

# Optimizing corridor placement using simulated annealing

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how many different chapter ones will i have hmm

## **1 Introduction**

2 Human activity has rapidly reshaped the face of Earth's surface, leaving fragments of patchy habitat.  
3 Although there is no shortage of debate as to the effects of fragmentation *per se* on biodiversity and  
4 ecosystem function (**cite?** ), it is generally accepted that the combination of habitat and ensuing  
5 subdivision produce negative outcomes for ecosystem function and services (**resasco?** review).  
6 In order to mitigate the consequences of landscape change on ecosystems, developing landscape *corridors*  
7 has seen much attention in the last several decades. Bit more evidence for corridors here. But still, the  
8 spatter of fragments in a landscape, where should ecologists choose to use their limit resources to build a  
9 corridor?  
10 Here we propose to answer that question by proposing an algorithm to estimate the landscape  
11 modification that results in optimizing a specific ecosystem process (in this paper maximizing the time  
12 until extinction of a metapopulation, although the algorithm and associated software can be generally  
13 applied to any process-based model with a quantifiable target state).  
14 Although algorithms have been proposed for this (**peterman?** etc), they are focused on finding the where  
15 the paths of least existance for a given species is given data on that species dispersal.

## **16 An algorithm for optimizing corridor placement**

17 Start with some definitions and notation.  
18 Define the set of possible landscape modifications,  $\mathfrak{M}$ , in optimization language called the *search-space*.  
19 Introduce uncountability argument of this space.  
20 Because we cannot test every possible modification in  $\mathfrak{M}$ , we use simulated annealing, a method for  
21 estimating the global optimum of functions with NP search-spaces.

## **22 Proposing landscape modifications**

23 This is really important. We propose (no pun intended) several algorithms for generating landscape  
24 modifications. Some of the details here might have to go in a supplement/appendix.

25 **Graph-based**

26 Consider only modifications that consist of connecting nodes.

27 **The two stage approach** Stage-one: accept a new topology of connected nodes with probability in  
28 proportion to chain temperature (see next section).

29 Stage-two: modify way that the connection for a given topological structure is chosen. Because we are  
30 working in a 2D raster, all distances between points are Manhattan distances, and any link between points  
31 is composed of  $x$  horizontal steps and  $y$  vertical steps. There are thus  $2^{(x+y)}$  ways to connect two nodes  
32 that far apart.

33 **Not graph-based**

34 The reason to avoid this is because the search-space grows much faster with lattice size and budget. That  
35 being said, we can use some simply heuristics to weight proposals using “common-sense.”

36 **Simulated annealing to explore the space of landscape modifications**

37 The transition probability function,  $q$ , which gives the probability of moving from one modification  $i \in \mathbb{M}$   
38 to a new proposed state  $j \in \mathbb{M}$ , as a function of a chains temperature.

39 Here we define  $q(i, j)$  using a logistic function,

$$q(i, j, \alpha) = \frac{1}{1 + e^{\alpha(s(j) - s(i))}}$$

40  $s(i)$  is the function that gives the score of a proposed modification. Here, the mean time to extinction.

41 Simulated annealing can be written described as the following.

42 A markov-chain, denoted  $\pi_\alpha$

43 **Figure 1: concept fig**

44 **Process-based optimization**

45 Here we use occupancy dynamics as the process, although we emphasize that this method works for  
46 arbitrary process models and is instead limited only by the computational demands of a given process  
47 model.

48 **Figure 2: MTE versus epoch fig:** shows the chains move toward higher extinction times over time, i.e. it  
49 works.

50 **Simulation of data for testing the algorithm**

51 **Simulation of occupancy dynamics**

52 **Simulation of landscapes**

53 **Generation of landcover maps**

54 **Generation of points**

55 **Resistance values assigned to each land cover type**

56 **Some type of performance fig vs. raster size and budget figure**

57 **Actual data st. lawrence lowlands**

58 **Discussion**