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A Process for Selection and Implementation of Conservation Approaches

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In this book, we have described a variety of approaches designed to achieve biological conservation objectives for both rare and little-known species. Resource managers are usually most concerned, for practical reasons, with approaches that conserve large-bodied and better-known taxa. Because we know so little about population status and life history requirements of rare or little-known (RLK) species, conservation managers have been forced to assume that the needs of these species are being met via proxy through our management of vegetation communities and well-studied species. Because so much of the world's biological diversity consists of rarer and more poorly known species (see chaps. 3 and 4), our focus on these species is warranted. In this chapter, we propose a process by which a land manager might evaluate the conservation issues on a particular planning area and select a set of approaches to address those issues. We organize this discussion around a set of steps, as illustrated in figure 12.1:

1. Identify geographic area and scope
2. Identify social, economic, and ecological requirements and considerations

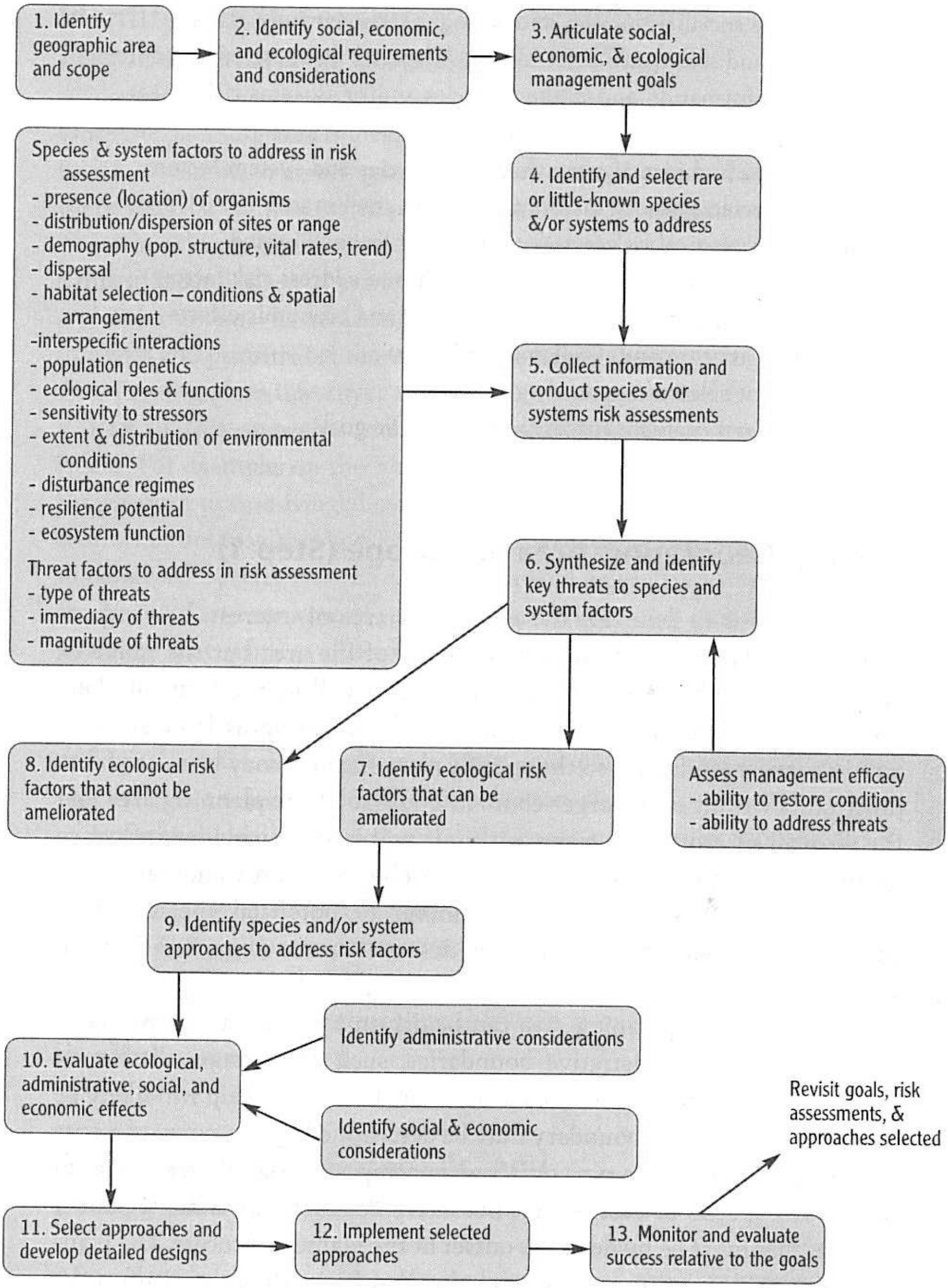

Figure 12.1. Flow chart of a process for selecting and testing alternatives to conservation of rare or little-known species as discussed in this book.

3. Articulate social, economic, and ecological management goals
4. Identify and select rare or little-known species and systems to address
5. Collect information and conduct species and/or systems risk assessments
6. Synthesize and identify key threats to species and system factors
7. Identify ecological risk factors that can be ameliorated
8. Identify ecological risk factors that cannot be ameliorated
9. Identify species and/or system approaches to address risk factors
10. Evaluate ecological, administrative, social, and economic effects
11. Select approaches and develop detailed designs
12. Implement selected approaches
13. Monitor and evaluate success relative to the goals

Identify Geographic Area and Scope (Step 1)

The first step is to delineate the geographic area of interest. It is important to identify not only the overall extent of the area but the range of ecosystems or subareas within the extent that will be the focus of planning. For example, one may be interested only in grassland systems within a larger landscape, so the specific planning area may be a set of disjunct units within some larger context. The size of the planning area and the number of ecosystem types within it will have an obvious influence on the complexity of the conservation problem. As area and variety of ecosystems increase, so will the number of potential species to be addressed, following the familiar species–area curve (e.g., Fisher et al. 1943).

Delineation of a planning area can be driven by a variety of factors or considerations. Administrative boundaries, such as a ranger district or project area, may be a primary consideration. Landownership will likely be important as well. The boundary may be determined by the range of a critical species or ecosystem type or it may encompass the combined ranges of several key species or ecosystems. Boundary delineation is a management decision that must be made at the outset of the planning process. The planning area needs to encompass an area that is sufficiently large to affect the species and processes of greatest concern, and at the same time allow assessment of the planning area's context at larger scales.

Identify Social, Economic, and Ecological Requirements and Considerations (Step 2)

Once the planning area is identified, the next step is to articulate the various social, economic, and ecological issues and considerations that apply. First, there may be constraints imposed by the ownership pattern in the area. There may be multiple jurisdictions (e.g., counties, towns) and there may be a mix of federal, state, or private lands, each with their attendant regulations and requirements. In addition, it will be important to identify and list the interests and priorities of the various stakeholders within the planning area. Any existing plans that cover the area may need to be modified or replaced.

Part of this step also includes characterizing the primary ecological issues. For example, on the Sheyenne National Grassland, the presence of the western prairie fringed orchid (*Platanthera praeclara*) is a major consideration because this species is federally listed as threatened under the Endangered Species Act (ESA) and is ranked as globally imperiled under the NatureServe ranking of species conservation status (see chap. 3). Note, however, that a full evaluation of the various species and systems in the planning area, as well as any threats to these species or systems, occurs in steps 5 and 6. At this point in the process the intent is to bring forward the ecological, social, legal, administrative, and political considerations that will influence objectives for the conservation plan.

The initial identification of social and economic considerations occurs in this step. Social considerations may include values of affected communities, the inclusiveness and balance of the decision-making process that will be used, and political and institutional dynamics that may affect the decision. Economic considerations should include economic efficiency and economic impacts. Interrelationships between economic and social effects should also be considered.

Articulate Social, Economic, and Ecological Management Goals (Step 3)

After identifying the major issues to be addressed, the next step is to specify the ecological, social, and economic goals and objectives for the plan (see chap. 2). Some of these goals will be quite broad (e.g., reintroduce fire as a natural disturbance process) whereas others may be quite specific and measurable to tie into tangible monitoring elements to assess program success later (e.g., provide conditions to support a viable population of the western prairie fringed orchid). Both short- and long-term objectives will facilitate the adaptive management of the program and help assure its success. Setting goals and objectives will involve feedback from other steps in this process. Goals may be revised or refined as information develops in subsequent steps. Consequently, we anticipate a fluid process between succeeding steps.

For example, if a land management plan is already in effect for the planning area of interest, any new goals or objectives will need to be reconciled with it. There may be additional mandates that will influence the specific goals and objectives for the area; these will have been brought forward in Step 2. These various goals and objectives, as well as existing mandates, will be blended to set priorities for management action. Setting priorities for the area should be an inclusive process that involves collaboration among affected parties and recognition of social, economic, and ecological requirements and considerations for the planning area.

Identify and Select RLK Species and Systems to Address (Step 4)

This is a critical step that will significantly impact future resource needs. The process of selecting species and systems to address is strongly influenced by the overall scope, complexity, and goals noted previously.

Identify and Select RLK "Species"

In this step, RLK species may include taxonomic species and also selected subspecies, populations, or other entities below the species level (hereafter referred to collectively as species). Before selecting individual species, the process begins by addressing which major taxonomic groups (viz., taxonomic classes) will be considered for risk analyses. Considerations are influenced by a combination of factors that relate to the initial goals as well as to the practical science issues and resource needs. Legal considerations are often defining factors. Species listed under the ESA, for example, are given high priority in conservation programs. Broad goals such as conserving total biodiversity may include many more species and other taxa than simply protecting ESA-listed species and may therefore require comprehensive processes for dealing with large numbers of species. Such was the case in developing the Northwest Forest Plan, where eight taxonomic groups, reflecting a broad array of biodiversity considerations, were selected for risk assessments (Meslow et al. 1994).

Several science- and resource-related issues must be weighed when considering which taxonomic groups to include, because each taxon has unique attributes. Some practical considerations for selecting species and taxa include number of species; availability of information on natural history, ecology, habitat requirements, dispersal, and threats; issues of detectability and sampling difficulty; availability of taxon experts; and overall practical experience in developing feasible management strategies. The size of the planning area and scope of the problem (box 12.1) strongly influence which taxa are selected.

After taxonomic groups are selected, the level of species analysis is determined. Most assessments have traditionally focused on individual species, but depending on the scope of the issue, the focus could be on evolutionary significant units (ESUs), individual populations, or other entities below the species level. For some taxa or ecosystems, multiple species assemblages may be identified for consideration rather than individual species. This could be the case where taxonomic groups include hundreds or thousands of poorly known species. For example, given the tens of thousands of arthropods in forest ecosystems, the Forest Ecosystem Management Assessment Team (FEMAT) analysis addressed only 15 functional groups of arthropods (Meslow et al 1994).

A detailed and preferably streamlined process is then developed for the actual selection of species (or species units) for risk assessment. Examples of methods for generally identifying species at risk, which may be extended to RLK species, have been suggested or tested by Wright et al. (2001) for plants and Lehmkuhl et al. (2001) for nonfish vertebrates. In a further consideration of risk factors, being both rare and specialized can mean higher risk of local extinction in forest fragments—as reported by Davies et al. (2004), who suggested that synergistic characteristics of some rare forest beetle species prone to extinction include the interplay between their low abundance and their high degree of specialization. Several major ranking systems such as those by NatureServe and the International

Box 12.1. Selecting approaches to rare or little-known species conservation: a multiobjective assessment approach to risk assessment and management.

Essentially, the general procedure suggested in this chapter for selecting approaches to conservation of rare or little-known species is a problem of multiobjective management. There are a number of useful methods for conducting multiobjective risk management. For example, Mendoza and Prabhu (2000) applied multiple criteria analysis (MCA) to assess criteria and indicators for forest management by ranking and rating alternative management decisions in a participatory setting with stakeholders and experts.

Other approaches include multiattribute utility theory (MAUT), goal hierarchy, analytic hierarchy process (AHP), multiple criteria decision making (MCDM), quantitative risk analysis (QRA), and others (e.g., Varis 1980; Basak and Saaty 1993; Helles et al. 1999; Mendoza and Prabhu 2000). All of these approaches entail identifying potentially desirable conditions, such as high confidence of persistence of rare or little-known species; identifying sources and degrees of risk; identifying the expected influence of potential management actions on those causes; exploring potential costs, benefits, risk attitudes, and acceptable levels of influence; and eventually selecting the best course of action that will minimize risks and costs or maximize likelihoods of desired outcomes. More formally, the performance level of each objective is quantified, the preferences among different objectives are weighted, the alternative management approaches are ranked, and an interim decision is made on the optimal course of action. Sensitivity testing can be used to help identify the relative influence of risk factors on desired species and system conditions and the relative influence of alternative management decisions on those risk factors.

Union for Conservation of Nature and Natural Resources (IUCN) provide detailed processes to assess risk (see chap. 3). Local species analyses should take advantage of these and other ranking systems in developing a final species list for consideration.

Carefully considering information already available (e.g., species lists developed for the area) is advantageous. Information can range from private records, collections, and databases to federal and heritage listings. Taxon experts can be engaged at this point to collect and synthesize information. Selection criteria are chosen and applied to develop a list of species that require risk assessments. The entire process of species selection, including specific criteria used, should be well documented.

The early analyses leading to the development of the Northwest Forest Plan provide a large-scale example of this initial species selection. Using a combination of agency databases and knowledgeable taxa experts, the FEMAT science team selected approximately 1100 species, 21 groups of fish, and 15 groups of arthropods for risk analysis (FEMAT 1993). Efforts to develop the Sierra Nevada Framework (http://www.fs.fed.us/r5/snfpa) provide another large-scale example in selecting species. They used a carefully designed process to identify species for analysis that also explicitly recognized that the level of risk used as a cutoff in these evaluations was itself an important decision.

Identify Systems to Address

Selecting systems to address should be guided by the project size, scope, and objectives. Legal considerations such as protecting critical habitat of threatened and endangered species can play an initial role in the selection. Some systems themselves carry legal protection (e.g., wetland protection) which often influences their inclusion in the risk assessment.

Two areas need careful consideration when selecting systems. The first is availability of information (literature, databases, maps, etc.) and resources (particularly people) to define and characterize the systems. The second is the classification or characterization of the systems.

Definitions and delineations of systems can be a far more slippery task than that of species. There is no single taxonomy of ecosystems, ecological communities, species assemblages, or other representations of systems. Multiple classifications exist for these types of systems and for vegetation types, wildlife habitat types, ecoprovinces, and other systems-level entities (e.g., O'Neil et al. 1995; Rieman et al. 2000; Treitz and Howarth 2000; Kintsch and Urban 2002). Even the term "ecosystem" can mean vastly different things (Corn 1993; DeLeo and Levin 1997; Watson 1997). And, in addition, all such classifications are artificial abstractions whose attributes (other than geography) are often impossible to assign definitively at actual locations in the field, where a particular location may display properties of multiple classes.

Classifications can also include existing vegetation communities, potential natural vegetation types, and designations specific to particular environments such as riparian ecosystems or old-growth forest ecosystems, or even special landscape features such as caves (Sieg et al. 1999). Some systems are delineated by administrative boundaries such as planning units or reserve lands. Similar to selecting taxa groups, different system designations have unique attributes that influence the complexity of systems risk analyses (e.g., availability and quality of existing information). These unique attributes should be carefully weighed in selecting the final systems for risk analyses. As with taxon selection, all criteria used should be clearly documented and all assumptions and uncertainties described.

Collect Information and Conduct Species and Systems Risk Assessments (Step 5)

These analytical steps begin with collecting pertinent information. Sources vary widely and differ in quality and accessibility. They might include government and nongovernment databases, maps of species locations and distribution, maps of vegetation or ecosystems types, unit boundaries and land designations (e.g., reserves), and published scientific literature. Next, a list of risk criteria and threat factors is developed for the assessment process. The large box in the flow diagram (see fig. 12.1) provides a range of examples. Risk analyses should focus on the factors that put the species or system at risk, currently or historically. The main stressors and potential effects of threats should be thoroughly characterized (e.g., type, immediacy, magnitude), the main assumptions clarified, and the main uncertainties documented. The final desired products and outcomes for the assessment (e.g., relative importance of different threats) also influence the selection of factors.

The selection of factors is also influenced by the availability of information to address a factor, and the utility of that information to accurately reflect the condition or threat under consideration. There is often limited mapped information for the actual threats considered important, and the magnitude of threats often has to be estimated from surrogate data and coarse modeling efforts. An example might be sedimentation in streams, which may be treated in a risk assessment by looking at rainfall, slope, soil and vegetation types, grazing and fire regime, and so forth, rather than by directly measuring the transport of silt.

Developing and using standardized processes to summarize information and assess risk is the most critical step in the risk analysis. Standardized processes are especially important when evaluating many taxonomic groups or systems. The literature on decision analysis and risk management offers a plethora of procedures (e.g., Hope and Peterson 2000; Williams 2000; McDonald and McDonald 2003, and many others). Panels of experts are often used to conduct portions of such evaluations, such as gauging effects of potential threats (e.g., von Winterfeldt 1992), and this introduces the chance of inconsistent interpretations across taxa or systems. Careful standardization of the process ultimately increases the likelihood of developing a scientifically sound assessment for decision makers (e.g., Shaw 1999).

As an example of the successful completion of this process, Thomas et al. (1993) analyzed risks to 667 species associated with old-growth forests in the Pacific Northwest. Risks included broad-scale declines in habitat, loss of fine-scale habitat features, and threats from various forms of human disturbance. The risk assessment was used to develop potential management strategies that could be applied by federal agencies.

The outcome of Step 5 is a clear description of the factors that cause species and systems to be at risk. These may include past reduction in abundance or distribution of habitat, changes over time in level of threat from various human activities, or other parameters. Results of the risk assessment are carried into the next step and provide the foundation for designing management approaches.

Synthesize and Identify Key Threats to Species and System Factors (Step 6)

This step entails combining the results of the species and system risk assessments. Doing this requires summarizing the expected types, degrees, and effects of risk factors on systems and on the persistence of RLK species. As an example of this step, Cane and Tepedino (2001) summarized results from a workshop (expert panel) to identify causes and degrees of declines of native invertebrate pollinators in North America, which include some RLK species of bees, flies, and other taxa.

Identify Ecological Risk Factors That Can Be Ameliorated (Step 7)

After identifying the common causes of risks to species and systems, the next step is to identify which causes can be ameliorated by management activities, and determine the degree to which management could reduce or eliminate each risk factor and thereby restore desired conditions. For example, Feldman et al. (1999) used a comparative risk assessment approach to help set priorities for environmental conservation. Their approach entailed identifying the relative efficacy and benefits of environmental policy decisions. They specifically examined how projects were administered; how they involved the public; how they characterized, ranked, and prioritized risks; whether and how they implemented projects based on results of rankings; and whether and how they evaluated project results.

Identify Ecological Risk Factors That Cannot Be Ameliorated (Step 8)

This step requires identifying which risk factors likely cannot be fixed by management, and outlining their expected effect on species or systems of interest. This will provide an understanding of the degrees to which management can and cannot be expected to solve specific problems. In so doing, it will help provide realistic expectations for the effects of management and identify any critical causes of risk that may need to be addressed by other concerned parties, ownerships, or organizations outside the immediate management focus.

An example is the decline of pendant arboreal lichens from poor air quality caused by point and nonpoint air pollution sources, such as urban industrial centers and automobiles. This may be a major cause of decline in some RLK species of lichens (see Stolte et al. 1993), although there may be little to nothing that forest management activities can do to slow or reverse the degradation. Similar off-site causes of risks to RLK species may be adverse regional climate change, spread of invasive species, noise pollution, and other risk factors.

In general, Steps 6 through 8 can be conducted as part of a structured decision-making procedure. Such a procedure serves to synthesize findings on risk levels and causes, and, eventually, on potential management actions that can ameliorate, restore, or mitigate for adverse effects. This is essentially a problem in *multiobjective risk management*, to which the preceding three steps and the next two steps pertain.

Identify Species and/or System Approaches to Address Risk Factors (Step 9)

The objective of this step is to make a preliminary determination of approaches that could be useful in conserving species (chap. 6) and systems (chap. 7) that were identified in Step 4, and that will address those threats identified in Step 7. At this point in the process, the identification of approaches should not be heavily constrained by economic, political, or administrative considerations. Those factors should be considered when implications of the approaches are reviewed in the next step (10). Final selection and refinement of the approaches takes place in Step 11.

There is no accepted, comprehensive guide to the selection and design of conservation strategies for various situations. However, consideration of the following factors can help inform the preliminary selection of conservation approaches:

Identified Ecological Risk Factors That Can Be Dealt with by Management

The risk factors identified in step 7 may provide important clues to the general type of conservation approach that would be helpful, as well as clues to some specific design considerations for that approach. As shown in chapter 8 (see table 8.2), each of the approaches addresses a subset of the factors that are important to species conservation. So if we know the factors that are causing a species to be at risk, this table can help guide the selection of a conservation approach. For example, if the loss of current species locations is a significant risk factor, and the species has strong co-occurrence associations with other more easily monitored species, then a useful strategy might combine the use of a biodiversity indicator species, a geographic approach, and some applications of individual viability strategies. Other surrogate approaches (e.g., umbrella or flagship species) and system approaches would be less applicable. Conversely, if the dynamics of a species' habitat was a key risk factor, the system approaches would tend to be useful, and the species approaches would be less useful. Of course, it will often be the case that there are a variety of risk factors that would best be dealt with through some combination of approaches.

Level of Our Knowledge about the Species/Systems

The level of our knowledge about a species or system may also be critical in the selection of a conservation approach. Although level of knowledge should not be considered an absolute long-term constraint to the selection of a conservation approach (i.e., with the proper investment it is possible to gain additional knowledge), it may be a very important consideration in the choice of a conservation approach that can be applied in the short term. Table 12.1 shows information that is needed for application of the various conservation approaches and may be helpful in determining which approach can be applied in a given situation. For example, if the only information available for an RLK species is information on its current locations, then the most useful approach over the short term may be management for specific locations of the species. If additional information is available, there may be a broader selection of possible approaches.

Basic Natural History of the Species/Systems

Natural history of a species may influence the choice of conservation approach. If a species tends to occur in small, isolated populations, then a focus on management of the locations of those populations may be most appropriate. On the other hand, if a species tends to occur more broadly, is relatively mobile, and has individuals that disperse among populations, then an approach based on viability of individual species, which would focus on the current location of populations, suitable but unoccupied habitat, and dispersal habitat, would be more appropriate.

Underlying Management Goal

As discussed in chapters 2 and 8, managers may operate under a variety of different management goals, and different conservation approaches may best

Table 12.1. *Information needed to implement species- and system-based approaches for conservation of rare or little-known species.*

Approach	Presence (locations) of organisms	Distribution/dispersion of sites or range	Demography (pop. structure, vital rates, trend)	Dispersal	Habitat selection—conditions and spatial arrangement	Interspecific interactions	Population genetics	Ecological roles and functions	Sensitivity to stressors	Extent and distribution of environmental conditions	Disturbance regimes	Resilience potential	Ecosystem function
Species-Based Approaches													
Viability of Individual species													
Viability of individual species	2	1	2	2	1	2	2	2	2	—	—	—	
Surrogate species[a]													
Focal species	2	1	—	1	1	—	—	—	1	—	—	—	
Umbrella species	—	1[c]	—	—	1	—	—	—	—	—	—	—	—
Guilds	—	2	—	—	1	2	—	2	—	—	—	—	—
Habitat assemblages	—	2	—	—	1	—	—	—	—	—	—	—	—
Biodiversity indicator species	2	1[c]	—	—	2	—	—	—	—	—	—	—	—
Flagship species	—	—	—	—	—	—	—	—	—	—	—	—	—
Geographic approaches													
Management for locations of target species	1	2	—	—	2	—	—	—	—	—	—	—	—
Hot spots (of RLK spp.)[b]	2	1	—	—	2	—	—	—	—	—	—	—	—
Reserves or protected areas	2	1	—	2	2	—	—	—	—	—	—	—	—

(continues)

Table 12.1. *Continued*

Approach	Presence (locations) of organisms	Distribution/dispersion of sites or range	Demography (pop. structure, vital rates, trend)	Dispersal	Habitat selection—conditions and spatial arrangement	Interspecific interactions	Population genetics	Ecological roles and functions	Sensitivity to stressors	Extent and distribution of environmental conditions	Disturbance regimes	Resilience potential	Ecosystem function
System-based Approaches													
Maintaining system structure and composition													
Managing for RNV	—	—	—	—	—	—	—	—	—	1	1	—	—
Managing for diversity of habitats using concept other than RNV	—	—	—	—	—	—	—	—	—	1	2	—	—
Strongly interacting species[c]	—	1	—	—	1	—	—	1	—	—	—	—	—
Maintaining system function													
Maintaining disturbance regimes	—	—	—	—	—	—	—	—	—	2	1	2	—
Maintaining other ecosystem functions	—	—	—	—	—	—	—	—	—	2	2	2	1

This table assumes that approaches would be crafted anew based on the central objective of conserving rare or little-known species.
RNV = range of natural variability
1 = minimum required information
2 = desired but not essential information
— = neither minimum required nor desired (i.e., n/a)
[a] may include non-RLK species
[b] information needed on > 1 RLK species
[c] includes information on co-occurrence with other species

contribute to each of those goals. Although the goals may not be mutually exclusive, emphasis on particular goals could influence the choice of conservation approach. For example, if the primary goal is to maintain RLK species over at least the short term, focus on approaches that maintain the current locations of the species is warranted. On the other hand, if the primary goal is to restore system resiliency, system approaches would be appropriate. Again, it is likely that a variety of goals could best be achieved through some combined approach. Many overall strategies also have a variety of specific implementation scenarios that may perform similarly for species conservation, for example, in establishing a network of protected sites totaling to some particular total acreage or budgetary target. In this case, the land manager would want to know relative costs and benefits for each proposed scenario.

Evaluate Ecological, Administrative, Social, and Economic Effects (Step 10)

The conservation approaches identified in Step 9 may have profound implications for social, economic, and ecological systems. They may also differ greatly in requirements for knowledge, trained personnel, budget, and administrative structures. These implications must be assessed before managers can make an informed decision about adopting an approach or set of approaches. Effects evaluation should tell the land manager whether the approach protects the species, is socially supported, and is worth adopting based on its cost–benefit analysis.

Evaluation of Ecological Effects

The following guidelines should be consulted in the evaluation of ecological effects:

- If the conservation approaches to be evaluated include the use of surrogate species or species assemblages, appropriate analysis should be completed to identify them. They then become the focus of species evaluations.
- Evaluation of effects should be framed as a risk and uncertainty assessment (e.g., Meslow et al. 1994; Raphael et al. 2001).
- The evaluation must include assessment of both short-term

and long-term risks. The timeframe over which long-term risks are projected should be determined based both on biology of the species (e.g., generation time, response time to changed conditions, recolonization capability) and on the time needed for the overall ecosystem to respond to proposed management. Assessment over such a timeframe is important to a full understanding of the long-term effects of management on ecosystems and species, but it must be understood that confidence in the accuracy of risk evaluations decreases rapidly as the timeframe of projections increases.

- The spatial scale of the evaluation should reflect the scale at which biological populations of the species operate and the scale at which ecological processes occur within the system, including its ecological context.
- In addition to the projected future, the analysis should also address the current condition and, where possible, the historical condition of the species and/or system.
- For most species, the only practical quantitative analysis is an assessment of habitat conditions. It is, however, essential that we connect habitat conditions with population consequences, even if this connection is estimated using general ecological principles due to lack of population data or knowledge of species population processes.
- The evaluation should be logical and consistent, consider relevant information, and disclose both risks and levels of uncertainty. It is important to document important sources of uncertainty, including uncertainty due to environmental stochasticity.
- Where surrogate species or species assemblages are used, the evaluations of the surrogates or assemblages should be applied to all of the species that they represent.

Evaluation of Administrative Considerations

Careful evaluation of administrative issues is key to determining the practical implications of implementing the conservation approaches identified in step 9. In particular, the various approaches will require different information sets, expertise, administrative structures, and costs. First, different approaches require different types and levels of information. Specific information needs of approaches are shown in table 12.1. Figure 12.1 provides a general view of the level of information required to implement a generalized set of conservation approaches.

Second, availability of specialists with the appropriate expertise will vary with approach chosen. Some approaches require the availability of highly specialized skills. For example, approaches that focus on protection of extant locations of RLK species require the availability of personnel who can identify the species. In some cases, identification of RLK species is an extremely specialized skill, and there may be few qualified personnel available. On the other hand, approaches that rely on conservation of habitats rather than conservation of species occurrences generally require less-specialized personnel assuming there is an accepted classification of vegetation or ecosystems within the planning area, and an understanding of the role of disturbances in maintaining the systems.

Third, administrative structures must be able to accommodate the conservation approach chosen and number of stakeholders involved. Well-designed administrative structures are needed for consistent implementation of conservation approaches over large geographic areas incorporating multiple landowners. For some approaches, these administrative structures may deal with facets of management that are familiar to the agencies involved and so may not be much of a departure from day-to-day management. For example, managing systems based on the range of natural variability involves forms of management that are similar to historic practices of the land management agencies. Conversely, managing for sites of individual species may involve issues that are much less familiar to the agencies and require coordinating structures that are new to the agencies.

However, perhaps the most important administrative consideration for implementing an approach is its cost. The fundamental capability of administratively implementing an approach involves its cost and available funding source. In general, the cost per species is often higher for individual species approaches and lower for systems approaches, surrogate approaches, and other approaches that address multiple species.

Evaluation of Social Considerations

The social sciences provide a mechanism to measure the social/cultural human context of the biological requirements of species conservation strategies (see chap. 9). The following guidelines should be consulted in evaluating the social consequences of alternative species conservation strategies.

Values

The foundation for building consensus begins with an understanding of the social values at play at the personal, family, business, and community levels. Values range across a wide spectrum from personal environmental stewardship ethics, to family values, including their traditional use of natural resources, to economic prosperity.

Decision-Making Process

Inclusiveness and balance of perspectives are keys to credible and successful consensus building. It is imperative to understand the perspectives of the stakeholders, their priorities, and how they are manifested in the process.

Institutional Dynamics

Traditional approaches and policy can create a precedent that narrows perspectives and stifles unbiased assessments of alternative conservation strategies. An open decision-making process should foster new ideas and consideration of alternative strategies.

Political Dynamics

Social values are manifested in political positions on issues of concern. More often than not, political influence drives the decision-making process and can detract from an open-minded assessment of alternatives. The political perspective concerning federal land stewardship and use is shifting away from national public opinion toward local special interests. These dynamics influence all aspects of the social dimensions of evaluating alternative species conservation.

Evaluation of Economic Effects

Economic considerations should be included early and continuously throughout the RLK species conservation process. This reduces surprise and distrust when biologically and technically feasible conservation outcomes may not be achievable based on economic efficiency grounds later in the decision process. The evaluation of economic efficiency should be framed as a comprehensive benefit to cost analysis. Costs should include the opportunity costs of alternative resource uses when conservation requirements preclude existing or next-best uses, and benefits should include nonmarket benefits accruing not only to the conserved species or systems, but when possible, also to ancillary positive externalities, such as cultural and biological diversity. Evaluation of risk and uncertainty should be framed as risk to benefit analysis so that biological and ecological risks can be compared with potential economic benefits.

Economic impacts such as jobs, taxes, and income must be estimated as equity or distributional effects, separate from efficiency benefits. In particular, both analysts and managers must avoid counting potential increases or decreases in regional employment as net benefits or costs in the benefit–cost analysis. The level of economic analysis effort should vary depending on the expected economic and social consequences of alternative management practices and policies. For example, new willingness-to-pay studies may be well worth the cost when expected nonmarket benefits are large, but they may not be cost-effective when expected nonmarket benefits are small. In the latter case, benefits-transfer methods that estimate RLK species benefits from existing similar studies may be used. Likewise, new economic impact analysis may be needed if expected employment effects are large, otherwise not.

Economic effects should be closely linked to other social effects, including cultural values and institutional dynamics. Because connected ecological and economic systems are complex, variable, and changing, they should be linked in common computer simulation models that can test and monitor the effects of alternative management actions meant to conserve RLK species.

Develop Final List of Approaches for Consideration

The final component of this step is the articulation of a reasonable set of approaches to be considered by managers in their selection process in Step 11. This may include only a subset of the approaches originally identified in Step 9. Some of the approaches identified in Step 9 may not be fully developed for consideration by management because the evaluation in Step 10 indicates that they would be ineffective, inefficient, or unfeasible.

Select Approaches and Develop Detailed Designs (Step 11)

The final selection of the conservation approach or approaches is a management decision and will rarely be determined entirely by the ecological, social, or economic data. Evaluation of information from Step 10 should be clearly articulated and summarized for use by managers in making this decision. It is extremely important that the evaluations be conducted in a consistent way across the alternative approaches, and that the summaries developed for managers are also consistent and focus on key differences. It is important to be clear about sources and levels of uncertainty associated with the results, and to emphasize true differences among the alternative approaches rather than apparent differences. Selection of approaches to be implemented should be based on a judgment about how well the approaches will accomplish the full set of goals described in Step 3. Managers should carefully document the basis for their choices, particularly where accomplishment of one goal has to be weighed against accomplishment of other goals.

The approaches developed and evaluated in the foregoing steps may still be somewhat conceptual and require further refinement before they can be implemented. The following may be important steps in the development of a final design:

- Determine data sources (e.g., species point locations, remotely sensed imagery, historical studies of disturbance patterns) and models (e.g., species habitat affinity, vegetation dynamics) that will be used in various parts of the conservation approach.
- Reconcile existing inventory standards or modeling approaches that might vary across the plan area.
- Develop new survey/inventory protocols and models if current data and existing models are found to be inadequate.
- Develop a framework to receive and/or harvest information from citizen monitoring and other nonexpert field observations, attach source/reliability metadata, and make it available for review, annotation, and analysis.

- Define a set of species or system elements that will be monitored to judge the success or failure of the plan, determine an appropriate monitoring schedule for the elements selected, define the monitoring protocols, specify how monitoring data will feed species or system models, and develop a strategy for how the results from monitoring will be used to revise the plan.
- Finalize the boundaries for specific types of management areas such as reserves or hotspots.
- Finalize management standards for specific types of management areas (e.g., the level of salvage that might be allowed within reserves, or standards designed to provide for persistence of RLK species on sites they currently occupy).
- Develop standards for management that are designed to emulate natural disturbance or move the system toward range of natural variability (RNV) conditions.

Implement Selected Approaches (Step 12)

Implementation of the selected approach or approaches begins as a planning process. With a focus on getting the job done, the scope and complexity of the program can be adjusted to fit the circumstances (see chap. 11). Approaches with objectives addressing large spatial scales, multiple habitat types, numerous species in multiple taxonomic groups, and the priorities of many stakeholders may easily lead to a complex program structure. Approaches with the broadest scopes may have management tiers that include decision makers, program managers, leaders of primary objectives, a variety of species specialists or resource specialists, data managers and analysts, communication specialists, and the necessary support staff and services. Depending upon the level of cooperation among the landowners involved, some similar roles may need to be filled for each of the primary stakeholders so that integrated teams are developed. The plan should also clearly define criteria for success, that is, measurable outcomes by which rare or little-known species can be judged to be sufficiently conserved or restored. The number of taxa included in the plan and the level of accountability desired to achieve the conservation objectives are key in determining the workforce needed. Simpler approaches and those monitoring only surrogate response parameters would require less staff, although the utility of such approaches for meeting resource objectives needs to be tested.

During this planning process, the capability of the resource managers to implement the selected approach should be assessed. Capability is largely a function of the level of involvement needed to conduct the program, funding, available expertise, time, and implementation constraints. If the approach requires only delineating a protected zone around a specific remote area, then the program may have some start-up effort, but subsequent maintenance would involve only required monitoring programs. Higher maintenance would be needed for an actively managed area, or an approach that requires intensive species- or resource-level monitoring, or for other approaches such as reserve boundaries that might be adjusted in response to disturbance or environmental changes.

Many constraints can arise during planning or actual program implementation. Funding, in particular, will limit the extent to which a complex program can be implemented and the extent to which specific design elements can be effectively managed and monitored. For example, many little-known taxa belong to taxonomic groups for which there may be little scientific expertise, or for which techniques for detecting their presence and managing sites or populations are not straightforward. Funding can help acquire or develop expertise and techniques, provided that there is time available for such new knowledge to be gathered. In addition to funding, authority may arise as an issue if the scope of the selected approach results in serious natural resource conflicts, such as reduced economic outputs. In particular, the approach may be challenged by some stakeholders if it does not appear to have a legal basis or opposes other policies. However, authority need not rely solely on a legal foundation but also on a mix of social advocacy, sociopolitical management decisions, and conservation leadership. And in the case of those RLK species that provide ecosystem services, act as architects, serve as potential biotechnology products, or otherwise enhance economic well-being, the policy may be undertaken because it produces economic benefits or reduces economic risks.

The implementation phase involves reiteration of many previous steps. Considerations from social, economic, and ecological arenas may be reevaluated. The initial objectives may be reassessed—and importantly, reprioritized. Implementation constraints may require the selection and design of the approach to be fine-tuned or outright changed. Implementation also requires looking forward to the next steps, because the monitoring plan and adaptive management process will need to be developed and incorporated into the program structure. Once the planning process has proceeded and resolved the major hurdles, and the resulting conservation plan has been approved for actual implementation, the infrastructure can be built and the approach(es) put to the test on the ground.

Monitor and Evaluate Success Relative to the Goals (Step 13)

Developing and implementing conservation approaches for RLK species is not a linear process; it is cyclical (see fig. 12.1). Once plans are implemented, the final step should include monitoring, adapting management, and being accountable to stakeholders. Selected approaches should be viewed as experiments, because rarely in our history have we undertaken species or systems management to the extent that is now being explored. As with any innovation, to ensure our best intentions do not go awry, the "test" needs to be checked, and, as necessary, adjustments made to the management plan.

Two monitoring elements are critical for conservation: implementation monitoring and effectiveness monitoring. Implementation monitoring is designed to assess if specific actions were taken, whereas effectiveness monitoring accounts for how well these actions are meeting the initial goals. Administrative progress reports may be sufficient to monitor the process of implementation, but data collection and analyses will likely be needed to assess whether ecological and socioeconomic goals are being met. With objectives involving species or ecological systems, repeated inventories of species or systems elements will likely be needed to assess species or systems status and trends, and to ensure that desired environmental conditions are being maintained or restored. However, conducting effective inventories to assess status and trends is difficult when dealing with low sample sizes of system responses, such as occurs when monitoring RLK species. This area warrants technique advancement. But there are a number of existing methods that may help solve this problem (e.g., sequential Bayesian analysis), and as new knowledge is synthesized, our ability to reassess and apply effective conservation approaches will be enhanced.

Adaptive management allows the conservation approach to be revised based on new knowledge. With the new knowledge obtained through both the experience of program implementation and monitoring for status and trends, conservation approach effectiveness can be addressed. More broadly, the initial goals and considerations may be readdressed, and with the new knowledge from implementation, the conservation plan may be redesigned with fine-tuned priorities and a new balance of considerations. Time intervals for adaptive management may be contingent upon implementation schedules and specific tasks being conducted. Nevertheless, more regular and frequent intervals might be needed, especially at program initiation, when changes can be anticipated. Frequent, iterative fine-tuning adjustments to a conservation plan may be preferred over irregular or infrequent, larger-scale changes. In some cases, iterative smaller changes in a conservation plan may be less dramatic to implement and may result in a lessened impact both on the program and on risks to RLK species.

Accountability blends both the monitoring and the adaptive management aspects of this step. Stakeholders will be interested in how the approach is implemented and how effective it is and will be interested in developing plans to change the approach or implementation process. Accountability may reveal the perceived problems of the original design and implementation process but will also demonstrate successes and how problems are being resolved. Accountability keeps the stakeholders engaged in the program and should improve partnership trust. Initial conflicts may resurface, but accountability will likely reinforce the importance of the goals and priorities and may enrich the program by an infusion of stakeholder feedback from their different perspectives. Accountability of the conservation approach to the public, beyond primary stakeholders, may similarly result in a recounting of conflicts, but may also increase advocacy.

Accountability can be achieved by a variety of communication avenues to diverse audiences. Oral and visual communication routes may reach different people. Oral routes, including stakeholder meetings, workshops, conferences, and tours, may be the most effective means to achieve one-on-one communication, forging new alliances between individuals. More remote visual means of communication could include publications, reports, brochures, videos, and Web sites. Involvement of communication specialists to help reach target audiences, such as funding agencies and advocacy groups, may be a key step for program longevity.

Conclusion

In any given collection of species that inhabit a particular planning area, most species will be represented by very few individuals (i.e., most species will be rare), and an even greater number of species will be nameless to science. The sheer number of species that are either rare or little known presents difficult challenges to biodiversity conservation. Inclusion of these RLK species in conservation programs adds inherent complexity due to the potentially large number of species to consider and uncertainty due to the fundamental lack of knowledge on their ecologies and natural histories. Careful attention is thus needed in prioritizing the selection of species based on perceived importance (ecological, social, economic, legal) of the species or species group, the probability of support of stakeholders and the public for the effort, the availability of expertise to guide information gathering and evaluation, and practicality from a programmatic point of view. Similar arguments pertain to selection of systems, with an emphasis on our ability to characterize and measure the selected system variables. When selecting priority species or systems, it is critical to develop a standardized process that is transparent to all stakeholders and documents all assumptions and uncertainties.

Although our text and associated figure (see fig. 12.1) discuss our suggested implementation process as a linear sequence of steps, we emphasize that our process is both cyclical (the last step informs a new first step) and contains internal feedbacks among all steps such that the process adapts continuously. We believe it is critically important to (1) set clear goals, (2) identify measurable short- and long-term objectives, and (3) include learning objectives to increase knowledge for little-known species.

We have described a variety of conservation approaches, some focused on species and others focused on systems. Each approach has utility and each has limitations. It is our hope that resource managers can use information we have summarized, evaluate potential approaches considering the context of their planning area, and select approaches that will best meet their goals and objectives. As shown in chapter 8, no single approach is highly effective in providing for species diversity, genetic diversity, and ecosystem diversity conservation objectives. Consequently, in most cases, a combination of approaches will best meet the full set of ecological goals and objectives that managers must meet. For example, approaches designed to meet objectives for RLK species will generally have to be combined with approaches for other species and additional approaches that are intended to meet ecosystem diversity objectives.

We have shown that selection of conservation approaches is not solely based on biological considerations. Regional economies and communities associated with the conservation of RLK may also be complex systems characterized by interacting private ownership and public agency responsibilities. The social effects of alternative RLK conservation actions must be considered, and these actions should also be separately evaluated for local economic impacts and efficiency cost–benefits, nonmarket benefits included. Conservation works best when social and economic considerations are integrated early with biological/ecological considerations in search of management alternatives that can enhance full measures of social, economic, and ecological well-being while conserving RLK species.

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