

## **Discussion for Monitoring Topic 1**

**Planning Rule Topic:** 1. THE STATUS OF SELECT WATERSHED CONDITIONS. 36 CFR 219.12(a)(5)(i)

**Forest Monitoring Question:** What is the status of select watershed conditions?

**Indicator-** Watershed Condition Class Score (12 indicators) - 24 Attributes Associated With 12 Core National Watershed Condition Indicators.

### **Discussion:**

In response to a 2006 Office of Management and Budget (OMB) review of the Forest Service Watershed Program, the Forest Service conscripted a team of experts to develop a nationally consistent, science-based approach to classifying the condition of all National Forest System (NFS) watersheds (Forest Service 2011). This team was also tasked with development of performance measures for documenting watershed restoration. The team evaluated different approaches for classifying watersheds (Forest Service 2007) and ultimately developed the Watershed Condition Classification (WCC) system (described in Forest Service 2011).

Among multiple other objectives (described in Forest Service 2011), the WCC was specifically designed to: 1) provide a consistent defensible methodology for assessing the condition of all NFS watersheds (watersheds with at least 10% NFS lands was considered to be "NFS"); 2) be quantitative to the extent feasible; 4) be implementable within existing budgets; and 5) include resource areas and activities that have been shown to influence watershed condition. The 6th-level watershed (see Seaber et. al 1987) was selected as the appropriate watershed scale on which to implement the WCC. In 2010/2011 all National Forests, including the Huron-Manistee National Forests', were required to apply the WCC system to document current status of all "NFS" 6th-level watersheds.

The Watershed Condition Class Score, identified here as indicator for Planning Rule Topic 1, is a direct outcome of the implementation of the Watershed Condition Classification (WCC) system. As described above, the WCC system is a nationally developed methodology for reporting watershed condition that integrates current scientific understanding of watershed function and professional judgement into a core set of 12 watershed condition indicators that can be assessed with existing budgets and staffing levels (Forest Service 2011). The Forest Service in general and Huron-Manistee National Forests specifically, have already invested substantially in the WCC and it makes sense to leverage the results of this investment to address the monitoring question, "*What is the status of select watershed conditions?*"

See Forest Service. 2011. Watershed Condition Classification Technical Guide. FS-978 for full listing of indicators (available at [http://www.fs.fed.us/biology/watershed/condition\\_framework.html](http://www.fs.fed.us/biology/watershed/condition_framework.html) at the time of this submittal). All Huron\_Manistee National Forest Watersheds would be included in each monitoring cycle; which will be once every 10 years.

### **References**

Forest Service. 2011. Watershed Condition Classification Technical Guide. FS-978. July 2011. 41p.

Forest Service. 2011. Watershed Condition Framework. FS-977. May 2011. 34p.

U.S. Geological Survey. 1987. Hydrologic Unit Maps. U.S. Geological Survey water-Supply Paper 2294. 63p.

## Discussion for Monitoring Topic 2

**Planning Rule Topic:** 2. THE STATUS OF SELECT ECOLOGICAL CONDITIONS INCLUDING KEY CHARACTERISTICS OF TERRESTRIAL AND AQUATIC ECOSYSTEMS. 36 CFR 219.12(a)(5)(ii)

**Forest Monitoring Question:** How much early successional aspen habitat is present on the HMNFs?

**Indicator-** Acres of aspen in the 0-9 age class, and acres of aspen sold in timber sales.

### Discussion:

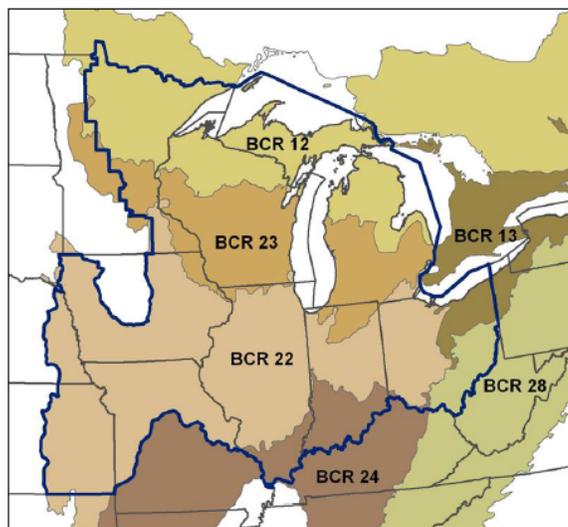
The Huron-Manistee National Forests (HMNFs) are within the Upper Mississippi River and Great Lakes Region Joint Venture (JV) Region (Figure 1). The *Landbird Habitat Conservation Strategy* (2007) for this region identifies the associated Bird Conservation Regions (BCRs) within the JV region. This strategy attempts “to ‘step-down’ continental and ecoregional landbird priorities to the Joint Venture (JV) region and to smaller manageable scales within the region, providing wildlife managers guidance in designing and managing landscapes with greater value to birds.” The HMNFs fall within two bird conservation regions – BCR 12 and 23.

A second document, the *Michigan BCR 12 – Assessment Summary* (2010), provides “general landscape trends based on the National Land Cover Database (2001 to 2006), comparisons between JV bird habitat objectives and cover type availability, and broad implications of land-cover trends to bird habitat conservation.”

In the past 45 years, the golden-winged warbler population has experienced one of the steepest declines of any American songbird, primarily due to a loss of breeding habitat (Roth et. al. 2012), and 86% of the world’s population occurs in the Upper Mississippi River and Great Lakes Region JV Region (Potter et.al. 2007). The *Landbird Habitat Conservation Strategy* calls for restoring 98 km<sup>2</sup> of golden-winged warbler habitat in Michigan.

Golden-winged warblers rely on early successional aspen stands for breeding habitat. Therefore, the status of early successional aspen was selected for monitoring because it is critical in the life cycle of the golden-winged warbler. The HMNF Forest Plan projected clearcutting 24,100 and 28,000 acres of aspen in decades 1 and 2, respectively.

Figure 1. Boundaries of the Upper Mississippi River and Great Lakes Joint Venture (JV) region (blue line) and associated Bird Conservation Regions (BCRs) from the North American Bird Conservation Initiative. The JV region largely consists of BCRs 22 (Eastern Tallgrass Prairie), 23 (Prairie Hardwood Transition), and the U.S. portion of 12 (35%, Boreal Hardwood Transition). Portions of BCR 24 (19%, Central Hardwoods), 13 (11%, Lower Great Lakes / St. Lawrence Plain), and 28 (7%, Appalachian Mountains) also are within the JV boundary.



According to the *Michigan BCR 12 – Assessment Summary*, “The area of available shrubland appears substantially lower than habitat objectives for shrubland birds and restoration of this cover type remains a priority. JV partner collaboration with foresters and the timber industry can result in strategic cutting operations providing a commercial means to create shrub and young-growth forest while being mindful of fragmentation concerns.”

Early successional aspen also provides habitat for other species of importance on the HMNFs, including American woodcock, ruffed grouse, whip-poor-will and white-tailed deer.

Acres of aspen in the 0-9 age class on the HMNFs are a good indicator of the amount of breeding habitat available to golden-winged warblers at any time. Age class tables and graphs are easily generated and efficiently summarize data that indicates the level of early successional aspen management that has occurred on the HMNFs. However, if the level of aspen offer for sale changes, the changes may not be reflected in the data for a number of years due to the length of timber sale contracts. Therefore, acres of aspen sold will also be monitored to better predict future changes in the amount of early successional aspen habitat.

## References

Pierce, R.L, B.M. Kahler, and G.J. Soulliere. 2014. State X BCR Assessment: Michigan 12 – Boreal Hardwood Transition. Upper Mississippi River and Great Lakes Region Joint Venture, U.S. Fish and Wildlife Service, Bloomington, MN, USA.

Potter, B. A., G. J. Soulliere, D. N. Ewert, M. G. Knutson, W. E. Thogmartin, J. S. Castrale, and M. J. Roell. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, MN. 124pp.

Roth, A.M., R.W. Rohrbaugh, T. Will, and D.A. Buehler, editors. 2012. Golden-winged Warbler Status Review and Conservation Plan. [www.gwwa.org/](http://www.gwwa.org/)

USDA Forest Service. (2006). Land and Resource Management Plan: Huron-Manistee National Forests. Cadillac, MI: USDA Forest Service. <http://www.fs.usda.gov/land/hmnf/landmanagement>

### **Discussion for Monitoring Topic 3**

**Planning Rule Topic:** 3. THE STATUS OF FOCAL SPECIES TO ASSESS THE ECOLOGICAL CONDITIONS REQUIRED UNDER 219.9. 36 CFR 219.12(a)(5)(iii)

**Forest Monitoring Question:** Does the HMNFs have adequate acres of trembling and bigtooth aspen in early successional habitat?

**Indicator-** Acres of aspen in the 0-9 age class, and acres of aspen sold in timber sales.

#### **Discussion:**

A number of wildlife species thrive when early successional aspen habitat is present in the landscape, including ruffed grouse, American woodcock, white-tailed deer and golden-winged warbler. Ruffed grouse, American woodcock and white-tailed deer are popular game species in Michigan. According to the Forest Plan, management of aspen is also key in providing high volumes of timber products in Management Prescription Areas 2.1, 4.2, 4.3, 4.4, 6.2, & 8.4. 45.2 and 54.2 million cubic feet of timber were projected to be harvest in decades 1 and 2, respectively.

Even-aged system of management (clearcutting) is recommended for growing and reproducing aspen (USDA 2006).

Acres of aspen in the 0-9 age class on the HMNFs are a good indicator of the amount of early succession aspen habitat (structure and composition) available present in the landscape at any time. Age class tables and graphs are easily generated and efficiently summarize data that indicates the level of early successional aspen management that has occurred on the HMNFs. However, if the level of aspen offer for sale changes, the changes may not be reflected in the data for a number of years due to the length of timber sale contracts. Therefore, acres of aspen sold will also be monitored to better predict future changes in the amount of early successional aspen habitat.

#### **References**

Dessecker, D.R. G.W. Norman, S.J. Williamson. 2006. Ruffed Grouse Conservation Plan. Association of Fish & Wildlife Agencies, Resident Game Bird Working Group.

Kelley, J., S. Williamson, T.R. Cooper. 2008. American Woodcock Conservation Plan. A Summary of and Recommendations for Woodcock Conservation in North America. Wildlife Management Institute, Washington, D.C. 168 pp.

Michigan Department of Natural Resources. 2009. A Review of Deer Management in Michigan. Michigan Department of Natural Resources, Lansing, MI. 50 pp.

Michigan Department of Natural Resources. 2010. Michigan Deer Management Plan. Michigan Department of Natural Resources, Lansing, MI. 50 pp.

Pierce, R.L, B.M. Kahler, and G.J. Soulliere. 2014. State X BCR Assessment: Michigan 12 – Boreal Hardwood Transition. Upper Mississippi River and Great Lakes Region Joint Venture, U.S. Fish and Wildlife Service, Bloomington, MN, USA.

Potter, B. A., G. J. Soulliere, D. N. Ewert, M. G. Knutson, W. E. Thogmartin, J. S. Castrale, and M. J. Roell. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, MN. 124pp.

Roth, A.M., R.W. Rohrbaugh, T. Will, and D.A. Buehler, editors. 2012. Golden-winged Warbler Status Review and Conservation Plan. [www.gwwa.org/](http://www.gwwa.org/)

USDA Forest Service. 2006. Land and Resource Management Plan: Huron-Manistee National Forests. Cadillac, MI: USDA Forest Service. <http://www.fs.usda.gov/land/hmnf/landmanagement>

## Discussion for Monitoring Topic 4

**Planning Rule Topic:** 4. THE STATUS OF A SELECT SET OF THE ECOLOGICAL CONDITIONS REQUIRED UNDER 219.9 TO CONTRIBUTE TO THE RECOVERY OF FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES , CONSERVE PROPOSED AND CANDIDATE SPECIES, AND MAINTAINS A VIABLE POPULATION OF EACH SPECIES OF CONSERVATION CONCERN. 36 CFR 219.12(a)(5)(iv)

**Forest Monitoring Question:** To what Extent is forest plan implementation contributing to the conservation of federally-listed endangered, threatened, or proposed species, and to the conservation of species of viability concern?

**Indicator-** Number of Kirtland's warbler (KW) singing males counted in the census and the estimated Karner blue butterfly (KBB) abundance from surveys.

### Discussion:

The Kirtland's warbler and Karner blue butterfly are federally-listed endangered species that occur on the Huron-Manistee National Forests (HMNF). Both species have extensive management programs and have been monitored for many years using established protocols.

Monitoring the relative abundance of both species is the best indicator of presence of ecological conditions required to recover these species. Each species success or failure depends on the amount and quality of habitat produced under HMNF Forest Plan direction and available funding.

#### Kirtland's Warbler

The management program for the Kirtland's warbler is carried out under the direction of the Kirtland's Warbler Recovery Plan. One component of the recovery plan is to "monitor breeding populations...in order to evaluate responses to management practices and environmental changes." The monitoring program consists of two phases: (1) year-round inventory of breeding habitat, and (2) counting singing males during a short period in June. The singing male census protocol covers the second phase of the monitoring program.

The original protocol used to monitor the Kirtland's warbler singing males was established in the early 1970s. The protocol has evolved over the years to incorporate changes in technology and new ideas for conducting the census effectively and efficiently. The KW census protocol is reviewed and modified annually by the US Forest Service and Michigan Department of Natural Resources.

Census procedures make use of the behavior of male Kirtland's warblers to locate and count territorial males during a fifteen-day period in June. Kirtland's warblers tend to occur in loose assemblages within dense stands of young jack pine usually 5 to 20 feet tall. The males defend their territories with loud and persistent singing, and under good weather conditions, a census participant should hear singing males within one-eighth mile. Research suggests that there is a good probability that a territorial male will sing at least once during any five-minute period between sunrise and 11:00 am in good weather.

The census consists of traversing occupiable habitat early in the morning and mapping the location of singing male Kirtland's warblers. Field surveyors traverse the blocks of habitat in parallel lines using a compass or GPS.

These transects are spaced no more than 0.25 miles apart. Surveyors keep track of their location on the line by using a compass and counting paces, or by using a GPS. Surveyors stop and listen for singing males every 10 chains (1/8 mile or 200 meters) or less, for one to five minutes. When a bird is heard from a stop, the surveyor documents its location on a map. Once a block of habitat is complete, surveyors compare parallel transects and create a master map and submit it to the census coordinator.

A paper was published that compares the census protocol to an observation-based mapping method (Probst et. al. 2005). The paper conclude that the official census transect counts are a satisfactory relative index, but results should not be interpreted as an absolute count. The paper also suggested improvements to help correct sources of error, and those suggested improvements were incorporated into the survey protocol.

#### Karner Blue Butterfly

The management program for the Karner blue butterfly is carried out under the direction of the Karner Blue Butterfly Recovery Plan (2003). The Plan specifies that “monitoring shall occur frequently during the initial period of maintaining a viable metapopulation. It may be relaxed as confidence accrues that the management system does maintain the metapopulation and habitat mosaic above that needed for a minimum viable population (VP). It shall be increased in frequency if new threats to the metapopulation are identified. A minimum VP shall be monitored intensively. If the metapopulation is greater than the minimum, then monitoring may be less intensive.” The Plan described four types of transect monitoring methods.

The HMNFs use two protocols for estimating KBB abundance: Distance Sampling Protocol and Pollard-Yates Protocol. Methods for each protocol are described in the Karner Blue Butterfly Survey Protocol for the Huron-Manistee National Forests (2015). In June of each year, permanent transects are established within sites occupied by Karner blue butterfly subpopulations. These transects are surveyed during second flight to estimate Karner blue butterfly abundance within each subpopulation.

Karner blue butterfly subpopulations consist of habitat patches that exist structurally as openings or corridors within a matrix of dry to dry-mesic oak/pine forest. Permanent transects are systematically established within each habitat patch. During second flight, Distance sampling is conducted to obtain an estimate of Karner blue butterfly abundance within each subpopulation. Distance sampling begins approximately 7 days after confirmation of first emergence of second flight butterflies. Surveys are conducted for each of the habitat patches every 7 days until second flight ends. Two-person teams functioning as observer and recorder are assigned to each habitat patch. The observer and the recorder walk each permanent transect segment within the patch and note any butterflies that can be positively identified as a Karner blue butterfly.

During second flight, Pollard-Yates counts are conducted within Karner blue butterfly subpopulations where  $\leq 10$  butterflies have been observed during past surveys, as well as selected savanna restoration areas and previously occupied Karner blue butterfly subpopulations, to determine if the butterfly is present. Pollard-Yates counts are conducted at least twice for each site, with at least 7 days between surveys.

To conduct Pollard-Yates counts, an observer meanders through a site covering all areas that appeared to be good Karner blue butterfly habitat (e.g., patches of lupine or other blooming nectar plants). The route an observer walks on a given unit can change from day to day as the locations of nectar sources and aggregations of butterflies change. While conducting Pollard Yates counts, observers record the number of butterflies that

can be positively identified as a Karner blue butterfly. If Karner blue butterflies are observed within a site during two successive surveys, the site is designated as “occupied” and added to the list of Karner blue butterfly subpopulations to be monitored.

## References

Michigan Department of Natural Resources, U.S. Fish and Wildlife Service, and U.S. Forest Service. (2015). *Kirtland's Warbler Breeding Range Conservation Plan*. Lansing, MI: MDNR.

Probst, J. R. (2005). Comparing census methods for the endangered Kirtland's Warbler. *Journal of Field Ornithology*, 76(1):50-60, 2005.

US Fish and Wildlife Service. (2003). *Karner Blue Butterfly Recovery Plan*. Fort Snelling, MN: Department of Interior, US Fish and Wildlife Service.

US Forest Service. (2015). *Karner Blue Butterfly Survey Protocols*. Cadillac, MI: Huron-Manistee National Forests.

US Forest Service, MDNR. (2015). *Instructions for the Kirtland's Warbler Census. June 6 through June 20, 2015*. Cadillac, MI: USDA Forest Service, Huron-Manistee National Forests.

## **Discussion for Monitoring Topic 5**

**Planning Rule Topic:** 5. THE STATUS OF VISITOR USE, VISITOR SATISFACTION, AND PROGRESS TOWARD MEETING RECREATION OBJECTIVES. 36 CFR 219.12(a)(5)(v)

**Forest Monitoring Question:** What is the status of visitor use and visitor satisfaction?

### **Indicator-**

- o Annual Visitation Estimates (by type of visit - day use, developed, general forest area, designated wilderness visits)
  - o Description of Visit (demographics, visit descriptions, activities)
  - o Economic Information (spending, substitute behavior, etc.)
  - o Visitor Satisfaction
  - o Wilderness Visit Demographics
- From the NVUM data report – every 5 years

### **Discussion:**

The National Visitor Use Monitoring survey completed on Forests across the nation will be used to monitor visitor satisfaction and visitor numbers. The national program has been implemented across the nation and is the only survey of visitors that takes place on a regular basis to track trends in visitation to the Forests.

NVUM methodology and analysis is explained in detail in the research paper entitled: Forest Service National Visitor Use Monitoring Process: Research Method Documentation; English, Kocis, Zarnoch, and Arnold; Southern Research Station; May 2002 (<http://www.fs.fed.us/recreation/programs/nvum>).

### **References:**

USDA Forest Service Huron-Manistee National Forest, Recreation Supply and Demand Analysis. January 2012.

USDA Forest Service, National Visitor Use Monitoring Process: Research Method Documentation; English, Kocis, Zarnoch, and Arnold; Southern Research Station; May 2002 (<http://www.fs.fed.us/recreation/programs/nvum>).

USDA Forest Service, Southern Research Station. Research Paper SRS-37. An Outdoor Recreation Use Model with Applications to Evaluating Survey Estimators. Stanley J. Zarnoch, Donald B.K. English, and Susan M. Kocis. September 2005.

USDA Forest Service, National Visitor Use Monitoring Process: Research Method Documentation. Donald B. K. English, Susan M. Kocis, Stanley J. Zarnoch, J. Ross Arnold. May 2001.

## Discussion for Monitoring Topic 6

**Planning Rule Topic:** 6. MEASURABLE CHANGES ON THE PLAN AEA RELATED TO CLIMATE CHANGE AND OTHER STRESSORS THAT MAY BE AFFECTING THE PLAN AREA. 36 CFR 219.12(a)(5)(vi)

### Forest Monitoring Question:

**Indicator-** Acres infested or infected and pathogen or pests detected on the Forests.

### Discussion:

Forest pest and pathogen occurrence and extent can be affected by climate, so tracking trends and new pest and pathogens may indicate changes to the forest associated with climate change.

The Forests are flown annually by the Research Station staff who use visual observations, photographic and satellite imagery to map areas of forest infestation or infection.

Flights are flown along flight lines that normally run at 3.45 miles apart, but vary with visibility, time constraints or in areas of special concern. Flights are normally flown at 1500 to 2000 feet above the terrain, but again height varies with visibility during the flight.

Flights are normally made in mid to late July and are generally coordinated with the Michigan DNR's flights.

A portion of areas identified are spot checked after the flights to verify data.

### References

Campbell, J. L., L. E. Rustad, E. W. Boyer, S. F. Christopher, C. T. Driscoll, I. J. Fernandez, P. M. Groffman, D. Houle, J. Kieckbusch, A. H. Magill, M. J. Mitchell and S. V. Ollinger (2009). "Consequences of climate change for biogeochemical cycling in forests of northeastern North America." *Canadian Journal of Forest Research* 39(2): 264-284

Dukes, J. S., et al. (2009). "Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America: What can we predict?" *Canadian Journal of Forest Research* 39(2): 231-248.

Rustad, L., J. Campbell, J. S. Dukes, T. Huntington, K. Fallon Lambert, J. Mohan and N. Rodenhouse (2012). "Changing climate, changing forests: The impacts of climate change on forests of the northeastern United States and eastern Canada." Gen. Tech. Rep. NRS-99. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 48 p. [http://www.nrs.fs.fed.us/pubs/gtr/gtr\\_nrs99.pdf](http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs99.pdf)

Handler, Stephen et al. (2014) "Michigan Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Northwoods Climate Change Response Framework Project. Gen. Tech. Rep. NRS-129. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.

## Discussion for Monitoring Topic 7

**Planning Rule Topic:** 7. PROGRESS TOWARD MEETING THE DESIRED CONDITIONS AND OBJECTIVES IN THE PLAN, INCLUDING PROVIDING FOR MULTIPLE USE OPPORTUNITIES. 36 CFR 219.12(a)(5)(vii).

**Forest Monitoring Question:** How close are projected outputs and services to actual?

**Indicator-** Miles or acres managed as described in Table D 6 of the Forest Plan: Proposed Practices

### Discussion:

The HMNF Forest Plan provides goals and objectives for the planning period across many resource areas. Some of these are long-term goals or qualitative objectives. The Forest monitors progress toward these goals and objectives and reports on that progress in Monitoring and Evaluation reports as information is available. However many of the Forest's goals and objectives are not quantifiable and do not have indicators that can be readily tracked and reported on consistently.

Appendix D of the Forest Plan describes the proposed and probable management practices of the 1<sup>st</sup> and 2<sup>nd</sup> decade. These include acres of the different silvicultural treatments by forest type, volume of timber produced by forest type and estimates of other management actions. Each of these estimates are clearly defined and quantifiable, suitable for tracking over time.

These estimates remain appropriate indicators of the Forests' success in managing resources to achieve the desired future condition described in the Forests' Plan.

This question and reporting indicators are unchanged from the 2006 Forest Plan. The public participated in the Forest planning process.

FS reporting systems used to record timber sales information will be used. TIM and FACTS Forest Service corporate databases. Used nationally to track timber and silvicultural accomplishments. Other databases of record used nationally for reporting accomplishments annually. Using the corporate databases is cost effective and shows accomplishments reported each year.

Many of the estimates identified in Appendix D also provide an assessment of the Forest's multiple use opportunities and a means for monitoring the Forest's social and economic contributions to the region. A socio-economic assessment for the Forest (USDA 2015) demonstrates the importance of the Forest's recreation opportunities and timber harvest to the local area. The volume of timber sold and acres of harvest using various practices and miles of trail improved provide indicators to track:

- the contribution of the Forest to overall wood production and jobs and income (USDA 2015, p. 76-77) and related jobs and income (Lefers et al 2003, p. 93-105),
- the Forest's role in Tourism and recreation (Lefers et al, 2003, p. 105-107),
- earnings from government and government enterprise (Lefers et al, 2003, p. 112-118) and

The Forests reports from the National Visitor Use Monitoring Report will be used to track the Forests' accomplishments in meeting recreation goals more closely.

**References:**

Lefers, Larry. Karen Potter-Witter, Maureen MacDonough. July 2003. Social and Economic Assessment for the Michigan National Forests. Michigan State University, Department of Forestry.

USDA 2006. Huron-Manistee Land and Resource Management. USDA, Huron-Manistee National Forests.

USDA 2006. Huron-Manistee Land and Resource Management Plan Final Environmental Impact Statement. USDA, Huron-Manistee National Forests.

## Discussion for Monitoring Topic 8

**Planning Rule Topic:** 8. THE EFFECTS OF EACH MANAGEMENT SYSTEM TO DETERMINE THAT THEY DO NOT SUBSTANTIALLY AND PERMANENTLY IMPAIR THE PRODUCTIVITY OF THE LAND (16 U.S.C. 1604 (g)(3)(c). 36 CFR 219.12(a)(5)(viii)

**Forest Monitoring Question:** Are the effects of Forest management, including prescriptions, resulting in significant changes in productivity of the land?

**Indicator-** Growth metrics of trees and remaining soil nutrient stocks following different harvest scenarios on FS land- data from LTSP study plot on Huron side of Forest.

### Discussion:

Several peer-reviewed studies were consulted during the identification of BASI for this monitoring question. That process indicated several important considerations when designing a soil productivity monitoring strategy:

- 1) Stand characteristics and soil factors have an inseparable connection to tree growth and nutrient uptake, and therefore, biogeochemical cycling between soils and trees is site-specific, dependent on a variety of factors, and highly spatially heterogeneous at the Forest-wide scale.
- 2) Most peer-reviewed studies are narrowly focused on either a single management system or a single soil type (or narrow range of soil types) in order to tease out relevant relationships between specific soil and site factors. Moreover, they typically are short term in duration or specific to a season.
- 3) The best way to derive meaningful conclusions about the effects of management systems on soil productivity is through repeated long-term measurements.

These considerations lead us to conclude that the best source of information to answer this monitoring question is data from the Long Term Soil Productivity (LTSP) study on the HMNF (Voldseth, Palik, and Elioff 2011). Nationwide, the LTSP study was designed by Forest Service Research Station Scientists to directly answer this monitoring question. The study design takes repeated measurements of soil organic matter, porosity, and soil nutrients with depth on sandy soils under nine different combinations of harvest intensity and soil compaction (actually compacted by harvest equipment commonly used on our forest). Furthermore, the site on the Huron side of the forest has been in existence and continually measured since 1994. The LTSP study also represents one of the most intensive kinds of management (aspen clear-cutting) on soils particularly susceptible to long-term depletion of nutrients (loamy sand soil). Therefore, it represents the most local, relevant, long-term dataset to use for monitoring the effects of forest management on soil productivity on the HMNF. Finally, the LTSP study is funded by the Northern Research Station, this data is provided to the HMNF at no expense.

One considerable draw back of the LTSP research design is that it does not address all of the intensive management systems that are currently in use on the HMNF- such as jack pine clear cutting, or repeated red pine regeneration on the same stands. Because of this limitation, we actively work with university

research partners in Michigan who focus on forest soil productivity to design studies that can directly help us answer this question on other management types (LeDuc and Rothstein 2007; Yermakov and Rothstein 2006; Curzon, D'Amato, and Palik 2014). Furthermore, a study is currently underway, which aims to answer questions related to soil disturbance levels in a pre- and post-harvest scenario on different management systems susceptible to productivity decline across the HMNF. While these additional studies are not long-term in nature, they help us refine important questions regarding specific effects of forest management on soil productivity, which can then be considered during future revisions of forest planning and monitoring efforts.

#### References:

1. Curzon MT, D'Amato AW, Palik BJ. Harvest residue removal and soil compaction impact forest productivity and recovery: Potential implications for bioenergy harvests. *For Ecol Manage.* 2014;329:99-107. [doi:10.1016/j.foreco.2014.05.056](https://doi.org/10.1016/j.foreco.2014.05.056).
2. Hazlett PW, Morris DM, Fleming RL. Effects of Biomass Removals on Site Carbon and Nutrients and Jack Pine Growth in Boreal Forests. *Soil Sci Soc Am Journal, North Am For Soils Confernce Proceedings, Whitefish, MT, 16-20 June 2013.* 2014;78(S1):S183. [doi:10.2136/sssaj2013.08.0372nafsc](https://doi.org/10.2136/sssaj2013.08.0372nafsc).
3. LeDuc SD, Rothstein DE. Initial recovery of soil carbon and nitrogen pools and dynamics following disturbance in jack pine forests: A comparison of wildfire and clearcut harvesting. *Soil Biol Biochem.* 2007;39(11):2865-2876. [doi:10.1016/j.soilbio.2007.05.029](https://doi.org/10.1016/j.soilbio.2007.05.029).
4. Thompson T, Rothstein D. Effects of Preceding Stand Age on Nutrient Availability in Postharvest Jack Pine *Pinus banksiana*. *North Journal Appl For.* 2009; 26(1):28-30
5. Voldseth R, Palik B, Elioff J. *Ten-Year Results from the Long-Term Soil Productivity Study in Aspen Ecosystems of the Northern Great Lakes Region: Northern Research Station Research Paper NRS-17.*; 2011. <http://www.treesearch.fs.fed.us/pubs/39448>
6. Yermakov Z, Rothstein DE. Changes in soil carbon and nitrogen cycling along a 72-year wildfire chronosequence in Michigan jack pine forests. *Oecologia.* 2006;149(4):690-700. [doi:10.1007/s00442-006-0474-4](https://doi.org/10.1007/s00442-006-0474-4).