Assessing the Health of Your Forest

Using standard forest metrics to give your forest a health check

Photo Courtesy of The Nature Conservancy/Emily Clegg

Two Hearted River Forest Reserve, Luce County - We are walking through an evenly spaced sugar maple forest in central Luce County. The maples are all about the same age and size. While the forest doesn't seem to be diseased, and the trees are not dying or falling down, we are concerned about the lack of diversity both in size and age of the maples as well as a lack of other tree species. What would happen if there was a disease that hit sugar maple? We would have no forest at all.

We wish there was a way to determine how healthy the forest is, using some standard measure of forest health. Is the lack of diversity in size and age something to be concerned about? Should management change in some way?

The Nature Conservancy was faced with this issue within its Luce County ownership in Michigan. The Conservancy owns and manages 24,000 acres in Luce County. The property is enrolled in the commercial forest act and is Forest Stewardship Council (FSC) certified. However the forest was noticeably uniform in terms of tree species and the number of species.

Nature Conservancy staff began to think of the following analogy – When you visit your doctor, and you talk about your health, she measures your weight, blood pressure and pulse and asks about family history and your history and uses that information to assess your health and make recommendations to improve it. Conservancy staff want the same thing for forests; what are the metrics, what do they mean, how does that information inform future choices and actions of forest managers.

"Through routine measurement of these KEAs, the Conservancy maintains a robust and concise diagnostic scorecard that rates the quality of forests under our management."

Using standard forest metrics collected and measured by all foresters, the Conservancy developed a set of Key Ecological Attributes (KEAs). These KEAs are critical components of a forest related to its life history, physical or biological processes, composition and/ or structure. KEAs are further defined and measured through specific *indicators. Indicator ratings* define thresholds of Very Good, Good, Fair and Poor condition

for each KEA; and are scaled by expected ranges of variation (as determined by literature reviews, standard Forest Inventory Data and expert opinions). These KEAs and their indicators were selected by Conservancy staff as the most important and logistically-feasible forest attributes to use in measurement of forest composition, structure and regeneration. Through routine measurement of these KEAs, the Conservancy maintains a robust and concise diagnostic scorecard that rates the quality of forests under our management. In most cases, KEA indicators will be measured in the field concurrent with 10-year commercial timber inventories. As a result, tracking of forest health and economic productivity trends will be on a decade by decade basis.

Below are details and more information can be obtained from The Nature Conservancy in Michigan.

The Summary of KEAs Collected from the Forest

KEA	Metric	Description
KEA 1	Total Stocking	Function of basal area and trees per acre, expressed in percentage of "available" stocking
KEA 2	Acceptable Growing Stock	Similar to KEA 1 with "acceptable" stems per USFS guidelines
KEA 3	Tree Species Diversity (Richness)	Total number of overstory tree species in a given stand
KEA 4	Tree Species Evenness (Richness Distribution)	The relative abundance of all species found in the stand
KEA 5	Large Live Trees	Measure of trees greater than 19" DBH per acre
KEA 6	Large Snags	Measure of standing snags greater than 10" DBH per acre
KEA 7	Large Coarse Woody Debris	Measure of a downed woody debris greater than 13" diameter expressed in ft^3 per acre
KEA 8	Established Regeneration	Total number of seedlings/saplings greater than 1" DBH per acre
KEA 9	Desirable Seedlings	Total percentage of established regeneration determined "desirable"*

See the sheet below for an actual read out of a stand. Note that KEAs currently are for Northern Hardwood Stands.

Key Ecological Attributes (KEA) Rating System adjusted to Northern Hardwoods

	Composition				Structure				Regeneration		
RAT-ING	% Stock-ing	AG S	Diver-sity	Even-ness	live>16"	live>19"	snags>/= 10"	CWD cu.ft. >13"dia.	seed-lings/ acre	% de-sirable seed-lings	Brow se Index
POOR	< 40 and > 100	<40	<3	0 to 0.6	0 to 3	<3	0 to 2	0 to 100	0 to 100	<25	4 or 5
FAIR	41 to 60	41 to 53	3 to 6	0.61to 0.7	4 to 8	4 to 5	3 to 5	101 to 500	101 to 250	26 to 54	3
GOOD	61 to 79	54 to 69	7 to 9	0.71 to 0.8	9 to 16	6 to 12	6 to 8	501 to 999	251 to 400	55 to 74	2
V. GOOD	80 to 100	70+	10+	0.81+	17+	13+	9+	>1000	400+	>75	1

These attributes are common forestry concepts that are defined below and have references cited. The values were adapted to reflect local conditions since many of the referenced attributes were for more diverse (milder climate) forests. Available literature, as well as local expert opinion, was used to tweak the ranges.

Definitions:

% Stocking: Percent stocking measures stand density using basal area per acre and trees per acre. Gingrich (1967) developed stocking standards for northern hardwood stands to determine how completely a stand is occupying its area and how much of the stand may be removed without wasting growing space. Percent stocking is useful in the broad sense of evaluating optimal stand density and site utilization.

AGS: USFS Northeast Research Center definition of AGS includes desirable species that contain at least one grade 3 log or will in the future, likely to persist another 15 years, while Unacceptable Growing Stock (UGS) do not contain at least one grade 3 or better log and never will, or are not likely to persist another 15 years.

Diversity: Average number of tree species per acre (stems > 5" dbh).

Evenness: Evenness is an index on a scale from 0-1. The closer the value is to 1, the more evenly distributed the tree species are throughout the stand.

J' (evenness)=H'/H'max

H'=-∑(pilnpi) pi=ni/N

ni=# individuals in species i

N=total # individuals

ln=natural logarithm

H'max=lnS S=total number of species

References for the KEA's:

Stocking

Roach BA, Gingrich SF. 1968. Even-Aged Silviculture for Upland Central Hardwoods. Agriculture Handbook No. 355 :1-39, illus. Robison SA, McCarthy BC. 2000

Acceptable Growing Stock (AGS)

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Tree Species Diversity (Richness)

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Tree Species Evenness (Richness Distribution)

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Large Live Trees

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Large Snags

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Large Coarse Woody Debris

McGee G, Leopold D, and Nyland R. 1999**.** Structural Characteristics of Old-Growth, Maturing, and Partially Cut Northern Hardwood Forests. Ecological Society of America.

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Established Seedlings

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Read Out from Actual Data

Date	3/6/12
Cruiser	mdf

Pulp Sample Err.	18%
Saw Sample Err.	38%
Plot Acres	114
Full Plots	19

Covertype Code	NH
Size Density	8
Op Season	All
Access	1

Stand By Covergroup

Select Stand	SpottedHrd_UB

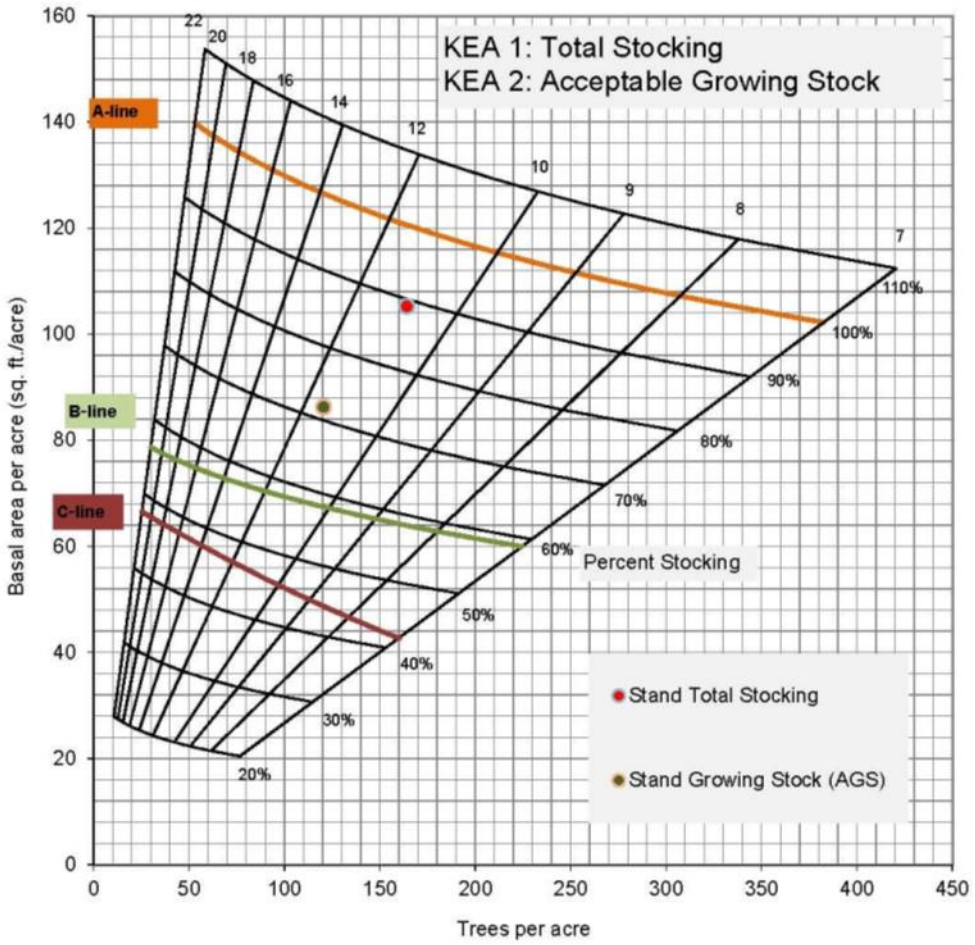
Row Labels	Values Stand BA	Stand TPA	TPA Acceptable	TPA unacceptable
Hardwood	105.3	164	120	44
Grand Total	**105.3**	**164**	**120**	**44**

KEA 1: Total Stocking

- Poor <40% and >100%
- Fair 41-60%
- Good 61-79%
- Very Good 80-100%

KEA 2: AGS

- Poor <40%
- Fair 41-53%
- Good 54-69%
- Very Good > 70%



KEA 3: Tree Species Diversity (Richness)

Indicator: Average number of tree species per stand (stems > 5" dbh)

- Poor <3
- Fair 3-6
- Good 7-9
- Very Good >10

Stand Richness	3.00

KEA 4: Tree Species Evenness (Richness Distribution)

Indicator: Distribution of tree species diversity across forest stand (stems > 5" dbh)

- Poor 0-0.6 — 0-0.6
- Fair 0.61-0.7 — 0.61-0.7
- Good 0.71-0.8 — 0.71-0.8
- Very Good > 0.81 — >0.81

$$J' = \frac{H'}{H'_{max}}$$

Stand Evenness	0.30

KEA 5: Large Live Trees

Indicator: Average number of live trees per acre (by stand)

>16" dbh

- Poor <= 3
- Fair 4-8
- Good 9-16
- Very Good >17

>19" dbh

- Poor <=3
- Fair 3-5
- Good 6-12
- Very Good >13

TPA >= 16" DBH	18.6

TPA >= 19" DBH	4.6

KEA 6: Large Snags

Indicator: Average number of snags per acre (by stand) >10" dbh

- Poor 0-2
- Fair 3-5
- Good 6-8
- Very Good >9

TPA Large Snags	0.5

KEA 7: Large Coarse Woody Debris

Indicator: Cu.ft. volume per acre; all pieces >13" diameter (large end) and 5' min. length

- Poor <100
- Fair 101-500
- Good 501-999
- Very Good >1000

CWD Ft^3	31.4

Regeneration

KEA 8: Established Seedlings

Indicator: total number all established seedlings per acre 1"-4.5"

- Poor 0-100
- Fair 101-250
- Good 251-400
- Very Good >400

Seedlings/Acre	136.8

KEA 9: Desirable Established Seedlings

Indicator: Ratio of total established seedlings to total desired established seedlings per acre.

- Poor <25%
- Fair 26-54%
- Good 55-74%
- Very Good >75%

Desireable Seedl./Acre	96.2%