❖ **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: **Scenario Building in the Utah High Plateaus Ecoregion**

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Purpose and region of analysis

The Utah High Plateaus Ecoregional Assessment team developed a scenario building approach to designing portfolios. Six potential portfolios were produced using three sets of conservation goals and two cost surfaces. These scenarios were then integrated into a final portfolio.

Criteria/Methods

Coupling an innovative approach to goal setting and scenario building using the Spatial Portfolio Optimization Tool (SPOT), the Utah High Plateaus Ecoregional Assessment team developed a novel approach to portfolio design. This exercise began with stratification of conservation goals into three numerical scenarios: low, medium and high risk. The estimated historical extent of each Ecological System type in the ecoregion was multiplied by 0.2 (high risk), 0.3 (medium risk) and 0.4 (low risk) to arrive at numeric goals express relative risk associated with numerical goal levels. A similar structure was used for assigning goals to species, assemblage and small patch forming systems. This approach considers different levels of biodiversity representation over a range of societal risk and scientific uncertainty, which can inform land management decisions. Goals were set for all fine and coarse filter targets varying with risk-level and distribution relative to the ecoregion. For more detail about goal setting see the UHP case study for Standard 8: Goal setting.

Spatial optimization tools were used in portfolio design. These tools allow for numerical goals to be stated, and many thousands of alternatives are created and compared to one another to identify efficient combinations of places that could contribute to conservation goals. These tools also allow users to depict the surface of ‘conservation suitability’ or ‘cost’ of doing conservation in any given place across the ecoregion, so not only do they identify an efficient set of areas to meet goals for many targets, they may also reflect real social, cultural, or economic ‘costs’ of selecting any given site. In this instance, numeric goals were coupled with two distinct composite suitability indices (CSI) to inform the portfolio assembly process. The CSI is a synthesis of the terrestrial and aquatic suitability indices. For each CSI, the ecoregion was subdivided into 750 hectare hexagon units for analysis. The Utah High Plateaus contained approximately 14,000 of these hexagons. Each hexagon is assigned an index score to create the cost surfaces. The index score is the sum of scores from the factors that comprise the index (Table 1 and 2).

Adding socioeconomic factors into the second cost surface encouraged the generation of a portfolio that met goals while avoiding lands with timber, grazing, mineral development, and intensive agricultural development values; i.e., these areas were depicted with 'high cost' or socio-economic tradeoff.

Table 1. Factors Used in the Aquatic Suitability Index (Additionally, the aquatic scores incorporated a "contributing area analysis" where scores from hexagons which are within the watershed of a given hexagon are added to that hexagons score to arrive at a final score).

Factor	**Data Source**	**Score (points)**	**Comments**
Dams and Diversions	USGS Geographic Names Information Systems	40 times # of dams or diversions	By Hexagon
Mines	USGS Geographic Names Information Systems	40 times # of mines	Includes both active and abandoned mines
Land Use/Land Cover	housing density 1990 (Theobald, pers. comm.)*	0 = natural/semi-natural land cover 5 = agriculture 10 = ex-urban 50 = suburban 100 = urban	Percent of area by hexagon times the Score value
Projected Urban Growth	(Theobald 2000 and 2050 block-group housing density)	500 = presence	Percent area not urbanized in 2000, but projected urban for 2050 was multiplied by the Score.
4WD Road Density	1998 TIGER files	0 = 0 km 10 = >0-2.5 km 30 = 2.5-5 km 62 = 5-10 km 125 = 10-20 km 250 = >20 km	By Hexagon
Local Road Density	1998 TIGER files	0 = 0 km 20 = >0-2.5 km 60 = 2.5-5 km 125 = 5-10 km 250 = 10-20 km 500 = >20 km	By Hexagon
Railroad Lines	1998 TIGER files	0 = 0 km 20 = >0-2.5 km 60 = 2.5-5 km 125 = 5-10 km 250 = 10-20 km 500 = >20 km	By Hexagon
Highway Road Density	1998 TIGER files	0 = 0 km 40 = >0-2.5 km 120 = 2.5-5 km 250 = 5-10 km 500 = 10-20 km 1,000 = >20 km	By Hexagon

Factor	Data Source	Score (points)	Comments
Interstate and Frontage Road Density	1998 TIGER files	0 = 0 km 60 = >0-2.5 km 180 = 2.5-5 km 375 = 5-10 km 750 = 10-20 km 1,500 = >20 km	By Hexagon
Power Transmission Lines	1998 TIGER files	0 = 0 km 10 = >0-2.5 km 30 = 2.5-5 km 62 = 5-10 km 125 = 10-20 km 250 = >20 km	By Hexagon
Superfund Sites	CERCLA, EPA - National Priority List	40 = CERCLA values of P or F	By Hexagon
303d Impaired Water Body	EPA	10 = Presence	
Industrial Discharge Facilities	EPA BASINS	10 times # of facilities	By Hexagon
Oil Well (point location)	EPA BASINS	5 times # of wells	By Hexagon
Toxic Release Inventory	EPA BASINS	40 times # of sites	By Hexagon

Table 2. Factors Used in the Composite Suitability Index (terrestrial factors + aquatic score) and the socioeconomic factors incorporated into the second CSI.

Factor	Data Source	Score (points)	Comments
Mines	USGS Geographic Names Information Systems	40 times# of mines	Includes both active and abandoned mines
Recent Fires for the past 20 years	USFS	20 = presence	Cost was calculated by the percent of area burned in each hexagon multiplied by the Score
Land Use/Land Cover	housing density 1990 (Theobald, pers. comm.)*	0 = natural/semi-natural land cover 5 = agriculture 10 = ex-urban 50 = suburban 100 = urban	Cost value scaled proportional to area of hexagon
Projected Urban Growth	(Theobald 2000 and 2050 block-group housing density)	50 = presence	Percent area not urbanized in 2000, but projected urban for 2050 was multiplied by the Score.
4WD Road Density	1998 TIGER files	0 = 0 km 10 = >0-2.5 km 30 = 2.5-5 km 62 = 5-10 km 125 = 10-20 km 250 = >20 km	By Hexagon
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Superfund Sites	CERCLA, EPA - National Priority List	40 = CERCLA values of P or F	By Hexagon
Oil Well	EPA BASINS	40 times # of wells	By Hexagon
Aquatic Suitability Score	FWI contributing area analysis	Aquatic score standardized between 0 and 250	By Hexagon
Socioeconomic Factors	**Data Source**	**Suitability Index 1**	**Suitability Index 2**
High Value Timber lands	Biophysical model; based on slope <35%, montane conifer and aspen forests	0 points	500 points Cost value scaled proportional to area of hexagon
High Value Grazing lands	Biophysical model; based on slope <35%, grassland and montane shrubland vegetation	0 points	500 points Cost value scaled proportional to area of hexagon
High Value Mineral Development Potential	States of UT and CO	0 points	500 points Cost value scaled proportional to area of hexagon
Potential Farmland Conversion	Biophysical model; low elevation zone, valley bottoms, flats, deep soil from STATSGO, current natural vegetation, proximity to current agricultural land use	0 points	500 points Cost value scaled proportional to area of hexagon

A matrix of goals by cost surface results in 6 scenarios from which to create a conservation portfolio (Table 3). SPOT was used to run these scenarios.

			Goal-Based Risk Levels		
			High risk to b.d.	Med. risk to b.d.	Low risk to b.d.
Land Use/ Economic-Based Suitability Indices	1.	Composite Suitability Index (CSI) alone	Suitability 1 High Risk	Suitability 1 Medium Risk	Suitability 1 Low Risk
	2.	CSI plus socio-economic factor cost values (Table 3)	Suitability 2 High Risk	Suitability 2 Medium Risk	Suitability 2 Low Risk

Table 3. Matrix showing the 6 scenarios that result from combining 3 goal levels and 2 cost surfaces.

A map displaying a potential portfolio resulted from each of these SPOT iterations. Summarizing the results of these iterations, a composite hexagon map and bar graph were produced indicating the number of iterations that selected a particular hexagon (Figure 1 and 2). Thirty percent of all hexagons were selected 3-6 times. A final portfolio was refined from those hexagons that were selected 4, 5 or 6 times. This portfolio underwent review and revision at an expert workshop and then finalized.

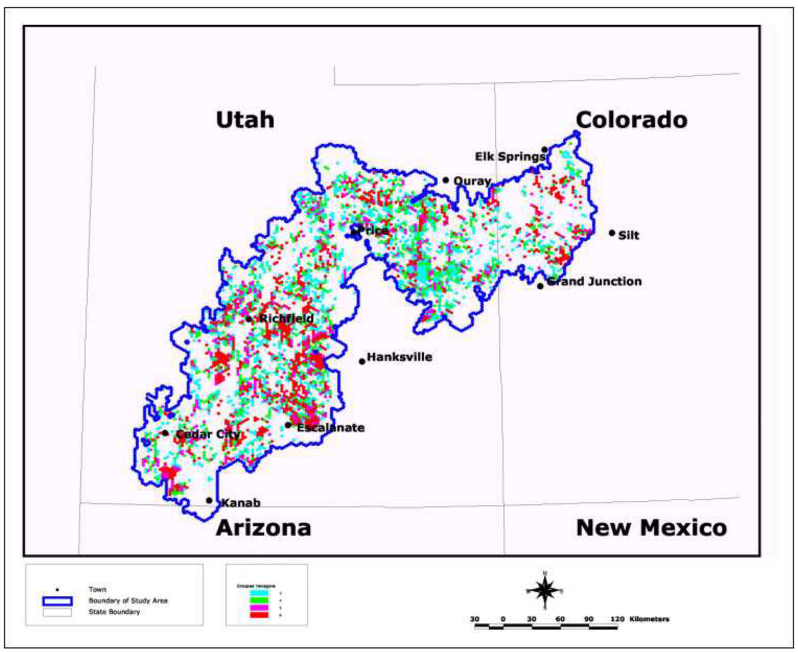

Figure 1: Composite hexagons showing areas where clusters of hexagons were consistently selected possibly indicating "seed" areas of biodiversity importance.

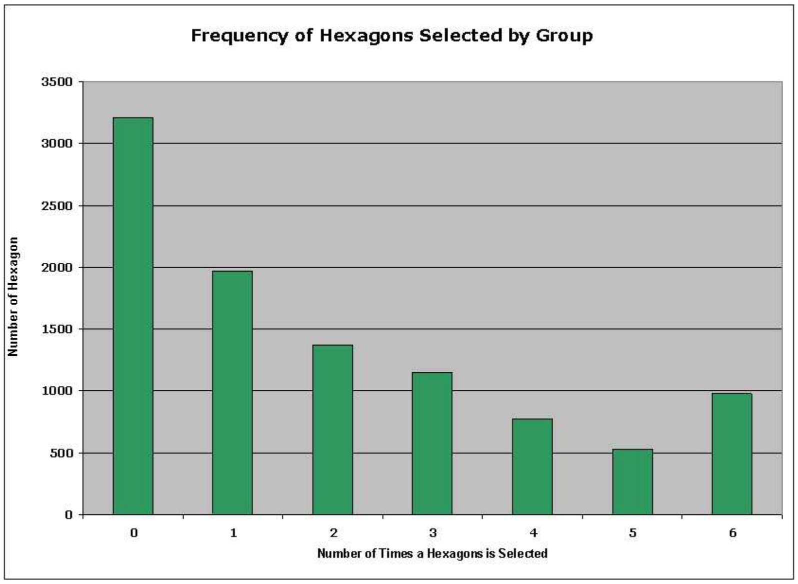

Figure 2: Composite hexagon histogram showing the frequency of hexagon selection across scenarios.

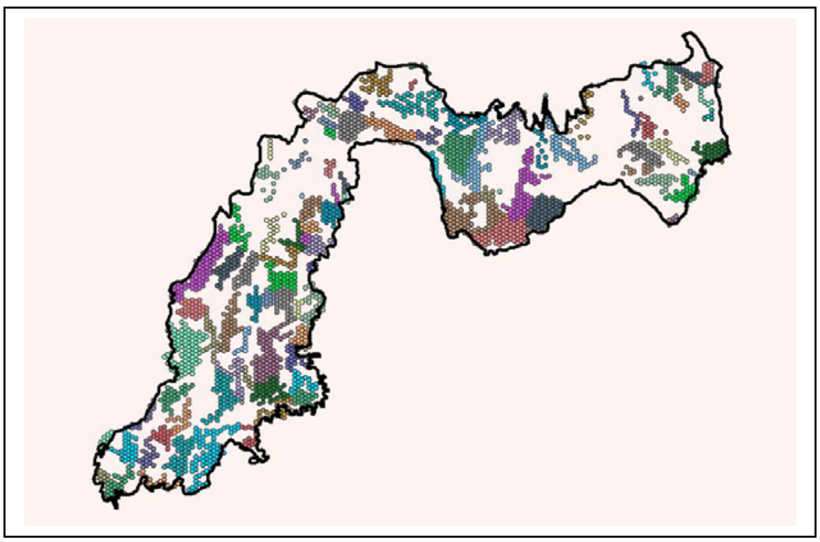

Figure 3. Final portfolio resulting from expert review and revision of composite results shown above.

Products/Outcomes

This approach should allow for a more robust portfolio design in that it allows users to better understand the relative significance of portions of the portfolio given varying assumptions and levels of uncertainty.

Data inputs include spatial models that reflect socio-economic tradeoffs across the entire ecoregion. These same layers may be re-used as needed to update portfolios in subsequent iterations.

Tools

SPOT-Spatial Portfolio Optimization Tool by Dan Shoutis (2003) is a technical document on the tool. A general power point presentation is available here. Contact Ecoregional Assessment data manager for technical resources (programming documentation) at era@tnc.org

Strengths and weaknesses

While spatial optimization tools allow users to report on how many times individual analysis units were selected across millions of iterations, this approach brings along an added dimension of expressing the relative irreplaceability of analysis units given a range of assumptions about goal sets and socioeconomic tradeoff.

Given that multiple scenarios are generated, it adds a step of expert-driven integration if one final 'blueprint' is a desired ecoregional product.

Suggestions for others considering similar analysis

Explore and document other ways where multiple scenarios could/should be developed and integrated, meeting needs of users in circumstances different from the UTHP ecoregion.