Designing Sustainable Landscapes: HUC6 Terrestrial Core Tiers

A project of the University of Massachusetts Landscape Ecology Lab

Principals:

- Kevin McGarigal, Professor
- Brad Compton, Research Associate
- Ethan Plunkett, Research Associate
- Bill DeLuca, Research Associate
- Joanna Grand, Research Associate

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Reference:

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2017. Designing sustainable landscapes: HUC6 terrestrial core tiers. Report to the North Atlantic Conservation Cooperative, US Fish and Wildlife Service, Northeast Region.

General description

HUC6 terrestrial core tiers is one of the principal landscape conservation design (LCD) products, and it is best understood in the context of the full LCD process described in detail in the technical document on landscape design (McGarigal et al 2017). This particular product was initially developed for the Connecticut River watershed as part of the Connect the Connecticut project (www.connecttheconnecticut.org) — a collaborative partnership under the auspices of the North Atlantic Landscape Conservation Cooperative (NALCC), and subsequently developed for the entire Northeast region as part of the Nature's Network project (www.naturesnetwork.org).

HUC6 terrestrial core tiers represents a two-tiered, spatially-nested hierarchy of terrestrial **core areas** and **supporting landscapes** (**Fig. 1**). These tiers in combination with the HUC6 terrestrial core-connector network (see terrestrial core area network document, McGarigal et al 2017) and the aquatic core areas (see aquatic core areas document, McGarigal et al 2017) spatially represent a tiered ecological network for the Northeast region. This ecological network is designed to provide strategic guidance for conserving natural areas, and the fish, wildlife, and other components of biodiversity that they support within the Northeast.

Figure 1. Terrestrial core areas and their supporting landscape (terrestrial natural blocks) overlaid by secured lands on a background of the ecological systems map (no legend).

More specifically, this layer depicts the HUC6 terrestrial cores (as described in detail in terrestrial core area network document, McGarigal et al 2017), encompassing ~25% of the landscape, nested within their supporting landscapes (a.k.a. terrestrial natural blocks). HUC6 terrestrial cores are designed to target the very best, highest priority areas within each HUC6 watershed. HUC6 terrestrial natural blocks represent the largely undeveloped, road-bounded blocks containing the cores, in which development, agriculture (cropland and pasture), barren land, larger bodies of open water, and all road classes except tracks function as boundaries. HUC6 terrestrial natural blocks, as defined, are intended to represent more practical on-the-ground conservation units and provide the supporting landscape necessary to ensure maintenance of the ecological values of the HUC6 terrestrial cores in the future.
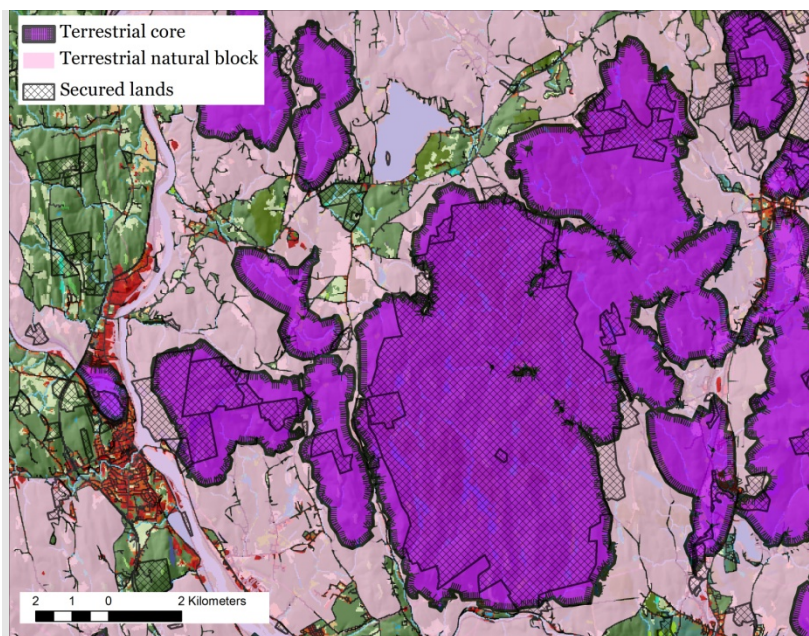
Use and interpretation of this layer

HUC6 terrestrial core tiers are intended to complement the HUC6 terrestrial core-connector network by providing an additional tier of ecologically important areas ("natural blocks") that can be used in combination with other sources of information to direct conservation action. HUC6 terrestrial natural blocks delineate more practical conservation units (i.e., largely undeveloped, round-bounded blocks) containing the HUC6 terrestrial cores. Thus, before using this product it is essential to understand the derivation, use

Figure 2. Probability of development through 2080 within the terrestrial cores (bold, feathered outlines), and the supporting landscapes (terrestrial natural blocks) on the DSLland cover background (without a legend).

and interpretation of the HUC6 terrestrial cores (see terrestrial core area network document, McGarigal et al 2017). The use of this product should be guided by the following considerations:

- It is important to acknowledge that the HUC6 terrestrial tier cores were derived from a model, and thus subject to the limitations of any model due to incomplete and imperfect data, and a limited understanding of the phenomenon being represented. In particular, the GIS data upon which this product was built are imperfect; they contain errors of both omission and commission. Consequently, there will be places where the model gets it wrong, not necessarily because the model itself is wrong, but rather because the input data are wrong. Thus, the terrestrial core tiers should be used and interpreted with caution and an appreciation for the limits of the available data and models. However, getting it wrong in some places should not undermine the utility of the product as a whole. As long as the model gets it right most of the time, it still can have great utility. Moreover, the model should lead to new insights that might at first seem counter-intuitive or inconsistent with limited observations, because the model is able to integrate a large amount of data over broad spatial scales in a consistent manner and thus provide a perspective not easily obtained via direct observation.

- This product can be used in combination with the probability of development layer (see probability of development document, McGarigal et al 2017) to identify places in the HUC6 terrestrial natural blocks that are relatively vulnerable to future development, and thus could represent priorities for land protection (**Fig. 2**).

- One of the main purposes of the HUC6 terrestrial natural blocks is to provide more practical conservation units, defined largely on the basis of road-bounded blocks;
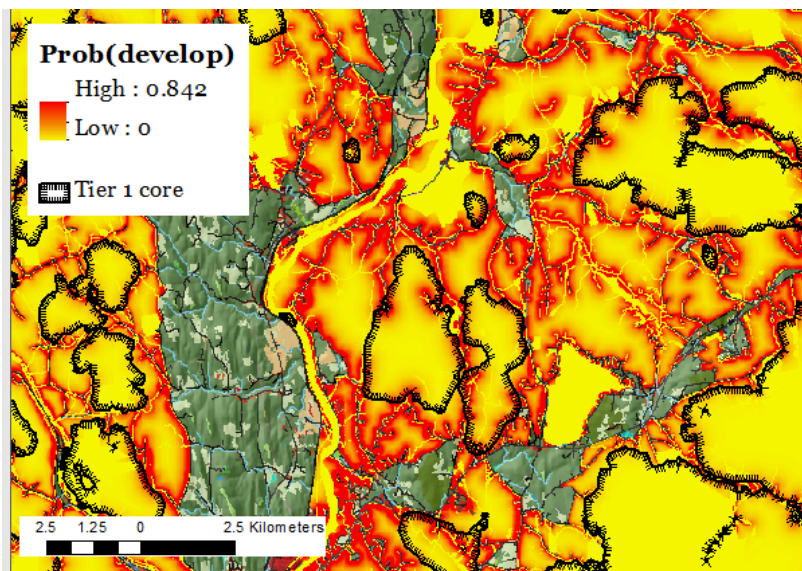
however, even these units do not necessarily correspond to ownership parcels, which are perhaps the ultimate practical conservation unit. Thus, the HUC6 terrestrial natural blocks merely to serve to focus attention on areas where practical conservation actions may support the integrity of the HUC6 terrestrial cores.

Derivation of this layer

The derivation of the HUC6 terrestrial core tiers was quite complex, as described in detail in the technical document on landscape design (McGarigal et al 2017). Here, we describe a highly abbreviated version of the process that is sufficient for the use and interpretation of this product.

1. Build terrestrial core areas

We built the HUC6 terrestrial core areas to meet several general criteria based on a two-stage strategy. In the first stage we selected core areas based solely on ecosystem-based considerations (i.e., without explicit consideration of individual representative species needs, but recognizing that ecosystem-derived cores contribute substantially towards meeting representative species' needs). In the second stage we extended the stage 1 core areas by building additional core areas based solely on meeting representative species needs (i.e., by adding on to the stage 1 cores in such a way as to ensure that collectively the core areas captured a minimum amount of habitat for each representative species). This process is summarized elsewhere (see terrestrial core area network document, McGarigal et al 2017) and described in detail in the technical document on landscape design referenced ealier. Overall, in the ecosystem-based first stage we captured ~20% of the landscape, and in the species-based second stage we captured an additional ~5% of the landscape to encompass a total of ~25% of the landscape in the cores.

2. Build terrestrial natural blocks (supporting landscapes)

After building the HUC6 terrestrial core areas, we built HUC6 terrestrial natural blocks. The purpose of these "natural blocks" is two-fold: 1) to recognize the area surrounding the cores as potentially important to the maintenance of the ecological value in the core areas (i.e., supporting landscape), and 2) to identify more practical conservation units for the focus of conservation actions. While there are many possibilities for identifying and delineating supporting landscapes, here we defined them as largely undeveloped, road-bounded blocks containing the core areas. Specifically, we defined our natural blocks as areas bounded by motorway, primary road, secondary road, tertiary, and local road, development, agriculture (cropland and pasture), barren land, and larger open-water bodies. Thus, these natural blocks, like the cores, can (and do) contain tracks. Any natural block containing any part of a terrestrial core was identified as a supporting landscape unit. Thus, the terrestrial cores and their surrounding natural blocks maintain a spatially-nested hierarchy.

GIS metadata

This data product is distributed in two forms that can be found at McGarigal et al (2017):

- **geoTIFFf raster** (30 m cells) — cell values:

1 = terrestrial ecosystem core

2 = terrestrial natural block (supporting landscape)

- **ESRI ArcGIS shapefile** (polygons) – including the attributes listed below for each (multi-part) polygon. Note, the terrestrial natural blocks may be multi-parted, consisting of several disjunct polygons surrounding one or more embedded terrestrial core polygons. For convenience, these multi-part polygons have been dissolved so that the attribute table contains a single row for each natural block associated with one or more cores. For more detailed information about each of the terrestrial cores see the tCoreNet product:

  - FID = ESRI assigned unique number (which we do not use) for each polygon.

  - Shape = ESRI assigned feature type = "polygon."

  - type = indicator designating the polygon as: "t1core" or "natural block."

  - typeCode = 1 for "t1core" and 2 for "natural block."

  - coreID = each terrestrial core has a unique ID > 1; the terrestrial natural blocks (supporting landscape) all has an ID = 1.

  - areaCount = size of the core area in number of cells (30×30 m); this includes any developed cells.

  - areaHa = size of the core area in hectares; this includes any developed area.

  - rareCom = percentage of the core comprised of S1-S3 rare communities as defined and mapped by the state Heritage Programs.

  - system1, system2, system3 = The top one to three terrestrial or wetland ecological systems for which the core is particularly important based on index1 described below. For these systems the cumulative ecological integrity of the system within the core is greater than expected (from a statistical perspective) given its distribution across the entire core area network (i.e., index1>1). A blank indicates that no additional ecosystem had an index1>1. Note, the systems listed here reflect the systems for which the core is especially important, but are not necessarily the most abundant systems in the core. A complete listing of the relative importance of the core for all ecological systems, including the relative abundance of systems within the core, is available separately in the Ecosystem table described below.

  - species1, species2, species3 = The top one to three representative species for which the core is particularly important based on index1 described below. For these species the cumulative landscape capability index within the core is greater than expected (from a statistical perspective) given its distribution across the entire core area network (i.e., index1>1). A blank indicates that no additional species had an index1>1. Note, the species listed here reflect the species for which the core is especially important, but are not necessarily the species with the highest total landscape capability in the core. A complete listing of the relative importance of the core for all species, including the total landscape capability in the core attributed to each species (index2, see below), is available in the Species table described below.

Detailed core area composition statistics

Detailed composition statistics are available for each individual core and are divided into ecosystems and species tables (see files in the tCoreStats folder corresponding to the coreID field in the shapefile). In these tables, there are four different indices computed (and their corresponding ranks) that represent different ways of understanding the relative importance of the individual cores to specific ecosystems or species. In all cases, larger values indicate greater importance.

Ecosystem table:

- coreID = unique number assigned to each core.

- systemName = name of the ecosystem as given in the dslLand map (developed classes are not included).

- areaCount = number of cells of the corresponding system in the core. Note, because developed classes were excluded, the sum of areaCount across systems in the core as listed in this table may be less than the core area size as given in the layer attributes.

- areaHa = hectares of the corresponding system in the core.

- index1 = index of importance of the core for the corresponding system, based on deviation of the observed sum of the selection index for the system from its expected value, which is based on the size of the core and the system's average selection index and proportional representation across all cores. The index ranges from 0 to unbounded on the upper end; <1 indicates observed value less than expected, whereas >1 indicates the opposite.

- index1Rank = rank of index1 (1 = max index1).

- index2 = index of importance of the core for the corresponding system, defined as the percentage of the core's total selection index comprised of the corresponding system. The index ranges from 0-100.

- index2Rank = rank of index2 (1 = max index2).

- index3 = index of importance of the core for the corresponding system, defined as the percentage of the system's total selection index across all cores found in the focal core. The index ranges from 0-100.

- index3Rank = rank of index3 (1 = max index3).

- index4 = index of importance of the core for the corresponding system, defined as the difference between the system's average selection index in the focal core and its average selection index across all cores. The index ranges from -1 to 1; negative values indicate an average selection index in the focal core less than its average across all cores, whereas positive values indicate the opposite.

- index4Rank = rank of index4 (1 = max index4).

Species table:

- coreID = unique number assigned to each core.

- speciesName = name of the representative species.

- sumLC = sum of the current landscape capability (LC) index for corresponding species.

- index1 = index of importance of the core for the corresponding species, based on deviation of the observed sum of the LC index for the species from its expected value, which is based on the size of the core and the species' average LC index across all cores. The index ranges from 0 to unbounded on the upper end; <1 indicates observed value less than expected, whereas >1 indicates the opposite.

- index1Rank = rank of index1 (1 = max index1).

- index2 = index of importance of the core for the corresponding species, defined as the percentage of the core's total LC index comprised of the corresponding species. The index ranges from 0-100.

- index2Rank = rank of index2 (1 = max index2).

- index3 = index of importance of the core for the corresponding species, defined as the percentage of the species' total LC index across all cores found in the focal core. The index ranges from 0-100.

- index3Rank = rank of index3 (1 = max index3).

- index4 = index of importance of the core for the corresponding species, defined as the difference between the species' average LC index in the focal core and its average LC index across all cores. The index ranges from -1 to 1; negative values indicate an average LC index in the focal core less than its average across all cores, whereas positive values indicate the opposite.

- index4Rank = rank of index4 (1 = max index4).

Literature Cited

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2017. Designing sustainable landscapes products, including technical documentation and data products. https://scholarworks.umass.edu/designing_sustainable_landscapes/