❖ Standard 11: Design ecoregional portfolios/biodiversity visions to best meet goals for all conservation targets/ biodiversity elements, using the principles of efficiency, representation, irreplaceability, and functionality.

Case Study: **Using SITES 1.0 and Expert Review to Create a Portfolio of Sites for the Southern Rocky Mountains Ecoregion**

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Purpose and region of analysis

The Southern Rocky Mountain ecoregional assessment team used SITES 1.0 to assist in designing a quality, integrated portfolio. The team incorporated many spatial data sets into the SITES model striving to create an efficient yet representative portfolio that optimized the percentage of goals met.

Criteria/Methods

SITES is decision support system software program that compares millions of possible portfolio designs in attempt to identify the optimal portfolio. An optimal portfolio is one that minimizes the total conservation cost of a design (*define cost*). The site selection module (SSM) is based on the following equation:

$$Total\ Cost = \sum_i Cost\ site\, i \quad + \quad \sum_j Penalty\ \cos t\ \ for\ element\ j \quad + \quad w_b \sum boundary\ length$$

Or in plain language,
Total Portfolio Cost =
(cost of selected sites) +
(penalty cost for not meeting the stated conservation goals for each element) +
(cost of spatial dispersion of the selected sites as measured by the total boundary length of the portfolio).

-- from Andelman et al, 1999

SITES offers two procedures for the determination of site design; greedy and simulated annealing. The greedy option is a stepwise, iterative process that produces reasonably efficient results very quickly. The simulated annealing option was chosen by the SRM planning team because, though it is more time intensive, it generally produces better results. This procedure begins with a random set of sites to which it adds and removes sites, recalculates cost and retains the changes that reduce cost. This recalculation occurs millions of times until an optimal design is produced.

The input necessary for SITES to design a conservation portfolio is contained within seven data files. The table below summarizes these files.

	Generic contents	SRM specific
Files for planning units		
name.dat	contains a unique identifying number for each unit	As described in generic contents column
puvspr.dat	area of each element in each planning unit	Each unit was 1200 hectares
bound.dat	optional, contains length, or cost, of each boundary between planning units--default is that all boundaries are equal	Boundary modifier was set to 0.01
cost.dat	optional, contains the fixed "cost" of selecting a planning unit--default is that all costs are equal	Base cost (240) + suitability index score
pustat.dat	optional, contains status of planning units, e.g., locked in or out of portfolio--default is that all units are available	Default
puxy.dat	optional, contains coordinates of each planning unit--required if separation rule is invoked	None
Files for elements		
species.dat	for each element, contains number/name, representation goal, penalty factor and spatial goals	Contains data for all targets including name, overall and stratification goals and a penalty factor of 1000 for each goal not met

(Andelman et al., 1999)

The following paragraphs describe the methods used and decisions made by the SMR assessment team in attempt to facilitate the potential of SITES to create a conservation portfolio that adequately incorporated elements of quality portfolio design. As addressed in the Geography of Hope conservation portfolios should incorporate a coarse scale focus, be representative, efficient, integrated, and complete and select sites containing viable populations and high integrity systems.

<u>Planning units</u>
Planning units should be approximately the same size and shape and must fill the entire ecoregion, but can be defined in a number of ways. Regular grids, watersheds, or other geographically defined units can be used. In the SMR, a hexagonal grid was created where each hexagon was 1200 ha (2,965 acres). The rationale for this size was that it was "sufficient for efficiently representing local-scale targets in small functional sites while allowing for aggregation of ecological systems into extensive landscape scale conservation areas" (Neely et al. 2001). Each unit was populated with target occurrence information using GIS as described in the *Elements* section below/

<u>Configuration variables</u>
There are several configuration variables that can be manipulated to further refine desired outcome. The <u>boundary length modifier</u> can be altered to increase or decrease the weight

given to minimizing the cost associated with boundary length. A minimum area can be specified to ensure patches large enough to support a target or target group of interest. A separation distance can be included where results will include at least 3 planning units separated by that distance to protect against catastrophic events. For the Southern Rocky Mountain ecoregion, the team chose a 0.01 boundary length modifier which was found to encourage clumping but not so much so that less desirable sites were included for the sake of further aggregation. A minimum area was set for each intermediate and coarse scale target (e.g., at least 12,000 contiguous hectares of a given woodland ecosystem to approximate Minimum Dynamic Area for target viability/integrity).

Costs

A suitability index was developed within the Southern Rocky Mountain ecoregion to reflect the value of a given planning unit as defined by attributes of that area that influence the potential for successful conservation of targets within that area. It served as a surrogate for ecosystem integrity/target viability through its valuation of landscape context. The suitability index incorporated 15 biological, socio-political and economic factors (Table 1). The point system for each of these 15 factors was determined by the planning team depending on its likely impact on conservation targets. Two SI values were calculated, one based on the area within the hexagon and one based on the total area upstream of that hexagon. Each hexagon was assigned a base value of 240 (representing a “base” cost of the land) plus the sum of scores received for the suitability index factors.

Table 1. Parameters used in the suitability index with data sources, cost (in classes), anc comments.

Class	Data Source	Cost (points)	Comments
Dams		40 X # of dams	
Fire Fuel Conditions	USFS national assessment of fuel/fire regime departure from natural range of variation	10 = presence of condition class 2 20 = presence of condition class 3	Areas with higher ranks have missed multiple return intervals
Land Use/Land Cover	National Land Cover Data (NLCD), and housing density c. 1990 (Theobald, personal communication)*	0 = natural/semi-natural vegetation & land cover 5 = Agriculture 10 = Ex-urban 50 = Suburban 100 = Urban	Cost value scaled proportional to area of hexagon??
Mines		40 X # of mines	Includes both active and abandoned mines
Minimum Land Area	SITES hexagon grid	240	Applied to all hexagons
Projected Urban Growth	(Theobald 1990 and 2050 census block-group housing density)	50 = presence	Area not urbanized in 1990, but projected urban for 2050
Protected Land Status	SRM Protected Areas Assessment	10 = presence of GAP rank 3 20 = presence of GAP rank 3 and/or 4	
Recent Disturbance	National Land Cover Data, Gap land cover	10 = presence	NLCD transitional category and SRM ecological system recent clear-cut category (since 1990)
Recreational Impact	ESRI 1990 census blocks DLG trails	20 = presence of trails within 10 km of urban block.	Hexagon with 1 or more trails within 10 km of urban block gets 20 points
FWD Road Density	1998 TIGER files	0=0km 10 =>0 –2.5km 30 = 2.5 – 5 62 = 5 – 10 125 = 10-20 250 = >20 km	
Interstate Road Density	1998 TIGER files	0=0km 60 =>0 –2.5km 180 = 2.5 – 5 375 = 5 – 10 750 = 10-20 1,500 = >20km	
Highway Road Density	1998 TIGER files	0=0km 40 =>0 –2.5km 120 = 2.5 – 5 250 = 5 – 10 500 = 10-20 1,000 = >20 km	
Other Road Density	1998 TIGER files	0=0km 20 =>0 –2.5km 60 = 2.5 – 5 125 = 5 – 10 250 = 10-20 500 = >20 km	
Superfund Sites	CERCLA, EPA-National Priority List	40 = CERCLA values of P or F	
Water Quality Indicators	EPA 303d streams, EPA RF3 river reach files	0 = ratio of 303d to total stream length <10% 10 = ratio 10-50% = ratio >50%	

<u>Element data</u>

Numeric goals are entered into the element file (species.dat). Here representation goals were entered for each target for the ecoregion in its entirety, and within set stratified units (ecoregional subsections for terrestrial and ecological drainage units for aquatic). The penalty factor was set at 1000. This means for every target for which the set goals are not attained, 1000 points is added to the cost of the portfolio. This provides the model with incentive to achieve goals. In addition to this penalty factor, cost of a given portfolio design is determined by the suitability of the selected planning units.

The Southern Rocky Mountain assessment team chose to create an integrated portfolio. Planning units were populated using GIS with local- to intermediate-scale species and communities, linear riparian and aquatic riverine systems, and intermediate- to coarse-scale ecological systems and species habitats. Because a wealth of information on species and rare community viability was available in this region, *point* occurrences were weighted to reflect viability. A-ranked occurrences received 100% of their initial value of 1 (number occurrences X 1). B-ranked occurrences received 75% (number of occurrences X 0.75) and C-ranked occurrences received 50% (number of occurrences X 0.5). This biased the model toward selecting units with a higher percentage of the most viable occurrences.

In order to describe terrestrial and aquatic systems (*polygon* and *linear* occurrences) the SMR team created biophysical models. Terrestrial systems were defined using a modeled vegetation distribution map. Within SITES, a minimum dynamic area was set for these systems eliminating the possibility of including small occurrences in the portfolio. The vegetation types were then coupled with Ecological Land Use data. After removing those occupying less than 1% of the ecoregion, 410 unique vegetation type/ ELU combinations were present. Rather than using a minimum dynamic area, the model was set to require that 10% of the total extent of each combination be included in the portfolio. Adding this component to the model promoted the conservation of environmental variability within a given terrestrial system. A similar process was carried out for aquatic systems and macrohabitat types, setting linear goals for system types and stratifying goals within unique aquatic ecological system/macrohabitat type combination.

Once the model was run and an optimal portfolio determined, the SMR assessment team refined the output to create the final portfolio. Several expert workshops were held to discuss and modify conservation areas within the portfolio. Experts employed the use of several additional datasets including Natural Heritage Program "potential conservation area" boundaries, expert-derived sites, and potential habitat overlays for wide-ranging species (to evaluate overall representation and identify important linkages). SITES was run a final time with the modified set of conservation areas "locked in" in order to determine how well the final portfolio met the desired goals. Detailed site boundaries were not delineated for this assessment and will be part of site conservation planning efforts.

Products/Outcomes

The final portfolio contained 188 sites designed as a functional network able to support the 6 wide ranging species identified as targets. 48% of terrestrial systems, 79% of aquatic systems, 98% of rare plant community occurrences, and 95% of the species occurrences are contained within the portfolio. The portfolio benefited from the coupling of the SITES optimization software used to create an efficient portfolio with the experts who can provide current and intimate knowledge of biodiversity that remains difficult to account for quantitatively.

Tools

Sites v1.0

Ecological Land Units can be derived using an annotated AML code from a DEM and geology grid using ArcInfo. Much easier than ArcView process. Download this tool from ftp://ftp.tnc.org/software/Analysis_tools/eluamls.zip

References

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