Skill Check – Multiple Objectives Tradeoffs

Rolling Thunder Prairie Management

You've just become the biologist at Rolling Thunder NWR in the upper Midwest. Years ago, the refuge acquired several prairie parcels to protect rare orchids. These plants only grow in open grasslands, usually requiring direct habitat manipulation to limit the invasion of woody species. Management objectives on these parcels have also included maintaining habitat for game birds, especially winter vegetation cover. More recently, conservation objectives have been expanded to include sustaining rare butterfly and beetle populations, which are also endemic to these prairie habitats. Meanwhile, residential development has increased and is now in proximity to these areas, prompting new constraints on management to avoid conflicts with local residents.

Multiple Objectives Trade-Off Exercise: The refuge manager has asked you to tell her the best options for managing the grassland vegetation. You need to select the vegetation treatment alternative that performs best across the seven objectives.

Objectives: Minimizing costs and neighbor complaints, while maximizing rancher support (grazing opportunity), and of course, conservation of birds, plants, butterflies, and beetles.

Alternatives: The refuge has five treatment options: Spring Burning, Fall Burning, Mowing, Grazing, and No Action.

Performance Attributes: The refuge has collected some data on the effects of different management strategies, such as grazing, mowing and controlled burning, on a variety of species. Your predecessor as refuge biologist has already compiled a 'Consequences Matrix' summarizing the performance of the five treatment alternatives on the seven objectives. He used 'proxy measures' for the objectives, such as 'stem density' as the index for effects on plants, 'estimated number of complaints' for neighbor complaints (from a survey), and 'grazing units' or number of permitted cattle-months as an index for rancher support (see full matrix, attached).

Additional Background Information:

- The most influential habitat factor predicting bird population density is the presence of over-winter grass cover. Thus, the bird conservation objective can be considered through winter vegetation cover.
- Except in wet years or locations, fall burning leaves the prairie relatively bare of standing vegetation until spring regrowth.
- Plants benefit most from burning, which not only limits woody plant encroachment but releases nutrients into the soil.
- Butterflies suffer direct mortality from burning, yet are strongly dependent on several species of plants that thrive with burning. Burn timing affects butterfly survival, with losses greater in spring burns as eggs die or fail to emerge. Because they can fly between patches, adult butterflies are able to recolonize habitat patches after treatments provided source populations are maintained.

- Beetles are relatively non-vagile and therefore suffer direct mortality in burning and some mortality from cattle trampling, and also are slow to recolonize areas where local populations are eliminated. Fall burning also leaves beetles exposed to winter mortality.
- Mowing causes the least direct mortality to beetles and also orchids (which cattle eat), but is also logistically most challenging and cannot be implemented across all patches consistently to control woody vegetation. Mowing during butterfly hatch can reduce populations.
- Failing to conduct any vegetation management (no action alternative) has the fewest direct impacts, but by allowing woody encroachment, harms prairie species conservation in the long term.
- Rancher revenue stems from the issuance of grazing permits on the refuge, thus, can be considered an economic or monetary value.
- Grazing permits generate $120/grazing unit in revenue.

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Part I

Reduce the number of alternatives in this table by finding and eliminating any dominated alternatives, in the process also deleting any irrelevant objectives that result as alternatives are dropped.

CONSEQUENCES TABLE		Treatment (Alternative)				
Objective	**Goal**	**Spring Burn**	**Fall Burn**	**Mowing**	**Grazing**	**No Action**
Cost ($/year)	Min	10,000	10,000	15,000	7,000	2,000
Rancher Revenue (# of Grazing Units)	Max	0	0	0	50	0
Neighbor Complaints (Estimated Number)	Min	5	5	0	1	1
Maintain Cover for Birds (Yes = 1, No = 0)	Max	1	0	1	1	1
Effects on Listed Plants (Stem density / m^2)	Max	10	9	2	1	1
Effects on Butterflies (Emergence Index % hatch)	Max	0.05	0.03	0.1	0.2	0.01
Effects on Beetles (% Area Occupied)	Max	0.02	0	0.35	0.2	0.02

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Part II.

Good work! The refuge manger liked your earlier work, went to the Regional Office for funding and was told to come back with a single proposal. So, she's asked you to provide her with the single best option with a full explanation.

Your task, using the 'reduced' consequences table, is to complete the SMART ranking method:

1) Put the information in the reduced consequences matrix (attached) into the appropriate places in the blank spreadsheet provided: "SkillCheck_5_Students.xls";
2) Enter formulas to normalize the consequences to a (0-1) scale;
3) Assign and enter weights to the objectives; and
4) Enter formulas necessary to calculate the sum of the weighted scores for each alternative.

Now, perform some sensitivity analysis (by adjusting the weights), and come up with your recommendation for the 'best' option and explain it to the refuge manager.

We want you to explain a single 'best' solution from the existing options. If you want you can also go farther and develop new alternatives, using your insights from the results and sensitivity analysis.

Rolling Thunder Prairie Management
(Multiple Objectives Tradeoffs Exercise)

Part II Reduced Consequences Matrix to enter in spreadsheet for SMART method ranking.

SIMPLIFIED TABLE		Treatment (Alternative)		
Objective	**Goal**	**Spring Burn**	**Mowing**	**Grazing**
Cost ($/year)	Min	10,000	15,000	1,000
Neighbor Complaints (Estimated Number)	Min	5	0	1
Effects on Listed Plants (Stem density / m^2)	Max	10	2	1
Effects on Butterflies (Emergence Index % hatch)	Max	0.05	0.1	0.2
Effects on Beetles (% Area Occupied)	Max	0.02	0.35	0.2

Math Tip:
One formula to normalize, or convert a series of numbers to their relative ranks on a 0-1 scale is: [(value – min) / (max-min)]
For example, for the series 1, 2, 10, the normalized score for 2 is: [(2 – 1)/(10 – 1)] = [1/9] = 0.11 on a 0-1 scale.

Showing these scales visually:

Original ranks:	**1**	**2**	**10**
Normalized ranks:	0	0.11	1

For objectives you want to *minimize* (cost, complaints), convert so the 'best' performing alternative gets the number 1. You can do this easily by calculating the normalized scores as above, then subtracting each score from 1, e.g., 1 - [(value – min) / (max-min)]