



MEMORANDUM

NatureServe

2400 Spruce Street, Suite 201, Boulder, CO 80302

voice: (303) 541-0352 fax: (303) 449-4328 e-mail: pat_comer@natureserve.org

To: Central Shortgrass Prairie Ecoregional Assessment Team

From: Pat Comer, Chief Terrestrial Ecologist

Re: Setting Representation Goals and Objectives for the Central Shortgrass Prairie
Ecoregional Assessment

Date: March 2005

Introduction

For the Central Shortgrass Prairie Ecoregional Assessment, we hope to provide an initial synthesis of biodiversity and conservation information that will inform subsequent management and land use planning. We intend to generate several regional scenarios that depict areas where biodiversity representation goals may most effectively be met (Pressey and Cowling 2001). We plan to use a scenario generation tool that organizes all mapped information into a grid of spatial analysis units (e.g., regular hexagons of 500-1,000 hectares in size) blanketing the entire ecoregion. The tool allows us to state numerical objectives for target representation in terms of acreage, linear distance, or numbers of discrete occurrences. It then uses the spatial analysis units to combine information on the type, location, and relative quality of our biodiversity targets with other information on the relative conservation 'suitability' of different landscapes. All of this information is used to create alternative conservation scenarios.

Here I outline initial phases of a "goal-based" approach to generating ecoregion-wide scenarios in support of target conservation. This approach establishes overall conservation goals, and then develops explicit, numerical objectives for representing conservation targets throughout the ecoregion. For many individual land/water use decisions, this broader perspective is needed to put particular places into context and to clarify alternatives.

Objective setting forces us to address the "how much is enough?" questions in conservation (Noss 1996, Soule and Sanjayan 1998). So, as examples, we will state explicit objectives for representing numbers of high-quality rare-plant occurrences that are needed to ensure long-term species viability, and acreage for each forest, shrubland, and grassland community or system type to maintain overall ecological integrity. When we state quantitative objectives for each conservation target, we may then evaluate which places are essential to meeting all objectives, and those places where alternative land

management may be considered. The areas we select may still be managed for multiple uses, but the needs of conservation targets would be a primary consideration. To make that consideration operational, management actions would need to be compatible with the ecological processes that support conservation targets in each area. So for example, aspects of composition, structure, and dynamic processes supporting grassland, riparian/wetland, and aquatic systems, and the habitat requirements of sensitive species, would be principle considerations in establishing compatible land management within these selected areas.

Given our limited knowledge, numerical objectives for target representation must be considered 'working hypotheses' in nearly all cases. They also, to a certain degree, reflect societal risk (i.e., the risk of losing a species known to be endangered). So multiple, alternative conservation scenarios may be developed by varying these numerical objectives; i.e., with low numerical objectives representing "high-risk" scenarios for conserving biodiversity, and higher numerical objectives representing "low-risk" scenarios. These alternatives would simply reflect a range of uncertainty and risk associated with making investment decisions for biodiversity conservation.

We may also find instances where habitat alteration has been extensive and realistic numerical objectives are impossible to meet with existing, high-quality occurrences. We may then choose to develop explicit conservation goals and objectives for ecological restoration, in terms of the number of places or acreage where restoration should be implemented, the type and intensity of restoration, and/or the measurable ecological conditions that should be achieved among certain occurrences.

So as you can see, there are many complex issues to consider in this phase of ecoregional assessment. First, I will provide some background on representation goals and objectives, and list some lessons learned over recent years, then propose a number of approaches and options for consideration in the Central Shortgrass Prairie.

Representation Goals and Objectives - Background

It can be useful to describe this approach in terms of representation *goals* and *objectives*. Representation goals describe the desired condition for targeted species, communities, ecosystems, or other conservation targets. These overarching goals may differ among targets. Some of these differences are imbedded in our "coarse-filter/fine-filter" strategy for biodiversity conservation and the purposes for which we focus on different groups of targets. For example, we often target a suite of imperiled, rare, and vulnerable species, and vulnerable species assemblages, as "fine-filter" conservation targets. We have targeted them individually because we believe that is the only way we can ensure that their individual needs can be addressed. Our goal focuses on the viability of these species within the planning area. So our goal for species might be stated as: "*targeted species remain invulnerable to loss of viability within the planning area.*" Importantly, this statement suggests that not only do we intend to maintain "minimum viable" populations, but we also hope to *specifically address the vulnerabilities they face*, due to habitat loss, habitat conversion, or direct exploitation.

Our "coarse-filter" targets might include all native ecosystem types. A "coarse-filter" strategy is aimed at maintaining the ecological processes that support the vast majority of species; thus permitting us to avoid targeting numerous species individually. In addition to maintaining non-target species, coarse-filter strategies emphasize the conservation of ecosystem services (e.g., air, water, nutrient cycling, etc.). While goals for species correctly emphasize the health and viability of their populations, coarse-filter goals focus on representing ecological variability and environmental gradients. So our goal for ecological systems might be stated: "*essential ecosystem services are secure and*

non-target species remain invulnerable to the loss of viability.” Put another way, we hope to use the coarse filter to ‘keep common species common.’

Representation objectives are the explicit - and hopefully quantifiable - expressions of broader goals. Objectives express the “how much?” “how many?” and “in what spatial distribution?” questions underlying target conservation. Conservation scenario generation is appropriately dictated by these explicit, numerical objectives for each targeted species, species assemblage, ecosystem type, or other conservation target. By mapping out areas that contribute to these objectives, we create a conservation vision at regional landscape scale (e.g., the Central Shortgrass Prairie ecoregion).

Some primary lessons learned in biodiversity objective setting include:

- 1) *An adaptive approach to setting representation objectives is essential.* We simply do not have sufficient knowledge when called upon to establish objectives and the environments supporting our targets will continue to change. All representation objectives should use the best available knowledge, but should also be viewed as “working hypotheses.” This requires careful documentation and a long-term commitment monitoring and re-evaluation.
- 2) We will always be dealing with both *uncertainty* and *risk*, and this should be clearly acknowledged. Uncertainty results from our incomplete knowledge and our inability predict future events. Risk reflects the fact that representation objectives are, in the end, social decisions, based upon societal willingness to accept the risk of biodiversity loss.
- 3) *Both risk levels and uncertainty should decrease with increasing target vulnerability.* For targets that are considered highly endangered due to rarity and current threats, we must urgently pursue research to reduce uncertainty and set objectives that reduce the risk of loss.
- 4) *The lands/waters surrounding selected conservation areas are important.* That is, in setting objectives, one should not presume that the lands and waters around selected conservation areas contribute no conservation value. In fact, land and water management throughout a given region will continue within a policy framework established by existing regulation, so considerable contributions of conservation values may be expected from surroundings.
- 5) *Ecoregional objectives should be placed in the context of range-wide objectives* for all targets. This means that any existing range-wide recovery plans or regional conservation plans should be referenced to determine if specific priorities were established for occurrences within the planning area.
- 6) *Use history as a guide to the future.* Wherever possible, use knowledge of target distribution and abundance over recent centuries for perspective when establishing of representation objectives.
- 7) *Spatial configuration matters.* While overall numbers and acreage are primary ways of defining representation objectives, the way those number and acreages are arrayed in conservation areas may matter just as much. For example, one might aim to represent the range of variability in environments for freshwater streams, but these selected areas must also be represented in an interconnected network that retains the integrity of the whole.
- 8) Develop useful *target groupings* and establish *initial objectives* to apply when lacking specialized knowledge, then *refine objectives* as possible with target-specific information.

- 9) *Use established guidelines* to describe the conservation status of species, especially to define a numerical threshold of “vulnerable” status. IUCN “Vulnerable” criteria, along with those established by NatureServe (Global Ranks 3/4 thresholds), should be used as an initial guide for objective setting.
- 10) *Sub-regional eco-geographic stratification* can be used as a practical tool to represent environmental variability supporting targets; especially for communities and ecological systems. Stratification for terrestrial targets may differ fundamentally from aquatic targets (e.g., USFS Sections for the former vs. watershed-based units for the latter). Subregional stratification is often less important for rare-to-imperiled targets and migratory species.
- 11) *State representation objectives within set time frames.* All objectives could be stated within e.g., 25-100 year time frame. For highly threatened targets, objectives stated within shorter time frames (5-10 years) may be appropriate to guide urgent conservation action.

As a general rule, representation of multiple examples of each target, stratified across its geographic range, is necessary to capture the variability of the target and its environment, and to provide some level of “replication.” Replication is needed to ensure persistence in the face of environmental stochasticity and likely effects of climate change. It is also required to allow for comparative study – to understand our targets better – and to detect change reliably. Although information is limited, we should take existing knowledge of our targets as far as possible. The following issues and approaches might be considered in light of existing knowledge.

- *Proportional Range Representation:* Representation objectives should reflect the historic range of distribution (e.g., under climatic regimes of the past 2,000 years) for the target. For example, if 50% of the known, historical range of the target falls within a given ecoregion, the goal for that ecoregion should reflect roughly 50% of a range-wide goal. In practical terms, we have sometimes used the target’s distribution, *relative to the ecoregion* as a guide to establish numeric differentials in objective setting (higher with endemic, to lower with peripheral). These categories may be assigned to all conservation targets.

Endemic = >90% of global distribution in ecoregion,

Limited = <90% of global distribution is within the ecoregion, and distribution is limited to 2-3 ecoregions,

Disjunct = distribution in ecoregion quite likely reflects significant genetic differentiation from main range due to historic isolation; roughly >2 ecoregions (or several hundred miles) separate this ecoregion from other more central parts of its range

Widespread = global distribution >3 ecoregions,

Peripheral = <10% of global distribution in ecoregion

- *Meta-population dynamics on real land/waterscapes underlie species viability.* In order to understand populations and simple models of meta-population dynamics, we need information on: 1) number of habitat patches, 2) probability of patch (i.e., *local population*) extinction, 3) rate of movement between patches, and 4) correlation of fates of separate populations (Morris et al. 1999). Number four is the instance where stochastic events effect multiple populations simultaneously due to their proximity to each other. A sort of “dynamic tension” therefore exists between factors 3 and 4, in that we need to allow for dispersal between distinct populations, but if too many are clustered, their fates may be strongly correlated. Theory, at least, suggests a combination of clustered and isolated populations. These are very important considerations as they apply to setting representation objectives and scenario generation. For example, if the fates of all

populations are highly correlated, we gain little from “replicating” multiple occurrences. If there is no correlation of fates and no movement, you can greatly reduce the overall chance of extinction by protecting best examples; but you gain little by adding poor quality examples (Morris et al. 1999; Chaplin 1999).

Unfortunately, available information tends to be limited to the first and second points above; e.g., locations of *occurrences* and some estimate of the *occurrence quality*. There are very few cases where we have any knowledge of points three and four. Even with the occurrence data we have, the relationship between populations and occurrences is not straightforward. NatureServe has established working assumptions about separation distances between extant occurrences so that clustered occurrences may be treated as one “meta-occurrence” counting towards representation objectives, if that is the likely biological reality. For species targets, knowledge of life history (e.g., home range, known dispersal distance) forms the basis for these assumptions. Similarly, knowledge of supporting processes and environments can inform these assumptions for community types and ecological systems.

- *Spatial Stratification*: In the United States, USFS *Sections* (U.S. Forest Service 2004 draft) have commonly been adopted as primary stratification units for terrestrial targets. The TNC freshwater ecosystem classification approach is spatially hierarchical, and *Ecological Drainage Units* (EDUs) are similarly scaled and serve the same purpose for freshwater targets. So in reality we apply *more than one stratification scheme* for a given ecoregional assessment. In most instances, some degree of target occurrence replication should be provided within each *Section/EDU* of their historical range within the ecoregion.
- *Spatial Pattern and Targets*: Characteristic spatial patterns for ecosystems and species habitat (Figure 1) often reflect key ecosystem processes and important life-history traits. Scaling of targets,

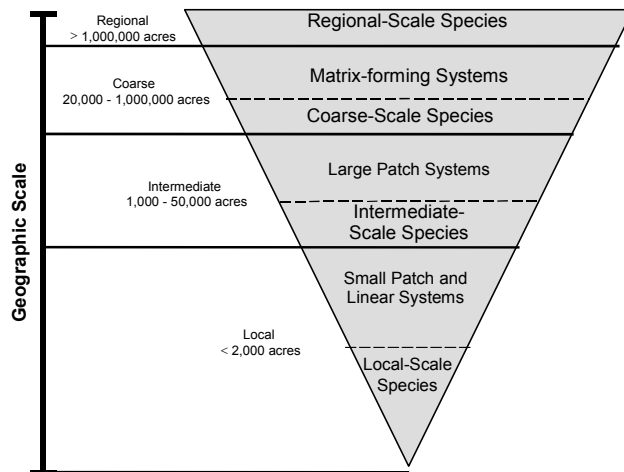


Figure 1: Categories representing geographic scale of conservation targets. Areal ranges are approximate and overlapping (Poiani et al. 2000).

as described by Poiani et al. (2000) can effect the assumptions we make as we express representation objectives. It is therefore useful to categorize each target according to its presumed spatial character, as it has occurred in recent millennia without significant human alteration. For matrix, and most large patch and linear systems, occurrences should be mapped as *large, continuous polygons* or *lines*, and representation objectives may be expressed as a percentage of

historical extent (e.g., *circa* 1800) proportionally represented across all major physical gradients. Objectives for remaining large patch systems, small patch systems – or where landscape fragmentation precludes mapping and modeling – may be mapped as *scattered polygons* and *points*, and objectives are best expressed as numbers of occurrences.

- *Specialized Objectives vs. Target Groupings*: Some entire categories of targets must be reviewed individually, and target-specific representation objectives must be established for scenario generation. For example, ‘regional-scale’ species (Figure 1) tend to be migratory mammals, birds, and fish. Individuals of these species may range across and beyond a given ecoregion. We typically represent these targets as *polygons (or lines)* of “*potentially occupied habitat*” and where possible, *polygons of specific habitat components*. In some instances, we have used software tools to simulate animal movements over regional landscapes to better understand population viability under different regional conservation scenarios. Analysis of their habitat requirements, especially identifying critical core habitats and landscape linkages may be best assessed sequentially with each regional scenario developed using all other targets. That way, regional scenarios can be evaluated individually for their impact on these species; then modified accordingly (e.g., Carroll et al. 2003).

Another class of targets requiring individual attention includes those that are extremely rare. Many naturally rare and narrow-endemic G1-G2 targets¹ have existed over millennia with very few distinct occurrences. In these cases, an objective of “all potentially viable occurrences” may be appropriate.

A third class of targets includes Threatened and Endangered species with current recovery plans. Plans should be reviewed against agreed-upon goals to define explicit representation objectives, and where applicable, these numbers should be applied to conservation scenario building.

Another, sometimes overlapping class includes targets for which conservation action is most urgent. These tend to be G1-G2 targets that occur in landscape where rapid land use conversion is taking place. For these targets, specific short-term (5-10 year) representation objectives might be established.

- *Preliminary Numbers for Target Groupings*: The majority of species, communities, and ecological systems fall outside the categories where specialized objective setting is essential. For these cases, we can also lack specialized knowledge to create target-specific objectives. So where do we begin to establish more generalized objectives? Theoretical work on species viability (e.g., Quinn and Hastings 1987) has been applied to many species in Florida (Cox et al. 1994). This suggests that 10 distinct subpopulation of 200 individuals should be sufficient for survival of at least one subpopulation over 10 generations/100 years. Though again, these were intended to represent minimum-viability estimates for genetic fitness.

Guidelines for determining the *conservation status* of species have been established by NatureServe and their network of member Natural Heritage programs (Master et al. 2002), and by the IUCN (Mace et al. 1994). These criteria include factors such as total population size, number of subpopulations or occurrences, condition/occurrence viability, range extent, trends, threats (severity, scope, and immediacy), intrinsic vulnerability, environmental specificity, and current levels of protection. Both the NatureServe and IUCN systems define “vulnerable” conservation status for species. We therefore can appropriately look to these published guidelines to inform our objective

¹ See Appendix 1 for explanation of NatureServe global ranks

setting. After all, our goals should presumably state that we intend to either ‘improve or maintain’ the *conservation status* of targets.

Our representation goals should likely aim to maintain or move species above the “vulnerable” status threshold. So we could specifically look to “vulnerable” threshold values for these status factors of total population size, number of sub-populations or occurrences, condition/ occurrence viability, range extent, trends, and threats (severity, scope, and immediacy) to establish initial numerical thresholds or ranges of threshold values for objective-setting. For example, in general terms, a given community type or species is ranked G3 (“Vulnerable”) by NatureServe when it is known from 21 – 80 occurrences, or (for species) 2,500 – 10,000 individuals, measurable declines <10% over 10 years or 3 generations, and many (>40) occurrences under protective management across its known range. Some or all of these numerical values could be drawn upon for objective setting.

Initial “Fine-filter” Objectives – Vulnerable Species and Species Assemblages

Table 1 provides a summary of initial objectives for whole groups of targeted species and species assemblages. Numbers in Table 1 draw upon estimates of numbers of occurrences for the “vulnerable” threshold as referenced above. Again, this could be used as a starting point when target-specific information is lacking and/or targets DO NOT belong to any of the more specialized classes mentioned above. In this case, targets have been grouped according to their *Proportional Range Representation*, or the proportion of the their range-wide distribution found within the ecoregion of interest. Numbers decrease as endemism decreases, in rough proportion to the ecoregions share of the global distribution. Within-ecoregion stratification is implied here with some degree of replication (>1 occurrence) in each stratification unit (*re: Section/EDU*) throughout its natural distribution in the ecoregion. Here, targets are assumed to be represented using ‘high quality’ occurrences – i.e., each crosses some established threshold of occurrence viability/ecological integrity.

In this instance, numbers are placed within three levels as an initial reflection of “risk,” with “high risk” scenarios using relatively low numbers and “low risk” scenarios using relatively high numbers.

Table 1. Initial Representation Objectives for Targeted Species and Species Assemblages, expressed as three levels for developing “High Risk,” “Moderate Risk,” and “Low Risk” conservation scenarios.

Distribution	“High Risk” Scenario	“Moderate Risk” Scenario	“Low Risk” Scenario
	Number of High Quality Occurrences		
Endemic	21	42	80
Limited	10	21	42
Disjunct	5	10	21
Widespread	5	10	21
Peripheral	2	5	10

These estimates should form a practical starting point for scenario generation. Experience suggests that the number of available occurrences for many species targets will be a limiting factor in fleshing out scenarios that are based on these numbers. These limitations are sometimes due to incomplete inventory effort for many conservation targets. Other limitations are due to past habitat conversions and suggest the relative need for habitat restoration and/or species re-introduction.

Initial “Coarse-Filter” Objectives - Terrestrial Ecological Systems and Aquatic Habitats

Again, one intention of these “coarse-filter” objectives might be to *prevent* new species from crossing the “vulnerable” thresholds mentioned above. The way we state objectives for ecological systems and communities might also take into account the target’s distribution relative to the ecoregion, as well as differences in their typical spatial pattern. Coarse-filter objectives are commonly expressed as areal extent. Areal measures have been commonly applied to conservation objective-setting at national scales using theory from island biogeography (MacArthur and Wilson 1967, Wilcox 1990) and working hypotheses on the role of species diversity in ecosystem function (e.g., see Hart et al. 2001). A well-established (albeit quite general) relationship exists between habitat area and the number of species that an area can support (e.g., Wilcox 1990). Loss of habitat tends, over time, to result in the loss of species within an approximate range. This relationship formed the basis for international objectives (10-12% of country area) set by IUCN for member countries (WCED 1987). This idea is graphically represented below and was adapted from Cincotta and Engleman (2000) (Figure 2).

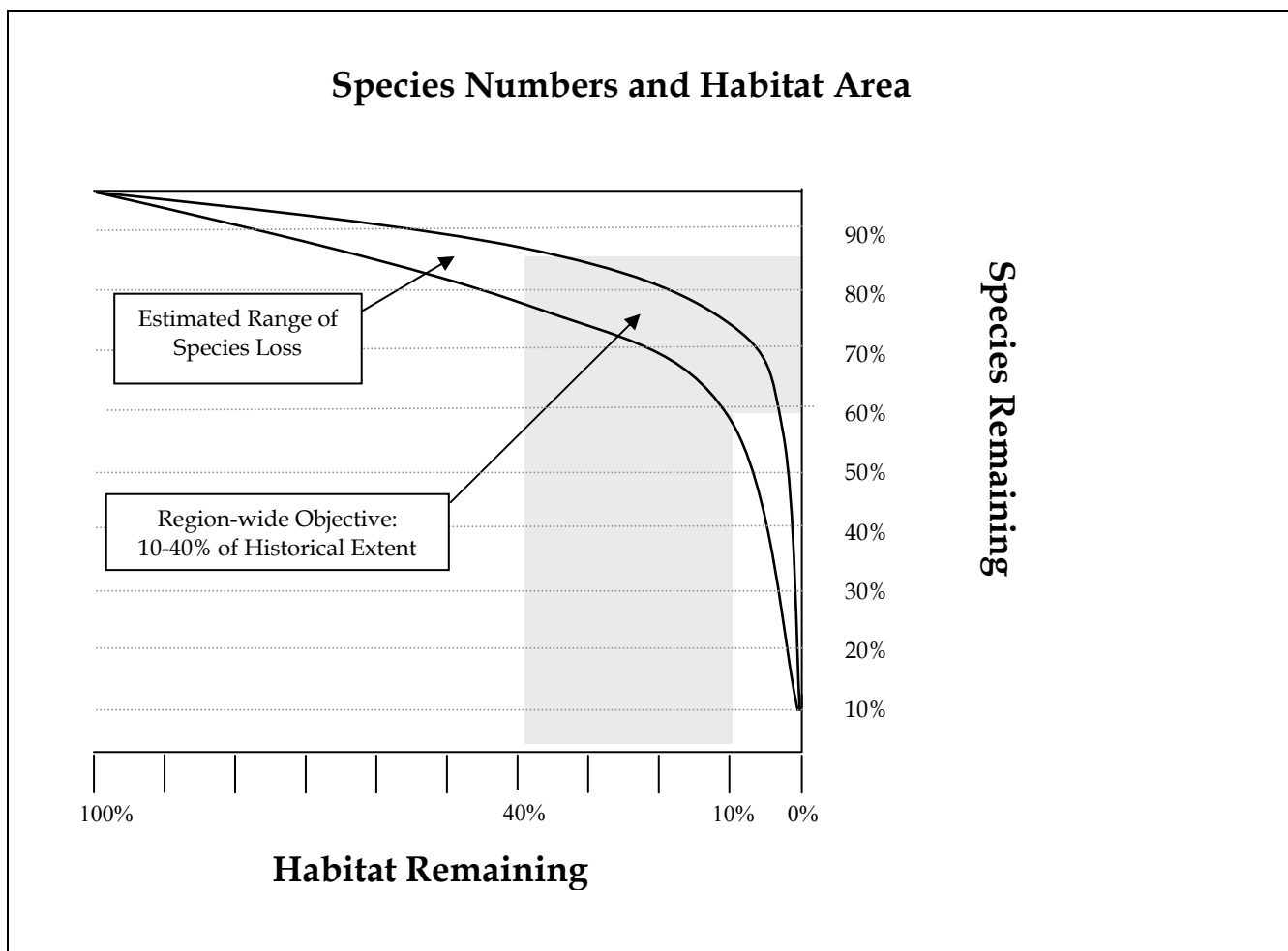


Figure 2: Estimated percentage of species loss with habitat loss over time, and potential effect of selecting representation objectives between 10 and 40% of historical extent (grey shade).

IUCN objectives were expressed in terms of extent for an entire country. Our representation objectives might best be stated for each target, and establish some historic context wherever possible, by expressing the desired extent as a percentage of estimated area *circa* e.g., 1800, or the time period

immediately prior to wide-spread European-American settlement of a given region. Ecosystems are dynamic, changing at varying rates, with short-term cycles, and long-term trajectories. However, in many places, short-term cycles *and* long-term trajectories have been abruptly altered through human land use, and have had obvious impact on native biodiversity (Wilson 1992). Our task is to understand natural dynamics, then evaluate our alterations and mitigate their effects. For example, in the Central Shortgrass Prairie, fire, scattered water diversion, and hunting historically supported Native American cultures over millennia, but the most rapid change to this ecoregion has been through intensive grazing, road construction, fire suppression, urbanization, and extensive water diversion. The 1800 time period marks the beginning of rapid and transforming, human/technology-driven changes to ecosystems in this region, but is recent enough to reflect vegetation patterns under modern climatic conditions. It therefore, provides a useful and important reference point to approximate the area of major ecosystem as they might be today without intensive human alterations.

Establishing an estimate of historic extent for ecological systems is no simple task. In some highly altered ecoregions, it is nearly impossible. However, for purposes of establishing numerical representation objectives, a reasonable approximation will suffice. Historic extent for linear riparian systems can be modeled using riverine ecological systems and other biophysical models. For most other terrestrial ecological systems, percent change for each system type can be estimated within 10% intervals using current land use/land cover data, as well as specific studies. We can then add (or subtract) area from the current mapped extent to approximate extent *circa* 1800. Where change was estimated to be less than 10%, current extent can be used.

In order to establish an initial percent area goal, we should consider the species/area relationship (Figure 2). We should also consider the fact that several hundred of the most vulnerable and sensitive species are targeted either individually, or in rare communities. In many ecoregions, we have selected an initial objective of 30% of historic extent (as estimated *circa* 1800) for each system in the ecoregion. This percentage, on its own, would suggest that we could lose between 15% and 25% of native species (Figure 2). But given the other targets and considerations, this 30% goal may be an adequate point of departure. This should also be a reasonable “middle point” for developing three distinct scenarios; from “20% = High Risk” to “30% = Moderate Risk” to “40% = Low Risk” scenarios. Table 2 provides a summary of recommended initial representation objectives for coarse-filter targets.

Table 2. Initial Representation Objectives for Ecological System and Rare Community Targets, expressed as three levels for developing “High Risk” “Moderate Risk” and “Low Risk” conservation scenarios.

Distribution Relative to Ecoregion	Spatial Pattern of Occurrence					
	Matrix, Large Patch, and Linear Ecological Systems			Small Patch Ecological Systems and All Rare Communities		
	Area or Length, per Section or Ecological Drainage Unit			Number of High Quality Occurrences		
	“High Risk” Scenario	“Moderate Risk” Scenario	“Low Risk” Scenario	“High Risk” Scenario	“Moderate Risk” Scenario	“Low Risk” Scenario
Endemic	20%	30%	40%	21	40	80
Limited				10	21	40
Widespread/Disjunct				5	10	21
Peripheral				2	5	10

As noted in the table, representation objectives for many “patch-forming” targets are expressed as a number of occurrences. These objectives draw on similar assumptions and numerical estimates used above for fine-filter targets as well as those described by Anderson et al. (1999). Again, as with fine-filter targets, Section/EDU scale stratification is implied in these numbers for the entire ecoregion.

Design Criteria: Capturing Environmental Variability and Connectivity

In addition to an objective for numbers or areal extent, all targets should be represented across major biophysical gradients. Representation of major biophysical gradients helps to ensure that each regional scenario encompasses native ecosystem diversity while providing a hedge against a changing climate. This can be accomplished in two ways. First, as mentioned earlier, targets could be represented in each of the ecoregional *Sections/EDUs* of their natural distribution. Second, for large patch, linear, and matrix forming ecological systems (both terrestrial and freshwater), they should be represented in combination with biophysical land units and aquatic biophysical environments to help represent ecological variability and gradients. So for example, the scenario generation software can be programmed to apply percent objectives to ecological system/biophysical environment and riverine system/biophysical environment combinations; ensuring that the major biophysical gradients of each system would be represented in proportion to their occurrence for the ecoregion as a whole. A common approach successfully used elsewhere is to apply a given percent area objective (e.g., 30% of historical extent) using one layer (e.g., the ecological systems map) while at the same time, apply a 10% areal objective to each unique combination of the ecological systems layer and a finer-scale biophysical land unit map. The combination of these allows you to represent both a total area objective and ensure that much environmental variability within and across types is also represented.

Connectivity among and within target occurrences over large distances presents some difficult design problems. These often are limited to representing aquatic/riverine habitats across major drainages, and for migratory species, where certain landscape linkages may be critical at regional scales. Representation objectives should be explicit where possible to describe these types of long-distance connectivity that are critical to viability/ecological integrity of the target or suite of interconnected targets. In some cases, well-known connecting corridors may be treated as conservation targets in their own right (i.e., a critical habitat component for a species target) and “locked-in” to all potential conservation scenarios.

However, in most instances, that level of knowledge is lacking, so scenarios may be generated in a sequential fashion to efficiently address this type of design problem. For example, many interconnected ‘headwater’ streams may be represented in conservation areas identified to represent adjacent upland targets. The results of these runs may be “locked in” to then identify downstream reaches in these critical watersheds that will effectively represent aquatic variability in a series of connected sub-watersheds. Similar sequential approaches were mentioned previously for migratory species using tools that simulate population movements across regional landscapes.

Factoring in the Quality of Occurrences

While objectives are generally described in terms of representation, there are many cases where it is desirable to state objectives in terms of *improving the relative quality* of occurrences for a given target in all or part of a given ecoregion. In these cases, it is worthwhile to consider the ways one can quantify the change in quality that is desired so that it will be clear when the objective has been achieved. For example, for Ferruginous Hawks (*Buteo regalis*), one might state objectives in terms of numbers of nest

sites “with restricted human use within 0.5 miles between March and August” and/or “with prairie dog colonies for X size or density,” etc. Many of these quality factors may already be documented in the occurrence ranking criteria developed by the Natural Heritage programs, which score occurrences along a scale of “A=very good quality” to “D = poor quality.” This enables us to state objectives in terms of “X number of A ranked occurrences, Y number of B ranked occurrences,” etc. Where we use more indirect measures of occurrence quality, e.g., with a landscape condition/integrity model, we may first characterize the landscape condition scores for target occurrences today, then choose a desired level of change in landscape condition, as measured by these same scores, that we would like to reach by a given time into the future.

Factoring in Needs for Ecological Restoration

As previously mentioned, there will undoubtedly be instances where target inventory is relatively complete, but the number of known target occurrence is far lower than the numbers all would agree are needed for long-term viability/ecological integrity within the ecoregion. Goals and objectives for ecological restoration may then be needed and desirable. Most forms of ecological restoration can come in cases where the evaluation of a given occurrence is considered “poor quality” or where species and communities have been extirpated from a given location. It is generally most productive to identify and score all/most potential restoration sites before factoring them into the planning process. With this information in hand, one could effectively bring these potential locations into scenario generation.

Conclusions

For the Central Shortgrass Prairie Ecoregional Assessment, we hope to provide an initial synthesis of biodiversity and conservation information that will inform subsequent management and land use planning. We plan to develop several distinct land/water management scenarios utilizing “goal-based” biodiversity representation and socioeconomic/land use options. Here I outline background and numerical objectives for the “goal-based” approach to generating regional scenarios. In many instances, target-specific objectives should be established according to individual needs. Where knowledge is lacking, groups of targets may be addressed with more generalized approaches to objective setting. The range of issues and examples presented here are intended to provide a foundation for objective setting among the technical teams of the Central Shortgrass Prairie Ecoregional Assessment.

References

- Anderson, M, P. Comer, D. Grossman, C. Groves, K. Poiani, M. Reid, R. Schneider, B. Vickery & A. Weakley. 1999. *Guidelines for Representing Ecological Communities in Ecoregional Plans*. The Nature Conservancy.
- Carroll, C., R.F. Noss, P.C. Paquet and N.H. Schumaker. 2003. Integrating population viability analysis and reserve selection algorithms into regional conservation plans. *Ecological Applications* 13
- Chaplin, S. 1999. Population Viability and Representation Objectives. Presentation at the 1999 Western Regional Science and Stewardship Conference. Denver, CO.
- Cincotta, R.P. and R. Engleman. .2000. *Nature’s place: human population and the future of biological diversity*. Population Action International, Washington DC.

- Cox, J., R. Kautz, M. MacLaughlin, & T. Gilbert. 1994. *Closing the Gaps in Florida's Wildlife Habitat Conservation System*. Tallahassee: Florida Game and Fish Commission.
- Dobson, A. 1996. *Conservation and Biodiversity*. Scientific American Library, New York. p. 66.
- Hart, M.M., R.J. Reader, & J.N. Klironomos. 2001. Biodiversity and Ecosystem Function: Alternate Hypotheses or a single Theory? *Bulletin of the Ecological Society of America* Vol. 82, No. 1. pp.88-90.
- MacArthur, R. H. and E. O. Wilson, 1967. *The Theory of Island Biogeography*. Princeton Univ. Press, Princeton, NJ.
- Mace, G. M. and Stuart. S. N. 1994. Draft IUCN Red List Categories, Version 2.2. *Species* 21-22:13-24.
- Margules, C.R., and R.L. Pressey. 2000. Systematic conservation planning. *Nature* 405:243-253.
- Master, L. L., L. E. Morse, A. S. Weakley, G. A. Hammerson, and D. Faber-Langendoen. 2002. Heritage conservation status assessment factors. *NatureServe*, Arlington, VA.
- Morris, W., D. Doak, M. Groom, P. Kareiva, J. Fieberg, L. Gerber, P. Murphy, & D. Thomson. 1999. *A Practical Handbook for Population Viability Analysis*. The Nature Conservancy.
- Noss, R.F. 1996. Protected Areas: How much is enough? In R.G. Wright (ed.) *National Parks and Protected Areas*. Blackwell Science, Cambridge MA. pp. 91-120.
- Poiani, K., B. Richter, M. Anderson, & H. Richter. 2000. Biodiversity Conservation at Multiple Scales. *Bioscience* 50 (2). 133-146.
- Pressey, R.L., and R.M. Cowling 2001. Reserve selection algorithms and the real world. *Conservation Biology* 15:275-277.
- Quinn, J.F., and A. Hastings. 1987. Extinction in subdivided habitats. *Conservation Biology* 1:198-208
- Soule, M.E. & M. A. Sanjayan. 1998. Conservation Targets: Do They Help? *Science* Vol. 279, Number 5359 Issue of 27, Mar 1998, pp. 2060 - 2061.
- U.S. Forest Service. 2004 (draft). ECOMAP Domains, Divisions, Provinces, and Sections of the United States. U.S. Forest Service Reg. 2. Digital map.
- WCED. 1987. *Our Common Future*. New York: Oxford University Press for the UN World Commission on Environment and Development.
- Wilcox, B.A. 1980. Insular Ecology and Conservation. In *Conservation Biology: An Ecological-Evolutionary Perspective*, M.E. Soule; and B.A. Wilcox, Eds. (Sinauer, Sunderland, MA.), pp. 95-118.
- Wilson, E. O. 1992. *The Diversity of Life*. Norton, New York

Appendix 1. NATURESERVE GLOBAL CONSERVATION STATUS DEFINITIONS

The Global (G) Conservation Status (Rank) of a species or ecological community is based on the *range-wide* status of that species or community. The rank is regularly reviewed and updated by experts, and takes into account such factors as number and quality/condition of occurrences, population size, range of distribution, population trends, protection status, and fragility. The definitions of these ranks, which are not to be interpreted as legal designations, are as follows:

- GX Presumed Extinct:** Not located despite intensive searches and virtually no likelihood of rediscovery
- GH Possibly Extinct:** Missing; known only from historical occurrences but still some hope of rediscovery
- G1 Critically Imperiled:** At high risk of extinction due to extreme rarity (often 5 or fewer occurrences), very steep declines, or other factors.
- G2 Imperiled:** At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
- G3 Vulnerable:** At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
- G4 Apparently Secure:** Uncommon but not rare; some cause for long-term concern due to declines or other factors.
- G5 Secure:** Common; widespread and abundant.

G(#)T(#): Trinomial (T) rank applies to subspecies or varieties; these taxa are T-ranked using the same definitions as the G-ranks above.

Variant Global Ranks

- G#G# Range Rank:** A numeric range rank (e.g., G2G3) is used to indicate uncertainty about the exact status of a species or community. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).
- GU Unrankable:** Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.
- GNR Not ranked:** Global rank not assessed.

Rank Qualifiers

- ? Inexact Numeric Rank:** Denotes inexact numeric rank.
- Q Questionable taxonomy that may reduce conservation priority:** Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank.