-species approach (like many taxon-based surrogate schemes) relies in part on patterns of nestedness (sensu Patterson 1987) among species within taxonomic groups, and among different groups. In the context of habitat fragmentation, nested subset theory is often interpreted to imply that species-poor small fragments should support assemblages that are subsets of larger species-rich fragments (Doak & Mills 1994; Fig. 1). The focal-species approach inherently pre-supposes nestedness in the response of species to disturbance—although the concept of nestedness is not specifically mentioned in explanations of the focal-species approach. The focal-species approach deals with disturbance in the form of "threatening processes." Therefore, if species A in Fig. 1a was chosen as a focal species for a particular threatening process because it was, for example, the most area-sensitive, resource-limited, or disturbance-affected species, it is assumed that species B (which is a less area-sensitive, resource-limited, or disturbance-affected species) and species C (which is the least area-sensitive, resource-limited, or disturbance-affected species) would also be conserved.

An implicit assumption of nestedness in biodiversity surrogate schemes such as the focal-species approach is problematic for four reasons. First, it is inappropriate to assume *without evidence* that communities are nested. Although nestedness is a common phenomenon in natural systems (Wright et al. 1998), some communities are not nested (e.g., Malmqvist & Eriksson 1995; Lindenmayer et al. 2002). The focal-species approach would fail in situations where nestedness does not occur. Figure 1b depicts a situation where protecting species A would not automatically protect species B or C because the community is not nested.

Second, even if nestedness was detected for one group (e.g., birds) it cannot be assumed that other groups of biota (e.g., plants) are nested with respect to the same environmental variable (e.g., patch size; Hansson 1998). Several authors have failed to find nestedness in species' responses and among sets of species (e.g., Hansson 1998; Gascon et al. 1999). For example, Lindenmayer et al. (1999*a*, 1999*b*, 2002) examined the responses of a range of vertebrate groups (including birds) to a fragmented landscape at Tumut in southern New South Wales. The response of birds was very different from that of mammals, and there was no nestedness within or between groups. No single species or suite of species would have been a reliable surrogate for the response of other taxa to the set of landscape conditions in the study. The result at Tumut is important because birds have been proposed as a candidate group from which to select focal species (Freudenberger 1999; Lambeck 1999; Watson 1999). Given the uncertainties surrounding the concept of nestedness, it appears inappropriate to base conservation strategies on the assumption that ecosystems are nested.

Failure to Account for Effects of Spatial Scale, Temporal Scale, and Population Viability

The aim of the focal-species approach is to guide landscape restoration. This may entail the restoration of habitat patches to, for example, a minimum of 10 ha to meet the needs of the most area-limited species (Freudenberger 1999). But the influence of factors at different spatial and temporal scales on species response is overlooked. First, each species is influenced by factors at a range of spatial scales (Lindenmayer 2000). For example, Forman (1964) demonstrated how factors at a hierarchy of spatial scales from global climate to the microhabitat of an individual log influenced the distribution of the moss *Tetraphis pellucida*. Similarly, Diamond (1973) showed how the distribution of birds in New Guinea was influenced by multi-scaled processes ranging from broad geographic factors to branch sizes of individual trees. Second, different species respond to different factors at different spatial scales (Wiens et al. 1997). Thus, a given restoration activity at a particular spatial scale thought to be appropriate for a particular taxon in a landscape may be ineffective for other species for which that taxon was thought to be a surrogate.

The focal-species approach also overlooks issues of temporal scale and population viability. Lambeck (1997) suggests the Western Yellow Robin (*Eopsaltria griseogularis*) as a focal species in the wheatbelt of Western Australia. Data were plotted for the presence or absence of the species in patches of different size and isolation. From these data, Lambeck (1997) inferred a critical threshold patch size and level of isolation below which the species was absent. This approach is flawed for two reasons. First, the two key threatening processes, patch size and isolation, are unlikely to operate independently. Second, the data were gathered from a system that had been fragmented only relatively recently. Nonviable patches could be presently occupied, but may not be in the future (e.g., Loyn 1987). Thus, setting minimum thresholds for patch sizes based on current species-occurrence patterns is inappropriate. It may be better to reconstruct some larger patches in which populations have a greater probability of medium- to long-term persistence.

Lack of Data

The focal-species approach is data-intensive and demands detailed information about the suite of species, the attributes of vegetation cover, the array of threatening processes (and their interactions), and many other factors in any given landscape. For most landscapes in need of restoration, basic knowledge is lacking to determine which taxa would be the most area-sensitive, dispersal-limited, resource-limited, or ecological process–limited. In fact, for all but a few species, we lack basic information on (1) distribution and abundance; (2) dispersal ability (particularly for plant species) or maximum gap-crossing ability; (3) the influence of adjoining land use on behavior and habitat suitability; (4) individual responses to disturbances such as grazing and fire, and (5) the cumulative effects of threatening processes. Without this information it is not possible to determine an appropriate spatial scale or set of scales to measure and then mitigate threatening processes. These problems increase uncertainty about which focal taxa to choose. Moreover, even if the assumptions underpinning the focal-species approach were to hold, considering the number of species that exist in a given landscape and the range of interacting threatening processes, the probability of selecting the wrong species or overlooking an important threatening process is high.

Lack of Testing and the Problem of Falsification

Although the focal-species approach is presently being applied in on-the-ground restoration efforts in parts of Australia, it remains largely untested. The approach is clearly intended to be a practical restoration tool for decision-makers, but practical application does not excuse the need for rigorous scientific testing (i.e., the ability to falsify the underlying theory on which the concept is based; Harrison 1991). Lambeck (1997) suggests a "strategic monitoring program" to track the response of systems to "management actions." This is not conventional scientific testing that provides the opportunity for the falsification of the underlying theory or principles. Indeed, Lambeck (1997:854) wrote that "The failure of any species to respond to these actions as predicted may indicate that the purported focal species are not the most sensitive to the process being managed or that some threatening process has been over-looked." This means that if the focal-species approach fails it is because the wrong focal species was chosen or a particular threatening process was not identified—not because the underpinnings of the approach are invalid. Thus, the way in which the focal-species approach is currently constructed makes it difficult to test empirically.

An important way forward is to (1) assess the value of restoration programs as a management action per se and the response of populations of a given set of species to those actions and (2) test the theory that underpins the focal-species approach by determining if strategies to restore landscapes for a selected set of taxa are also effective for conserving the rest of the biota. It should be possible to gather important new knowledge and insights if rigorously designed monitoring programs and experimental testing are applied to test the effectiveness of restoration programs that are implemented (including ones based on the focal-species approach). This would allow decision-makers to make an informed assessment of the "usefulness" of the focal-species approach and to determine whether to proceed with it or adopt (or increase the emphasis on) other restoration strategies.

Alternative Approaches to Landscape Restoration and Spreading Risk

It is possible that the requirements of the focal-species approach could be so demanding that landscape-restoration targets for them will not be feasible. Watson (1999) concluded that the extent of re-vegetation required to conserve the focal bird species (and associated other bird taxa) in the northern Australian Capital Territory and adjoining parts of New South Wales was not feasible because of financial constraints and problems of land tenure. For a conservation tool to be effective for practical application, social, economic, and political realities also need to be considered. The focal-species approach does not address these trade-offs. On this basis, we contend that in some cases it may be more appropriate to use explicitly stated objectives for landscape restoration other than the conservation of a particular taxon or suite of taxa nominated as focal species.

Given the potential limitations of the focal-species approach, a range of approaches (possibly including the focal-species approach), not just one strategy, should be adopted both in any given landscape and between different landscapes. If a single strategy by itself is found to be deficient or unworkable, then other strategies will have been implemented that might better achieve conservation and restoration objectives (for an example in a forestry context see Lindenmayer & Franklin 1997).

Some restoration approaches that could be employed in addition (or as an alternative) to the focal-species approach might include (1) restoration of watercourses and associated riparian vegetation (Fisher & Goldney 1997); (2) restoration and expansion of roadside vegetation (Fortin & Arnold 1997); (3) restoration of a nominated proportion of a landscape (e.g., 10%, 20%, or 30% of original cover) to create a mosaic of patches of a range of size, isolation, and other classes; (4) alteration of management regimes within existing remnant vegetation to improve habitat quality (or some aspect of vegetation condition); and (5) supplementation of existing patches of remnant vegetation, preferably through natural regeneration, to expand them to a given size. Numerous other options will vary between landscapes, depending on restoration objectives and a host of other factors. Unlike the focal-species approach, these strategies can be implemented without an associated claim that, by restoring the landscape for a selected subset of taxa, the remaining biota also will be conserved.

We are acutely aware that, like the focal-species approach, these strategies (and others not mentioned) have limitations. For example, restoration of riparian areas will not conserve species dependent on other parts of the landscape (Lindenmayer 1998). Restoration of a landscape to a given level of vegetation cover will not be sufficient for some taxa, and different threshold levels of vegetation cover (sensu Andrén 1994) will be required for different species in different landscape types (Mönkönnen & Ruenanen 1999). The key point is that it is risky to adopt a single approach to a complex problem such as landscape restoration, and a risk-spreading strategy that includes a range of approaches is preferable given present uncertainty. The response of ecosystems and biota should be monitored. To assist learning and improve future management decisions, restoration programs should be designed to allow formal analysis of the results and should have sufficient replication to determine the relative efficacy of different approaches.

Conclusions

The theoretical underpinnings and practical implementation of the focal-species approach are not sound for several reasons. First, it is a taxon-based biodiversity surrogate scheme, and such schemes have proven highly problematic (Andelman & Fagan 2000; Lindenmayer et al. 2000). Species-specific differences in dispersal, habitat requirements, and responses to threatening processes limit the ability of one taxon or a subset of taxa to act as a useful surrogate for others. Although a landscape could be restored in an attempt to meet the requirements of a given suite of species, it is inappropriate to assume automatically that the requirements of the remaining biota can also be met (cf. Lambeck 1999). Second, the focal-species approach is data-intensive, but data on most species, threatening processes, and responses of taxa to threatening processes are limited in most landscapes. Third, targeting the set of species most sensitive to a range of threatening processes may set impossible and unachievable goals for landscape restoration. Other targets that do not rely on potentially problematic and data-intensive ecological constructs may represent more robust (or at least additional) ways to set attainable benchmarks for landscape-restoration efforts.

The uncritical adoption of relatively new ideas and approaches in conservation biology and restoration ecology could have negative consequences for conservation, despite the best of intentions. It is sobering to recall the excitement generated by island biogeography theory and its implications for the design of nature reserves championed by Diamond (1975) and many others. As a result of the uncritical adoption of island biogeography theory, the overwhelming focus was on large reserves. However, the conservation value of small reserves is increasingly recognized (e.g., Semlitsch & Bodie 1998; Schwartz 1999). Therefore, we need to be cautious about the adoption of new proposals and approaches, however appealing they may first appear. The onus must fall on the scientific community to better inform land managers, governments, and politicians about the true complexity of environmental problems, including landscape restoration. In this case, scientists must work to prevent land managers from developing a false sense of security that the focal-species approach will conserve all biota. Harrison (1991:123) elegantly noted that ". . .it may be both unrealistic and dangerous to promote general 'principles of conservation biology,' as is sometimes done on the grounds that non-academics must be presented with simple rules. The alternative is to accept that conservation biology is an essentially empirical science. . .and that in the practical arena, we may do better to explain than to hide the complexities and uncertainties involved."

Restoration strategies must be based on appropriate theory, realistic assessments of available information, and achievable outcomes for the private landholders that manage the majority of land in the most significantly affected landscapes. Although the focal-species approach is unlikely to meet the requirements of all biota, it may be a useful way to stimulate interest in landscape restoration and may act in a similar way to the flagship-species approach. In addition, the focal-species approach is clearly better than ad hoc or "do-nothing" approaches, because it is a systematic procedure that encourages the exploration of available data and priority setting. But the inherent complexity of all landscapes and ecological problems suggests that there may not be a single straightforward way to set targets for urgently needed restoration efforts. Rather, a risk-spreading approach that involves the adoption of a wide range of strategies for landscape restoration will be important. With this paper we hope to stimulate further discussion about how to develop approaches for landscape restoration that can best contribute to the goals of ecologically sustainable landscape management—something we are all striving to achieve.

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