Terrestrial Natural Community Health Indices: Methods Development and Implementation Protocol

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Mike Leahy, Missouri Dept. of Conservation and Kyle Steele, Mark Twain NF

Introduction

Natural resource managers need tools to rapidly assess natural community condition that go beyond professional experience and instincts. Increasingly state and federal natural resource agencies are asking for effectiveness monitoring rather than implementation monitoring only. We are being asked to not just report on the sum of acres treated with a management prescription but the more difficult question of "Is the trend in the particular resource treated heading in the direction we want?"

The concepts and methods of ecological integrity assessment have been in development by conservation biologists for over a decade now (Faber-Langendoen et al. 2019) with most recent efforts including developing metrics to track the restoration of southern open pine ecosystems (Nordman and White 2018). While monitoring is a critical component of strategic habitat conservation it often doesn't occur because intensive, plot-based monitoring is costly and time-consuming. Detailed vegetation monitoring also requires a high degree of botanical skill which is in increasingly shorter supply.

In 2014, the Missouri Department of Conservation (MDC) began developing terrestrial natural community health indices as a tool to both assess natural community restoration potential and more importantly to gauge restoration and management success. Informed by the work of ecological integrity assessments developed by NatureServe staff (Faber-Langendoen et al. 2016) and the Minnesota wetland rapid floristic quality assessment tool (Bourdaghs 2014) we define a natural community health index (CHI) as: a methodology to assess and monitor the health or ecological integrity of terrestrial natural community types based on four components:

- Landscape context and size of the natural community
- Composition of the plant and animal species
- Structure of vegetation and biomass
- Degrading factors (such as invasive species, soil disturbance, etc.)

Below we detail the methods used to develop CHIs and how they are currently implemented in the field.

Methods

The first step in the development of a CHI is to determine the target natural community type(s) that will be assessed. For our base classification we utilize the *Terrestrial Natural Communities of Missouri* (Nelson 2010) and Ecological Site Descriptions (ESDs; NRCS 2020) as the primary sources for information on characteristic species and vegetation structure to set as target conditions for restored communities. Ecological Site mapping by Natural Resources

Conservation Service and U.S. Forest Service provide the base map for implementation of CHI on the ground (Winthers et al. 2005).

Each CHI is composed of four modules (Appendix 1):1) landscape context (10% of score), 2) vegetation characteristics (80% of score), 3) animal species factors (10% of score), and 4) negative disturbance factors (negative points). The selection of metrics, indicator species, and point assignments within each of these categories are derived from a process of peer review and collaboration amongst expert biologists in Missouri (including review from the Missouri Natural Areas Committee). Following initial development of the CHI metrics, two rounds of field testing are completed.

Box 1 shows the CHI development process in short form. In many cases multiple natural community and ecological site types are lumped together in one CHI to avoid duplicative forms. For example, the Ozark Acidic Woodland Pine and Pine-Oak Subtype CHI (Appendix 1) includes several like ecological sites that have similar reference plant community compositional and structural conditions, that vary based on levels of productivity and physical setting (i.e., differences in landform, soils, geology, etc.; see Appendix 1).

Within the vegetation module we utilize the concepts of floristic quality analysis (FQA) and associated conservation value rankings (C-values; Spyreas 2019). Two species groups are identified: "matrix" species and "conservative" species. Matrix species are defined as those having C-values between 4 and 6, with conservative species having C-values between 7 and 10, respectively. For scoring, remnant-dependent conservative species are more heavily weighted due to their high conservation value. Flax-leaved aster (*Ionactis linariifolius*) is an example of a conservative species in the Ozark Acidic Woodland Pine and Pine-Oak Subtype CHI. In comparison, matrix species, which are the backbone of a natural community's ground cover, are given slightly lower scores. Big bluestem (*Andropogon gerardii*) is an example of a matrix species for the Tallgrass Prairie CHI.

During the plant species selection process, priority is given to those that are relatively easy to identify and are present throughout large portions of the growing season. Because this is a rapid field survey that can be conducted by biologists without a comprehensive knowledge of the state's flora, we selected species that could be identified in the field without extensive keying. This also allows the CHI to be conducted by a larger cadre of biologists, with appropriate training. Which translates into greater monitoring coverage. Thus, careful selection of species that effectively indicate broader natural community health is critical.

Implementation

Office Preparation

To conduct a CHI, begin with the exercises that can be completed in the office. First, delineate sampling units. CHI sampling units are variably defined based on the community/ecological site type and management history, similar to the concept of a "forest stand". Unit boundaries are defined using aerial imagery, topographic maps, and ecological site maps. In cases where ecological site or Terrestrial Ecological Unit Inventory (TEUI) mapping is not available, soils and geology maps in concert with information on the management and land use history of the

area can be used. Sampling units vary in size from 40 to 80 acres for typical Ozark woodlands. Sampling units for glade and prairie communities are often smaller.

Identify the boundaries of the sampling unit in ArcGIS. Sampling units should be based on ecological site groups/natural community types (ecological units) first and then management history second. For example, if an intermediate harvest boundary straddles two ecological site groups/natural community types it is recommended to split the units into two rather than lump two disparate ecological units into one sampling unit because they both had the same management treatment. Likewise, if an ecological unit has two very different management regimes it is recommended that the unit be split into two sampling units.

Box 1 – CHI Development Methods

1) Establish species lists, key metrics of interest, and point values to be documented for that particular CHI. Do this cooperatively and/or with peer review from field experts.

2) Complete first round of field testing on a range of 15 to 25 sites. Incorporate a variety of site histories and management regimes.

3) Summarize data, validate, and revise items from item #1 above.

4) Complete second round of field testing on at least 20 sites using same criteria as #2 above.

5) Summarize data, validate, and revise items from item #1 and #3 above.

6) Calibrate the CHI protocol with high intensity field data (e.g., FQA quadrats, data from local research projects, etc.).

7) Finalize species lists, key metrics of interest, and point values; publish field protocol and support products (such as data entry, databases, botanical manuals, etc.).

Sampling units should be as homogeneous as possible in terms of ecological unit and land-use and management history. For wooded communities, standard forestry variable radius prism plots are part of the sampling frame. Establish these sampling plots randomly and be sure to cover a representative array of topographic positions within the sampling unit. The points must be over 200 ft apart and include a minimum number of plots depending on the size of the sampling unit (Table 1). The ideal size of a sampling unit is 41 to 99 acres, which requires 7 plots.

Table 1 Prism Plot Sampling Intensity

Acres	# Prism Plots
10	2
11-40	4
41-99	7
100	10
>100	1 per every 10 acres

After delineating sampling units, proceed to filling out the metrics for the first module, landscape context, that can be answered in the office (e.g., % of surrounding landscape in native vegetation). Sample units and prism plots can then be uploaded onto devices for use in the field.

Field Work

With CHI sample units and prism plots loaded on devices and either paper or electronic CHI forms (in development) and field maps, head to the field along with the other gear needed (see Appendix 2, field gear checklist).

Once at the sampling unit, conduct a timed meander navigating to the different prism plots for wooded communities. For grassland communities just conduct a timed meander crossing a representative swath of the unit. Don't spend more than an hour sampling a 40-acre sampling unit. Aim to spend under 1 minute and 30 seconds per acre. The times listed here are ideal, but will vary depending on individual skillset and training. While walking you will be looking for the matrix and conservative plant species as well as making mental notes on the different vegetation and disturbance metrics.

While traversing the unit you will be checking off the ground cover indicator species within three timed intervals. Based on previous occupancy analyses (Stanton 2021) most species are encountered within 45 minutes for woodlands and 30 minutes for diverse prairies. Using the CHI example in Appendix 1, sampling would occur within three fifteen-minute timed intervals. At each plot the watch is stopped while you conduct the prism plot. When surveying for the ground cover indicator species you are sampling without replacement. That is, you will be looking for the same set of species individually in each of the timed intervals; a species counted in time interval one needs to be looked for again in intervals two and three.

At the prism plot points you will measure all "in" trees with a BAF 10 prism that are >5 inches d.b.h. Also, all standing dead snags >5 inches will be recorded. You'll measure the canopy cover in the four cardinal directions with a spherical canopy densiometer. Mid-way through the timed meander take a break and tentatively assign point values for all of the metrics in sections two and four that don't require calculations based on what you've observed thus far.

During the CHI, collection of animal data is preferred but optional. Because of the modular nature of the CHI and the difficulty in sampling animal species concurrently with the vegetation; the landscape context, vegetation characteristics and negative disturbance factors are often sampled independently of the animal species module.

If you are planning on collecting animal data, there are some additional considerations. First, to collect the bird data, you need to traverse the site during the breeding bird season safe dates (USGS 2020), generally between mid-May and late June in Missouri. Second, the birds are best observed from sunrise to around 10 am. Birds are not difficult to measure but these constraints for breeding bird data limit the timeframe for collecting these data. Unfortunately, collection of herptile data is difficult in most communities except for glades without more intensive sampling techniques (e.g., cover boards, drift fences, multiple visits, etc.). Most herptile data collected are often anecdotal observations. However, these can be utilized. Any animal records observed within the sampling unit as per the metrics within the past 5 years can be utilized in filling out the CHI animal module.

Once done with the timed meander and collection of prism plots (if needed), take a break and summarize what you've observed in the second half of the survey, comparing it to the first half notes. Decide on what is representative of the whole unit. Complete filling out the metrics.

Office Work Analysis
Once back in the office either download the electronically collected CHI data or enter the data manually. If surveying a wooded community type then proceed to the overstory calculations to fill out metrics 2a-2c. Last, determine the frequency of occurrence for each of the ground cover indicator species. Which species occurred in zero, one, two or three of the sampling periods?

It is anticipated that in the future data can be downloaded and summarized with immediate results including the CHI score and other values resource managers would find useful (e.g., % stocking, number of species found, etc.).

Appendix 1 – Example CHI: Ozark Acidic Woodland Pine and Pine-Oak Subtype CHI
Appendix 2 – Field Gear Checklist

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