Appendix 3: SHORTCUT APPROACHES TO MULTI-SPECIES ASSESSMENT

Regional assessments encompass vast areas, and species of conservation concern within such areas can number in the hundreds or thousands (e.g., Thomas et al. 1993*a*, *b;* Stephenson and Calcarone 1999). Moreover, information about many species' requirements, habitat conditions, and population status across such vast areas is highly variable—more complete information often is available for larger-bodied birds and mammals, and substantially less is available for other vertebrate, invertebrate, and plant taxa (Bonnet et al. 2002). Consideration of large numbers of species on an individual basis, combined with the high variability in knowledge of their requirements, pose formidable scientific and management challenges. Consequently, a variety of methods have been have been proposed to gain efficiency in conducting multi-species assessments. These approaches have been described as "shortcuts" for conservation planning (Fleishman et al. 2000).

The primary purpose of any "shortcut" method is to eliminate or reduce the number of individual species that are explicitly considered in an assessment and in subsequent management. Presumably, use of a shortcut in a regional assessment results in increased efficiency, in contrast to dealing explicitly with hundreds of species on an individual basis. For example, Thomas et al. (1993*a*, *b*) assessed conditions and management options on a 10.1-million ha area for >1,100 plant and animal taxa that included terrestrial and aquatic vertebrates, vascular plants, fungi, bryophytes, lichens, and arthropods. Assessment of such vast areas and diverse sets of species makes assessment and management a challenging, perhaps impossible, task if all species are considered individually.

In addition, assessing habitats or populations solely on a species-by-species basis results in fine-scale focus on individual species, thus diverting attention from more holistic management and consideration of the interactions among species and their commonalities and differences (Wisdom et al. 2001, Manley et al. 2004). Regardless of the shortcut chosen, the methods of assessment will be constrained by the quantity and quality of information available (Andelman et al. 2001), and driven by the objectives of the assessment (Caro and O'Doherty 1999).

SHORTCUT APPROACHES

Two broad categories of shortcut approaches can be distinguished. The first uses larger sets of species (e.g., Manley et al. 2004) or large land areas (e.g., Oliver et al. 2004) to represent or meet the needs of all species of concern in the analysis area. This approach may include selecting a large set of the more detectable species, use of species groups, or coarse-filter management and landscape indicators. The second approach uses individual species to represent a suite of species, based on some common attribute. This second approach consists of fine-filter strategies (see Glossary, Appendix 1), which include indicator, keystone, umbrella, flagship, focal, surrogate species, or landscape species (Noss 1990, Marcot et al. 1994, Caro and O'Doherty 1999, Andelman et al. 2001, Wisdom et al 2001, Sanderson et al. 2002, Coppolillo et al. 2004). A species-by-species assessment of all species can also be accomplished with a fine-filter strategy, perhaps first ranking species by degree of risk (e.g., species listed under the U.S.

Endangered Species Act [ESA] first, followed by federal or state sensitive species) and conducting more thorough assessments for these top-ranked species (Wisdom et al. 2001).

The First Approach: Selecting a Large Set of Species or Coarse-filter Strategies

One approach recently developed is to use a large set of the more detectable species as representatives of a much larger, comprehensive set of species of concern for assessment and management (Manley et al. 2004). The approach relies on extensive field sampling to identify and monitor the species of concern that are most detectable and thus easiest to monitor. By extension, these species become the targets for management, and were found to effectively represent a larger, more comprehensive set of species and species groups in field tests in the Sierra Nevada Ecoregion (Manley et al. 2004). The effectiveness of this approach rests on how well the more detectable species represent the needs of the larger set of species or species groups, and accounting for species' needs beyond those addressed by the more detectable species. In some ways, this approach might be considered comparable to focal species selection, but the difference lies with the retention of a larger number of species—to be monitored and managed—than are typically retained under focal species or other single-species approaches.

Another approach that explicitly considers a large number or all species for analysis and management is the use of species groups. With this approach, the criteria by which to classify species into groups must be selected, based on available data and the objectives of the assessment. Several classification criteria have been proposed, including risk (e.g., degree of risk and risk factors); ecological characteristics such as habitat associations or guilds; ecological functions; and body size or home range size (e.g., categories of body size and dispersal capability) (Wisdom et al. 2001). A recent report on species viability assessments under the National Forest Management Act recommended grouping species by factors that increase risk of population decline (Andelman et al. 2001). For an evaluation of habitat status and trends of >90 broad-scale terrestrial vertebrates of concern in the Interior Columbia Basin, Wisdom et al. (2000) classified species into nested hierarchical groups based on similarities in source habitats among species. The advantage of hierarchical grouping is that species can be efficiently addressed at multiple scales (e.g., by individual species, groups of species, or groups of groups; Wisdom et al. 2001).

Coarse-filter approaches, such as GAP analysis (Scott et al. 1993), the coarse-filter conservation targets of The Nature Conservancy (e.g., matrix communities; Groves et al. 2000), or environmental surrogates (Oliver et al. 2004), are those in which conservation and assessment are based on larger sets of species, typically vegetation communities. The assumption is made that identifying and protecting these communities also will protect the majority of species associated with those communities, without having to measure environmental conditions for all species individually (Hunter 1991, Marcot et al. 1994).

Similarly, landscape-indicator models rely on measurements of broad-scale characteristics (e.g., extent of native habitats converted to agricultural land) to indicate geographic areas of concern, without measuring conditions for individual species (Ator et al. 2001, Gergel et al. 2002). Thus, this method minimizes or eliminates an explicit connection to individual species, or to a larger set of species. Instead, the assumption is made that if the correct indicators are effectively addressed in management, the health of the ecosystem, including its native species, will be maintained. For example, landscape indicators may be used to specify an amount, distribution, and quality of native plant communities to be managed for the benefit of all associated species of concern.

The Second Approach: Focal Species or other Fine-filter Strategies

Fine-filter strategies use one or a small number of species to represent conditions for a much larger set of species (Marcot et al. 1994). Umbrella, surrogate, and focal species approaches all use a single species to represent a larger set of species, in order to gain efficiency when conducting assessments over large areas supporting many species (Fleishman et al. 2000). A similar approach has been advocated with the use of landscape species, whose area requirements, ecological functions, vulnerability to extirpation, and socioeconomic significance are assumed to represent a larger set of species on the same landscapes (Sanderson et al. 2002, Coppolillo et al. 2004). While definitions of these single-species approaches may differ, each rests on the key assumption that a given species' requirements, and its response to management, can approximate those of a much larger set of species whose needs are similar to the umbrella, surrogate, or focal species (Wisdom et al. 2001). While intuitively appealing, these approaches are challenging because each species occupies its own niche (e.g., see MacArthur and MacArthur 1961, Root 1967), and may respond differently to management in relation to its unique needs.

Although definitions exist for the plethora of single-species approaches (e.g., focal, keystone, umbrella species, or landscape species; see definitions in Table A3.1 and Appendix 1), confusion in use of terms abounds (e.g., Caro 2000, Armstrong 2002). One commonly used concept—focal species—has been proposed as a means to efficiently evaluate viability or habitat conditions for a suite of related species. As such, a focal species is deemed to provide "insights to the integrity of the larger ecological system to which it belongs" (Andelman et al. 2001).

Prior to identification of focal species, the environmental requirements, such as habitat associations and home range sizes, of all species of concern in the assessment area must be determined (Lambeck 1997, Wisdom et al. 2001, Manley et al. 2004). Otherwise, application of the focal species concept may be doomed, because the adequacy of the focal species to represent the larger group will remain unknown (Wisdom et al. 2001). If a focal species approach is selected, we recommend following the sequence previously outlined by others (Lambeck 1997, Wisdom et al. 2001, Andelman et al. 2001), in which all species of concern are assigned to groups, after which a focal species is selected to represent each group.

If the number of species of concern is small (e.g., <20), the best solution may be to dispense with any shortcut approaches and simply assess each species individually. Without first examining environmental requirements and habitat conditions for each species, it remains unknown whether any shortcut approaches will adequately address the needs of each species of concern. Once this information has been gathered for each species, the utility of the shortcut may be moot.

ADVANTAGES, DISADVANTAGES, AND CAVEATS

Although coarse- and fine-filter approaches for multi-species assessment have been considered for several decades by the conservation community and land management agencies, their efficacy remains largely unknown (Table A3.1, this Appendix). Moreover, evaluation of the performance of single-species approaches requires an assessment of all species that the single species is assumed to represent, thereby reducing the efficiency of the shortcut. Also, such single-species approaches often lack clear, operational definitions that can be tested, may fail to identify the larger set of species the approach is designed to represent, and rarely are evaluated for performance.

The umbrella species concept was found to be of equivocal value for black rhinos (*Diceros bicornis*) and other herbivores in Africa (Berger 1997), and was largely unsuitable when used for California gnatcatchers (*Polioptila californica*; Rubinoff 2001), primarily because the invertebrate community was poorly represented by the presence of gnatcatchers in coastal scrub habitats. Rowland et al. (2006) (Chapter 8) also documented strengths and limitations in use of greater sage-grouse as an umbrella species in the Great Basin. Fleishman et al. (2000) recommend that a suite of umbrella species be used, rather than single species, and that these concepts undergo rigorous testing to evaluate their utility. Similarly, Hansen et al. (1999) outlined a method by which multiple species of concern are selected, their populations and habitats subsequently analyzed, and results used to design and evaluate management strategies for key species and landscapes. These types of evaluations of the effectiveness of the shortcut approach, and steps taken to overcome documented problems, are essential to successful management applications.

By contrast, the advantage of a coarse-filter approach, such as landscape indicators, is the broader consideration of landscape conditions in the ecosystem, and the efficient focus on managing such conditions to address resources comprehensively. The disadvantage is that no explicit connection is made to species of conservation concern. Consequently, whether or not the indicators account for the varied needs of these species is uncertain. Alternatively, to evaluate how well the indicators represent the needs of species would require explicit knowledge of each species' relationship with the indicators, thus diminishing the purpose and efficiency of the indicators.

Despite the appeal of greater efficiency by assessing conditions for groups of species, single-species approaches will likely continue to dominate most assessments and monitoring efforts for two reasons: (1) single species are easier to understand than are ecological processes or groups of species; and (2) laws such as the ESA tend to focus on single species rather than on "other levels of organization" (Noss 1990). In addition, data on habitat conditions and population trends for wildlife have traditionally been collected with a focus on single species, rather than on communities or assemblages of species.

Use of species groups, however, need not be exclusive of an assessment of individual species. On the contrary, Wisdom et al. (2000) specifically defined their grouping approach to include both single- and multi-species assessment, depending on objectives. To address both single and multiple species in their assessment, Wisdom et al. (2000) established a hierarchical system to evaluate habitats for individual species, for groups of species, and for "families" of groups (Fig. 1.16, Chapter 1). Species selected for analysis were clustered into groups based on similarities in habitats. Likewise, groups of species were placed within families based on further similarities in habitats. Each species within a group, and each group within a family, was nested completely within each of the higher levels of grouping (Fig. 1.16). That is, each species was assigned to one group, and each group assigned to one family.

This hierarchical nesting allowed for analysis to be flexible and adaptive. For example, managers often must generalize or blend the habitat requirements of many species to accommodate the composite needs of all species under ecosystem management. Each species, however, occupies its own niche and therefore has a unique set of habitat requirements, suggesting that broad-scale, ecosystem-based management strategies may address the needs of some species better than others (Marcot et al. 1994). Under this grouping approach, the degree to which a given set of management strategies meets the needs of each species can be quantified by evaluating the efficacy of the management strategies at all three levels: species, group, and family. Often, results of the family or group evaluations likely reflect the species evaluations accurately; in such cases, the higher levels of generalization (group or family) index the species-level phenomenon more efficiently than a species-by-species approach. When the requirements of a given species are not reflected well at the level of the group or family, however, evaluations of individual species can be used to complement the group- or family-level evaluations. For example, a species listed as federally threatened or endangered may have specialized or stringent habitat requirements that dictate specific consideration within a broader, ecosystem-based approach. Under the hierarchical system of species-, group-, and family-level evaluations, managers can choose multiple levels of display regarding habitat trends for species, groups, or families, depending on objectives and the level of generalization desired.

WHICH APPROACH TO USE?

Selection of a particular shortcut to increase the efficiency of multi-species assessments may not matter as much as the means by which the shortcut is used to meet objectives. We recommend that any shortcut method include the following criteria for application:

1. Identify all species of concern, including supporting rationale for inclusion;
2. Document and summarize the status, requirements, and other pertinent information related to population or habitat concerns for each species;
3. Use knowledge documented from the full set of species of concern to select the particular single-species shortcut, such as umbrella, surrogate or focal species;
4. Provide a detailed explanation of how and why the shortcut was chosen, and describe the limitations, caveats, and guidelines for ecological understanding of the approach's shortcomings and subsequent application in management; and
5. Describe the research needed to evaluate performance of the shortcut approach, particularly how use of the approach in regional assessments, and in subsequent management, may be constrained or diminished if key sources of uncertainty about the use of the shortcut are not evaluated.

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Table A3.1. Comparison of shortcut approaches for assessing habitat conditions and trends for species of concern in regional assessments.

Method	Definition	Source(s)	Advantages	Disadvantages	Assumptions
Larger sets of species and coarse-scale approaches					
Coarse-filter management	"Conservation of land areas and representative habitats with the assumption that the needs of all associated species, communities, environments, and ecological processes will be met"	Marcot et al. 1994:36	Increased efficiency from not having to address environmental requirements of individual species	Efficacy of method is unknown; likelihood of not representing the needs of some species is high	Conservation of selected habitats or geographic areas will conserve all associated species and processes in the area
Detectable species	A large set of species more easily detected and monitored provides a basis for effective management of larger, comprehensive set of species occurring on the same landscapes	Manley et al. 2004	Clear empirical basis for selecting and monitoring species, and assessing how well these species address the needs of the larger set of species	Requires extensive field sampling to identify and monitor species, and to check how well the selected, detectable species represent the larger set	Management of a comprehensive set of species of concern for a given landscape can be addressed through monitoring and management of a subset of more detectable species
Grouping species	Assigning all species of concern in the assessment area to groups, based on pre-determined criteria (e.g., macro-habitat associations, type of risk factor)	Wisdom et al. 2000, 2001; Andelman et al. 2001	Increased efficiency by analyzing several species as one; all species are accounted for in the analysis	Requires cross-checking to ensure that needs of individual species are met through the groups	All species under consideration can be classified and assigned to a mutually exclusive group
Landscape indicator	A measurement of the landscape, calculated from mapped or remotely sensed data, used to describe spatial patterns of land use and land cover across a geographic area.	Ator et al. 2001, Gergel et al. 2002	Increased efficiency from not having to address environmental requirements of individual species	Efficacy of method is unknown; likelihood of not capturing the needs of some species is high; relations between landscape metrics and species' requirements are not well established	Indicators of landscape quality, as assessed through a variety of metrics, will appropriately index the needs of the species occupying the landscape

Table A3.1. Comparison of shortcut approaches for assessing habitat conditions and trends for species of concern in regional assessments.

Method	Definition	Source(s)	Advantages	Disadvantages	Assumptions
Single-species approaches					
Ecological indicator species or groups	"Species that signal the effects of perturbations on a number of other species with similar habitat requirements;" population size and trend reflect those of other species associated with same area and habitats	Noss 1990:360, Marcot et al. 1994 (see also Landres et al. 1988), Moore et al. 2003	Help simplify development and implementation of management guidelines for multiple species	Approach cannot account for unique niches of each species; similar responses in indicator species and others may be due to different underlying conditions	Similar habitat and population trends in indicator species and other species are not coincidental
Flagship species	Popular, charismatic species that serve as symbols and rallying points for major conservation initiatives; typically large, long-lived species that are sensitive to human disturbance	Noss 1990:361, Caro and O'Doherty 1999	Concept has intuitive appeal and may increase public support for conservation efforts which ultimately result in protection for a large number of species	Emphasis is on charismatic species that may not be ecologically significant and may not well represent the needs of the larger set of species of concern. Other species that presumably benefit often are undefined.	Other species benefit from beneficial management of the flagship species.
Focal species	"Serve as indicator of ecological sustainability…;" "umbrella species whose area requirements include the habitat needs of many other species;" "representative of larger groups of species with similar habitat requirements or functional roles"	Andelman et al. 2001 (also see Wisdom et al. 2001)	Use allows simplification of management for multiple species in an assessment area	Little empirical evidence that approach is valid or effective; term may be so imprecise as to be of little value in some applications	Focal species will adequately represent the requirements of multiple species
Keystone species	"Pivotal species upon which the diversity of a large part of a community depends;" impact of keystones is large relative to their abundance	Noss 1990:360, Caro and O'Doherty 1999	Provides for proper functioning of important ecological processes	Needs of other species in the ecoregion may not be adequately addressed	Adequate knowledge exists to identify keystone species in the ecosystem

Table A3.1. Comparison of shortcut approaches for assessing habitat conditions and trends for species of concern in regional assessments.

Method	Definition	Source(s)	Advantages	Disadvantages	Assumptions
Landscape Species	Species whose area requirements, heterogeneity, ecological function, vulnerability, and socioeconomic significance are assumed to provide an unbiased method of site-based conservation to benefit overall biodiversity	Sanderson et al. 2002, Coppolillo et al. 2004	Establishes a formal process of species selection, analysis, and focus for selecting conservation sites, with supporting rationale and documentation	(See ecological indicator, flagship, focal, and umbrella species)	Landscape species provide an adequate basis for selecting conservation sites to meet the needs of a larger set of species and overall biodiversity
Surrogate species	Species used to indicate the extent of anthropogenic influences or track population changes of other species; may also encompass indicator, umbrella, or flagship species	Caro and O'Doherty 1999:806	(See ecological indicator, flagship, and umbrella species)	(See ecological indicator, flagship, focal, and umbrella species)	(See ecological indicator, flagship, and umbrella species)
Umbrella species	Species with large area requirements, which if given sufficient protected habitat area, will bring many other species under protection	Noss 1990:361, (also see Berger 1997; Fleishman et al. 2000, 2001)	Concept relatively easy to grasp; increased efficiency in assessment realized by selecting umbrella species	Validity of approach is less well substantiated than that of similar concepts (e.g., indicator species)	Umbrella species has a high probability of persistence; taxa of different trophic levels will be similarly protected; protecting areas for the umbrella species will protect areas used by other species