APPENDIX D: Cecil County Green Infrastructure Network Identification Methodology

Core areas

1. Core aquatic areas

  1.1. Identify all riparian zones (including intermittent streams)
    1.1.1. 1% (100 year) floodplain
      1.1.1.1. Data layer: Cecil_100_year_floodplain.shp
    1.1.2. Riparian buffers
      1.1.2.1. Buffered streams and shorelines (frpm hydro_ln) 100 feet
      1.1.2.2. Buffered lakes and ponds (frpm hydro_poly) 100 feet
    1.1.3. Merge buffers
    1.1.4. Dissolve overlaps
    1.1.5. Save as Cecil_riparian_zones.shp
  1.2. Identify perennial riparian zones
    1.2.1. 1% (100 year) floodplain
      1.2.1.1. Data layer: Cecil_100_year_floodplain.shp
    1.2.2. Riparian buffers
      1.2.2.1. Buffered perennial streams and shorelines (frpm hydro_ln) 100 feet
      1.2.2.2. Buffered lakes and ponds (frpm hydro_poly) 100 feet
    1.2.3. Merge buffers
    1.2.4. Dissolve overlaps
    1.2.5. Save as Cecil_perennial_riparian.shp
  1.3. Nontidal streams
    1.3.1. <u>Focal species</u>: Pollution-sensitive fish and invertebrates
    1.3.2. <u>Optimal habitat</u>: Stream reaches with "Good" combined (fish + benthic macroinvertebrate) IBI scores (>4), which can indicate good water quality and stream habitat.
    1.3.3. Identify stream reaches with "Good" combined (fish + benthic macroinvertebrate) MBSS IBI scores
    1.3.4. Add stream reaches with MDE Tier II designation
    1.3.5. Add associated perennial riparian zone
  1.4. Rivers with rare species
    1.4.1. <u>Focal species</u>: Yellow lampmussel
    1.4.2. DNR provided a map of HUC12 stronghold watersheds in Cecil County (Bohemia River), which supports populations of this species.
    1.4.3. Select connected streams (i.e., not isolated by impoundment dams, etc. in these watersheds.
    1.4.4. Add associated perennial riparian zones.
  1.5. Coldwater streams
    1.5.1. <u>Focal species</u>:
      1.5.1.1. Brown trout

1.5.1.2. Benthic coldwater macroinvertebrates (*Tallaperla* spp. and *Sweltsa* spp.). Both are sensitive to sedimentation and pollution and need coldwater (similar stream temperatures to brook trout). These are the two species that MDE uses to fulfill the biological requirement for thermal protection of a stream.

1.5.2. Optimal habitat: Cold water natural streams with good water quality.

1.5.3. DNR Freshwater Fisheries provided a map of HUC12 watersheds that contain wild trout and benthic coldwater macroinvertebrates.

1.5.4. Select connected streams (i.e., not isolated by impoundments, dams, etc.) in these watersheds.

1.5.5. Add associated perennial riparian zones.

1.5.6. No brook trout or hellbenders currently in the county; not found in recent surveys.

1.6. Tidal waters

1.6.1. Focal species: Chesapeake logperch, anadromous fish, mummichog, native submerged grasses

1.6.2. Optimal habitat: High Priority Blue Infrastructure, SAV beds, Chesapeake logperch habitat, anadromous fish spawning and juvenile habitat

1.6.3. DNR supplied locations where Chesapeake logperch were found. We selected corresponding water and riparian zones.

1.6.4. Identify 2015 SAV beds

1.6.5. Identify High Priority Blue Infrastructure coastal watersheds

1.6.6. Add striped bass spawning habitat

1.6.7. Add herring and perch spawning and juvenile habitat

1.6.8. Clip above three to Blue Infratructure nearshore segments (delineated out to a depth of 2 meters) and shoreline buffers (up to 100 m from shoreline). Note: All 316 segments fell into one or more of these habitat categories.

1.6.9. Save as Cecil_nearshore_habitat.shp.

1.7. Combine

1.7.1. Created model to run much of this.

1.7.2. Removed isolated areas

2. Core Wetlands

2.1. Identify wetlands + buffer

2.1.1. To note, an effective buffer width will vary according to type of wetland, sensitivity to disturbance, intensity of adjacent land use, groundwater depth and hydraulic conductivity, proximity and characteristics of drainage ditches and other water control structures, slope and soil characteristics, species present, and buffer characteristics such as vegetation density and structural complexity, soil condition, etc.

2.1.2. From DNR wetland layer, remove wetlands not within the county boundary

2.1.3. Remove farmed wetlands (“Pf”) and permanent open water.

2.1.4. Buffer 100 feet

2.1.5. Data layer: Cecil_wetland_100ft_buffers.shp

2.2. Wetlands of Special State Concern + 100 ft buffer

2.2.1. In Maryland certain wetlands with rare, threatened, endangered species or unique habitat receive special attention. The Code of Maryland Regulations (COMAR) Title 26, Subtitle 23, Chapter 06, Sections 01 & 02 identifies these Wetlands of Special State Concern (WSSC) and affords them certain protections including a 100 foot buffer from development. The Maryland Department of the Environment is responsible for identifying and regulating these wetlands. In general, the US Fish and Wildlife Service's National Wetlands Inventory wetlands provide the basis for identifying these special wetlands. Additional information, determined from field inspections, is used to identify and classify these areas.

2.2.2. Remove WSSC not within the county boundary

2.2.3. Buffer 100 feet

2.2.4. Data layer: Cecil_WSSC_100ft_buffers.shp

2.3. Identify wetlands that have not been farmed, drained, ditched, or excavated.

2.3.1. Note: impounded wetlands (-b; -h) often provide good habitat

2.3.2. Note: filled (-s) may only be a small portion of the wetland, and this is not generally labeled consistently

2.3.3. ("CLASS" LIKE '%f') OR ("CLASS" LIKE '%d') OR ("CLASS" LIKE '%x')

2.3.4. Saved as Cecil_unmodified_wetlands.shp.

2.4. Compatible land cover includes unimpaired wetlands, forest patches, and open water.

2.5. Identify unimpaired wetlands (or portions of wetlands) that are at least 30 m from cleared or developed land, roads, railroads, ditches, or channelized streams.

2.6. Add 30 m buffers

2.7. Add WSSC’s + 100 ft buffers (even if not all the land cover is natural).

3. Core Forest

3.1. Background:

3.1.1. Forest edges contain significant gradients of solar radiation, temperature, wind speed, and moisture between the forest patch interior and the adjacent land, especially if the adjacent land is developed. Increased solar radiation at the edge increases temperatures and decreases soil moisture and, with increased wind flow, decreases relative humidity, which can desiccate plants. Increased wind speed at a newly created edge commonly knocks down trees that are no longer buffered by adjacent canopy and not structurally prepared. This poses a problem especially for wetland trees, which have shallow roots and less stable soil. Wind can also carry dust or other small particles, which can adhere to vegetation. Noise from developed land disrupts natural activity in adjacent forest or marsh, by drowning wildlife cues for territorial boundary establishment, courtship and mating behavior, detection of separated young, prey location, predator detection, and homing. Sudden loud noises can also cause stress to animals. Changes in insolation and other physical parameters at created edges change plant and animal communities there, and processes like nutrient cycling.

3.1.2. Since the eastern U.S. was primarily unbroken forest prior to European colonization, many species are adapted to interior forest conditions. Edge habitat differs from interior forest in tree species composition, primary production, structure, development, animal activity, and propagule dispersal capabilities. The edge communities shift to more shade-intolerant, more xeric tree and shrub species, and early successional species. These then broadcast propagules that invade the forest interior. Edges can favor invasive species, which can then displace native species in adjacent areas. Opportunistic animals like raccoons, opossums, and cowbirds also colonize patch edges, and often invade the interior. These edge species often influence ecosystem dynamics by preying on, outcompeting, or parasitizing interior species. Cats and dogs from developed areas can also prey on or harass wildlife.

3.1.3. Age, structure, composition, disturbance history, etc. of forest is often more important to functions like wildlife habitat than patch size. This information was not readily available throughout the county.

3.1.4. Note: took too long to run computations at 1 m, so we ran at 3 m.

3.2. Forest patches with at least 1 acre of interior (>30 m from edges)

3.2.1. We decided that this would be the minimum patch size for consideration. Forest patches dominated by edge effects may not contain suitable conditions for forest obligates.

3.2.2. Identify tree canopy from the combined land cover (imagery flown 2013, LiDAR flown 2014).

3.2.3. Identify orchards (apples, peaches) and Christmas trees from the 2016 Cropland Data Layer, and remove from tree layer.

3.2.4. Convert building polygons and other impervious surfaces to grid format.

3.2.5. Buffer roads, railroads, and utility corridors 3 m and convert to grid format.

3.2.6. Convert road and railroad centerlines to grids so there are no artificial breaks as happenes when converting polygons to grids.

3.2.7. Subtract impervious surfaces, roads, railroads, and utility corridors from tree canopy.

3.2.8. Identify interior forest (>30 m from nearest edge)

3.2.9. Identify contiguous groupings of at least 1 ac of interior forest, and add 30 m transition back.

3.2.10. Data layer: D:\Cecil_GI\Cecil_GI_GIS\forest\for_w_1ac_int

3.3. Forest patches with >100 ha (250 ac) of interior forest (>100 m from edges)

3.3.1. This patch size and depth is based on habitat requirements for forest interior birds (FIDS) in Maryland (Bushman and Therres, 1988).

3.3.2. There were only 6 such patches.

3.4. Key forest patches would best be identified from the ≥1 interior acre subset through presence of indicator species or surveys of forest quality. We lacked such data, though. We downloaded EBIRD data from GBIF, but the positions were not sufficiently accurate.

3.5. Calculate area of each forest patch with ≥1 acre of interior (>30 m from edge). Area calculated here includes the 30 m edge transition.

Patch area (ac)	% of patches	% of area
0-10	33%	4%
10-30	32%	11%
30-100	21%	24%
100-250	9%	27%
250-1227	4%	34%

3.6. From above, identify forest patches ≥100 acre (only 13% of patches, but 61% of area).

3.6.1. Save grid as forest_100ac

3.7. Add forest patches that overlap core aquatic areas, core wetlands, and BioNet Tiers 1-4.

3.7.1. 982 out of 1630 forest patches met one or more of these four criteria.

3.7.2. These were designated core forest.

4. Core Grassland - unable to identify grassland habitat

4.1. Identify grasslands
    4.1.1. From land cover, select Low Vegetation
    4.1.2. From Cropland Data Layer (CDL; 12/12/2016 publication), select Pasture/Grass and Grassland Herbaceous
    4.1.3. Comparing to aerial photos, it didn't seem accurate.

5. Combine core areas. Remove developed land and add forest within these areas.

    5.1. Convert polygons to rasters with value of 1.
        5.1.1. Used same map extent and cell size (3 m) as the forest grid
    5.2. Mosaic rasters together.
    5.3. Subtract impervious surfaces from fine-scale land cover and other data (see forest patch methodology)
    5.4. Add adjacent tree cover
    5.5. Remove areas only tenuously connected (<30 m wide) to core forest, wetland, or aquatic areas.
    5.6. Remove areas <1 ac

Hubs

1. Buffer core areas 100 m
2. Add small areas (<10 acres) within buffers
    2.1. 1 cell = 9 m^2 = 0.00222395 acre.
    2.2. 10 acres = 4497 cells
3. Subtract major roads
    3.1. Data source: streets_5km
    3.2. Select speed ≥40 mph
    3.3. Also select primary roads (roadclass = 1 or 2)
    3.4. Clip to study boundary
    3.5. Save as Cecil_major_roads.shp
    3.6. Buffer 10 m
    3.7. Convert to grid and subtract from core area buffers
4. Subtract areas within 30 m of buildings (likely to be frequently disturbed)
5. Subtract impervious surfaces and large areas of barren land (>1/4 ac)
6. Add core areas back in
7. Remove areas only tenuously connected (<30 m wide) to core areas.
8. Clip to study boundary.
9. Apply size threshold of 250 ac (112,444 cells)

Corridors

Had to run this at 10 m due to computer constraints.

Forest Corridors

1. Set environments and resample core forest

a. Set projection (Maryland State Plane, NAD 1983, meters), snap, mask, and cell size (10 m).
b. Resample or re-rasterize data to this.

<u>Forest movement impedance</u>

1. Bridges
   a. Merge bridge point files:
      i. Cecil_state_bridges.shp
      ii. Cecil_US_bridges.shp
      iii. county bridges.shp (except for ones replaced with culverts)
   b. Based on examination of data, buffer 20 meters
   c. From hydro_ln, select lakes, ponds, marsh, reservoirs, shorelines, and streams
      i. ("LAYER" = 'X-Lake-Pond') OR ("LAYER" = 'X-Marsh-Line') OR ("LAYER" = 'X-Reservoir') OR ("LAYER" = 'X-SHORELINE') OR ("LAYER" = 'X-STREAM')
   d. From Hydrology_Polygons, select lakes, ponds, and marsh
      i. ("Layer" = 'X-LAKE-POND') OR ("Layer" = 'X-MARSH-LINE')
   e. From land cover, select water and wetlands
   f. Identify water within 20 meters of bridge points.
   g. Had to manually digitize some bridges where the crossings were big, and the point buffer method didn't work. Also, some bridges were missing from the point files.
   h. Assign these areas the same code as water in the land cover raster (1).
2. Water
   a. From hydro_poly, select ("Layer" = 'X-LAKE-POND') OR ("Layer" = 'X-SW-Pond')
   b. Assign these areas the same code as Water in the land cover raster (1).
3. Assign buildings the same code as Structures in the land cover raster (7).
4. Assign major roads a unique code (99)
5. Assign roads and streets the same code as Roads in the land cover raster (9).
6. Assign impervious surfaces the same code as Impervious Surfaces in the land cover raster (8).
7. Assign railroads the same code as Impervious Surfaces in the land cover raster (8).
8. Assign abandoned railroads the same code as Barren in the land cover raster (6).
9. Assign gas line ROWs the same code as Low Vegetation in the land cover raster (5). No data was available for other utility ROWs.
10. Assign orchards the same code as Shrubland in the land cover raster (4).
11. Overlay buildings, bridges, major roads, other roads and streets, impervious surfaces, railroads, abandoned railroads, gas line ROWs, and orchards over land cover data. Save as grid bldg_rd_rr_lc.
12. Based on tests while performing the Greater Baltimore Wilderness resiliency assessment, reclass modified land cover as follows (No Data = impassable for non-aerial forest animals):

Code	Description	Forest corridor impedance
1	Water	250
2	Wetlands	20
3	Tree Canopy	10
4	Shrubland	20
5	Low Vegetation	50
6	Barren	250
7	Structures	No Data

8	Impervious Surfaces	1250
9	Impervious Roads	1250
10	Tree Canopy over Structures	No Data
11	Tree Canopy over Impervious Surfaces	1250
12	Tree Canopy over Impervious Roads	1250
No Data	Outside study area	No Data

   a. Give major roads an impedance of No Data (impassable except under bridges)
   b. Grid name: imp_lc_x5

6. Interior forest
   a. Reclass distance from forest edge (using grid tree_patches) as follows:

Distance from forest edge	**Divide impedance by:**
>100 m	3
30-100 m	2
<30 m, or non-forest	1

   b. Saved divisor grid as imp_intfor.

7. Proximity to buildings and roads: Multiply impedance by 2 within 30 m of buildings or roads
   a. Reclass road/street and building grids to 1 or No Data, and mosaic together.
   b. Reclass distance from roads and buildings as follows:

Distance from nearest road or building	**Divide impedance by:**
<15 m (1 cell diag.)	3
15-30 m	2
>30 m	1

   c. Saved divisor grid as near_rd_bldg.

8. Set impedance of offshore water (>30 m from shore) to NoData, so the program does not select forest corridors across large rivers or bays.
   a. Use water from land cover (specifically, grid bldg_rd_rr_lc, which reclassifies bridges as water)
   b. Save grid as imp_offshore
9. Protected lands
   a. From the layer ProtectedLands_Combined, we removed unprotected Rural Legacy Area land.
   b. For remaining, parks, easements, other public land, common open space, etc., the level of protection varied.
   c. Based on results from past projects, exclude paved surfaces and open water, using grid bldg_rd_rr_lc. Only trees, grass/shrubs, and bare earth receive a discount for being within a protected area.
   d. Reclass protected undeveloped land = 2; elsewhere = 1. Saved as imp_protect.
10. Combine
   a. Divide land cover impedance grid by interior forest impedance (i.e., lower impedance in forest interior), offshore water (i.e., no corridors >30 m from shore), protected land (i.e., lower impedance in undeveloped protected land), and multiply by proximity to roads and buildings (higher impedance near roads and buildings).
   b. Note that processing extent, cell size, etc. must align exactly between impedance and core area grids for the TMA tool to work.

Forest connectivity modeling

1. Created uncertainty grid for impedance layer, to be used with the new TMA version, such that each impedance value could vary but retain their rank order.

Impedance value	Min. value	Max. value	Fractional change to min.	Fractional change to max.	Smallest fractional change	Final min. value	Final max. value
1	1	1	0.000000	0.000000	0.0000	1	1
2	2	2	0.000000	0.000000	0.0000	2	2
3	3	4	0.000000	0.333333	0.0000	3	3
5	4	7	0.200000	0.400000	0.2000	4	6
10	8	12	0.200000	0.200000	0.2000	8	12
15	13	17	0.133333	0.133333	0.1333	13	17
20	18	22	0.100000	0.100000	0.1000	18	22
25	23	27	0.080000	0.080000	0.0800	23	27
30	28	35	0.066667	0.166667	0.0666	28	32
40	35	45	0.125000	0.125000	0.1250	35	45
50	45	55	0.100000	0.100000	0.1000	45	55
60	55	67	0.083333	0.116667	0.0833	55	65
75	68	79	0.093333	0.053333	0.0533	71	79
83	79	91	0.048193	0.096386	0.0481	79	87
100	92	112	0.080000	0.120000	0.0800	92	108
125	113	137	0.096000	0.096000	0.0960	113	137
150	138	200	0.080000	0.333333	0.0800	138	162
250	200	312	0.200000	0.248000	0.2000	200	300
375	313	437	0.165333	0.165333	0.1653	313	437
500	438	625	0.124000	0.250000	0.1240	438	562
750	625	1000	0.166667	0.333333	0.1666	625	875
1250	1000	1875	0.200000	0.500000	0.2000	1000	1500
2500	1875	3125	0.250000	0.250000	0.2500	1875	3125
3750	3125	4375	0.166667	0.166667	0.1666	3125	4375

2. Run TMA
   a. Impedance X5
   b. maximum movement from start locations = 1,000,000
   c. minimum pathway threshold = 1
   d. maximum movement around pathway = 1000
      i. Equivalent to 40 m of bare earth or 200 m of grass (seems kind of high)
      ii. Through ag fields, width was ~60-80 m.
   e. analysis iterations = 50
   f. start location % = 1
   g. It took 3 hours, 55 minutes.
3. Rank corridors

a. Use the “Remove Cores from corridors” tool to remove core areas and areas that do not connect at least two core areas (they may connect different parts of the same core area, or function as buffers, or, in some cases, act as dead ends.)
b. Reclassify all output values from above tool to 1
c. Multiply above corridors by movement potential grid (which combines area connected and impedance)
d. Make grid more normal (it is strongly right-skewed) by taking natural log (Ln)
e. Slice into ten equal-area increments (grid = for_corr_rank). 10 is best and 1 is worst. They are not truly equal-area because the program is imperfect.

Wetland Corridors

Wetland movement impedance

1. First, identify core wetlands to connect
   a. Set processing extent same as forest impedance layer.
   b. Relatively unimpacted wetlands (ce_wet_unimp) within core areas (ce_core_areas)
   c. Note: All unimpacted wetlands fell within core areas.
   d. Save grid as core_wetl_10m
2. Bridges – same as for forest
3. Water – same as for forest
4. Assign buildings the same code as Structures in the land cover raster (7).
5. Assign major roads a unique code (99)
6. Assign roads and streets the same code as Roads in the land cover raster (9).
7. Assign impervious surfaces the same code as Impervious Surfaces in the land cover raster (8).
8. Assign railroads the same code as Impervious Surfaces in the land cover raster (8).
9. Assign abandoned railroads the same code as Barren in the land cover raster (6).
10. Assign gas line ROWs the same code as Low Vegetation in the land cover raster (5). No data was available for other utility ROWs.
11. Assign orchards the same code as Shrubland in the land cover raster (4).
12. Assign DNR wetlands (other than farmed or open water) the same code as Wetlands in the land cover raster (2).
13. Overlay buildings, bridges, major roads, other roads and streets, impervious surfaces, railroads, abandoned railroads, gas line ROWs, wetlands, and orchards over land cover data. Save as grid lc_mod_wetl.
14. Reclass modified land cover as follows (No Data = impassable for non-aerial wetland animals):

Code	**Description**	**Forest corridor impedance**
1	Water	20
2	Wetlands	10
3	Tree Canopy	20
4	Shrubland	35
5	Low Vegetation	50
6	Barren	250
7	Structures	No Data

8	Impervious Surfaces	1250
9	Impervious Roads	1250
10	Tree Canopy over Structures	No Data
11	Tree Canopy over Impervious Surfaces	1250
12	Tree Canopy over Impervious Roads	1250
No Data	Outside county	No Data

   a. Give major roads an impedance of No Data (impassable except under bridges)
   b. Grid name: imp_lc_wetl
11. Core wetlands and other relatively unimpaired wetlands
   a. Reclass as follows:

Wetland context	Divide impedance by:
Core wetlands	3
Other relatively unimpaired wetlands	2
Elsewhere	1

   b. Saved divisor grid as imp_wetclass.
12. Floodplains
   a. Reduce impedance of stream buffers and 1% floodplains, except for open water, mined land, and impervious surfaces.
   b. Reclassify to 2 = inside, 1 = outside. Save grid as imp_floodpln.
13. Proximity to buildings and roads: Same as for forest impedance
14. Set impedance of offshore water (>30 m from shore) to NoData, so the program does not select forest corridors across large rivers or bays. (Same as for forest impedance)
15. Protected lands: Same as for forest impedance
16. Combine
   a. Divide land cover impedance grid by wetland impedance (i.e., lower impedance in core wetlands), floodplain impedance (i.e., lower impedance in floodplains), offshore water (i.e., no corridors >30 m from shore), protected land (i.e., lower impedance in undeveloped protected land), and multiply by proximity to roads and buildings (higher impedance near roads and buildings).
   b. Set minimum impedance to 1 (cannot be less than this)

Wetland connectivity modeling

1. Created uncertainty grid for impedance layer, to be used with the new TMA version, such that each impedance value could vary but retain their rank order.

Impedance value	Min. value	Max. value	Fractional change to min.	Fractional change to max.	Smallest fractional change	Final min. value	Final max. value
1	1	1	0.000000	0.000000	0.0000	1	1
2	2	2	0.000000	0.000000	0.0000	2	2
3	3	3	0.000000	0.000000	0.0000	3	3
4	4	4	0.000000	0.000000	0.0000	4	4
5	5	5	0.000000	0.000000	0.0000	5	5
6	6	6	0.000000	0.000000	0.0000	6	6

7	7	7	0.000000	0.000000	0.0000	7	7
8	8	9	0.000000	0.125000	0.0000	8	8
10	9	11	0.100000	0.100000	0.1000	9	11
12	11	12	0.083333	0.000000	0.0000	12	12
15	14	16	0.066667	0.066667	0.0666	14	16
17	16	18	0.058824	0.058824	0.0588	16	18
20	19	22	0.050000	0.100000	0.0500	19	21
25	23	25	0.080000	0.000000	0.0000	25	25
26	26	28	0.000000	0.076923	0.0000	26	26
30	28	32	0.066667	0.066667	0.0666	28	32
35	33	36	0.057143	0.028571	0.0285	34	36
37	36	38	0.027027	0.027027	0.0270	36	38
40	39	45	0.025000	0.125000	0.0250	39	41
50	45	51	0.100000	0.020000	0.0200	49	51
52	51	56	0.019231	0.076923	0.0192	51	53
60	56	61	0.066667	0.016667	0.0166	59	61
70	65	72	0.071429	0.028571	0.0285	68	72
75	73	87	0.026667	0.160000	0.0266	73	77
100	88	102	0.120000	0.020000	0.0200	98	102
105	103	115	0.019048	0.095238	0.0190	103	107
125	115	137	0.080000	0.096000	0.0800	115	135
150	138	200	0.080000	0.333333	0.0800	138	162
250	200	312	0.200000	0.248000	0.2000	200	300
375	313	437	0.165333	0.165333	0.1653	313	437
500	438	625	0.124000	0.250000	0.1240	438	562
750	625	1000	0.166667	0.333333	0.1666	625	875
1250	1000	1875	0.200000	0.500000	0.2000	1000	1500
2500	1875	3125	0.250000	0.250000	0.2500	1875	3125
3750	3125	4375	0.166667	0.166667	0.1666	3125	4375

2. Run TMA
    a. Impedance X5
    b. maximum movement from start locations = 1,000,000
    c. minimum pathway threshold = 1
    d. maximum movement around pathway = 1000
        i. Equivalent to 40 m of bare earth or 200 m of grass (seems kind of high)
        ii. Through upland fields, width was ~50 m.
    e. analysis iterations = 50
    f. start location % = 1
    g. It took 3 hours, 40 minutes.
    h. Most (but not all) of the corridors were in floodplains.
3. Rank corridors

a. Use the “Remove Cores from corridors” tool to remove core areas and areas that do not connect at least two core areas (they may connect different parts of the same core area, or function as buffers, or, in some cases, act as dead ends.)
b. Reclassify all output values from above tool to 1
c. Multiply above corridors by movement potential grid (which combines area connected and impedance)
d. Make grid more normal (it is strongly right-skewed) by taking natural log (Ln)
e. Slice into ten equal-area increments (grid = for_corr_rank). 10 is best and 1 is worst. They are not truly equal-area because the program is imperfect.

Aquatic Corridors

1. All the core aquatic areas were already connected except for the West Branch Christiana River, which drains into Delaware; Mill Creek south of the Amtrak line; and a section of Little Elk Creek north of I-95. We selected the 100 year floodplain connecting the two latter stream reaches to the Elk River, and that was our aquatic corridor.
2. Save grid as aqua_corridor.

Combine corridors

1. Merge forest, wetland, and aquatic corridors (versions with value = 1 or NoData).
2. Remove core areas (output grid = ce_corridors; shapefile cecil_corridors_poly.shp).