Development of Base Indicators for the Northern United States

The USDA Forest Service is using the criteria and indicators (C&I) framework nationwide to build partnerships and track progress in forest sustainability. At the national level, the agency is tracking a set of 7 criteria and 67 indicators that were developed in an international forum for the conservation and sustainable management of temperate and boreal forests.[1] In the Northern United States, the Northeastern Area State and Private Forestry (NA S&PF), a unit of the Forest Service, has been working with the Northeastern Area Association of State Foresters (NAASF) to use this C&I framework to monitor forest sustainability across the 20 Northeastern and Midwestern States and the District of Columbia. These partners agreed to fully adopt the seven criteria from the national C&I framework, but to limit the number of indicators for feasible continuous monitoring.

As requested by the NAASF, the base indicators of forest sustainability for the Northern United States were carefully selected by a work group of State forest planners and Northeastern Area staff (appendix I). This process (box 1) entailed six major steps: (1) agree on the indicator evaluation method, (2) develop an initial set of potential indicators, (3) evaluate potential indicators, (4) narrow the list of potential indicators and adjust the wording, (5) peer review and evaluation, and (6) refine the indicators as a result of review and evaluation.

Box 1. Steps for developing base indicators of forest sustainability for the Northern United States

1. **Agree on an indicator evaluation method.**
   - Develop indicator evaluation questions and worksheets.
2. **Develop an initial set of potential indicators.**
   Each C&I work group member drafts a list of potential indicators, considering the following:
   - Important and applicable indicators from the national C&I framework.
   - Indicators from other programs, e.g., *Maine Forest Sustainability Standards, Great Lakes Forest Alliance, Local Unit Criteria & Indicators Development Project (LUCID).*
   - Whether there are additional long-term issues of critical concern to forest sustainability in the Northern United States for which indicators should be developed.
3. **Evaluate potential indicators.**
   - Each work group member evaluates each indicator (results compiled and distributed to group).
4. **Narrow the indicator list and adjust the wording of the potential indicators.**
   From the results of the indicator evaluation:
   - Agree on a narrowed set of indicators (narrow to a set of no more than 20–25 indicators).
   - Agree on the wording of each indicator (making corrections and adjustments where necessary).
5. **Send out draft set of indicators for peer review and evaluation.**
6. **Consider the results of indicator review and evaluation.**
   - Narrow the list of indicators to the set that will be presented to NAASF.
   - Refine the wording of indicators and indicator definitions, where necessary.

The work group started by identifying and agreeing on a method to evaluate potential indicators. Several key resources were consulted to formulate a list of questions that potential indicators should be evaluated by (box 2), including how the indicator is worded, the relationship of a particular indicator to the overall C&I framework, scale appropriateness, reliability, data availability, and ease of interpretation.

Steps 2 through 4 of indicator development were carried out as an iterative process to evaluate and prioritize potential indicators. This process began with each work group member individually proposing a set of potential forest sustainability indicators for the Northern United States. There was no restriction on the number of indicators each member could propose. All indicators submitted were compiled into a draft list of indicators. Only those indicators that directly overlapped were condensed, resulting in a list of over 70 indicators. In the next step, each work group member reviewed the combined list of indicators and individually identified no more than

[1] Commonly referred to as the Montreal Process C&I, this set of criteria and indicators was developed by an international panel of forest experts. The United States and 11 other countries agreed to this C&I framework in 1995.

15 top indicators. Each indicator chosen by one or more work group member was then compiled into the second draft list, resulting in roughly 35 potential draft indicators. The work group met and used the indicator evaluation questions to further narrow the list to 20 potential indicators. Each work group member then fully evaluated each of the 20 indicators using the indicator evaluation questions.

Box 2. Indicator evaluation questions used to evaluate potential indicators

Indicator Wording Checklist

- ❑ The indicator is precisely defined.
- ❑ The indicator is a specific and measurable parameter (not too vague).
- ❑ The indicator is written nondirectionally (not suggesting a response in either direction).
- ❑ The indicator wording does not include or imply the methods or reference values (target/threshold).

Criteria and Indicators Framework Questions

1. Is the indicator closely and unambiguously related to one of the Montreal Process criteria?
2. Does the indicator link to or feed into any of the Montreal Process indicators? Which ones?
3. Does the indicator assess sustainable forestry at the regional level? (Relevance to Northern U.S.)
4. Is the indicator of unique/particular concern to the Northern U.S.? (Regional importance)
5. Does the indicator overlap with other indicators in the set?

Indicator Data/Measurement Questions

6. Is the indicator appropriate for data collection at the State level?
7. Is the indicator reliable? (Can you trust the information the indicator is providing?)
8. Can the indicator be feasibly collected?
   a. Is it costly or difficult? Does it require a special agency arrangement?
   b. Can it be measured over time or measured repeatedly?
   c. Can it be comparably collected across the 20 States?

Indicator Use Questions

9. Is the indicator useful to the intended audience? (Does it convey information that is meaningful to decisionmakers and/or the public, suitable for use across the 20 States and/or the region as a whole?)
10. Is the indicator relatively easy to analyze/interpret?
11. Is the indicator relatively easy to present and understand (for reporting to general public)?

All indicator evaluations were compiled along with information about related Montreal Process indicators from the U.S. Roundtable on Sustainable Forests.[2] Next, each work group member made recommendations for indicator revisions and the work group met to discuss the indicator evaluations and agree on proposed revisions. As a result, 18 forest sustainability indicators (box 3) were recommended as a base set of indicators for the Northern United States. The term *base indicators* conveys the message that they provide a solid base of information for sustainability assessments but cannot be expected to address every sustainability issue. Each base indicator has a clear linkage to the national C&I framework and is appropriate for use at State and regional levels.

Once the NAASF adopted the base set of indicators, the C&I work group developed metrics, including data sources, for each indicator. In part, the group was able to utilize information provided by work group members through the indicator evaluation matrix. A number of reports and efforts, including a draft of the *Sustainability Assessment Highlights for the Northern United States*[3] were consulted to identify reliable data sources. The C&I work group focused on data that are reliable, available for each State in the Northern United States, likely to be updated on a

[2] U.S. Roundtable on Sustainable Forests. 2001. Criteria and indicators technical workshop results. On file at USDA Forest Service, 271 Mast Road, Durham NH 03824.

[3] Carpenter, Constance A.; Giffen, Catherine; Miller-Weeks, Margaret. 2003. Sustainability assessment highlights for the Northern United States. NA–TP–05–03. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry. 99 p.

regular basis, and feasible to obtain and compile. As a result, data for the base indicators are compiled from a variety of Federal agencies, State forestry agencies, and other organizations. The base indicators of forest sustainability for the Northern United States, along with the metrics and data sources, are presented in appendix II. Although data are available for over 90 percent of the metrics, there are still a number of data gaps that the C&I work group, now a steering committee, continues to address.

Box 3. Base Indicators of Forest Sustainability for the Northern United States[4]

Criterion 1: Conservation of Biological Diversity

1. Area of total land, forest land, and reserved forest land
2. Forest type, size class, age class, and successional stage
3. Extent of forest land conversion, fragmentation, and parcelization
4. Status of forest/woodland communities and associated species of concern

Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems

5. Area of timberland
6. Annual removal of merchantable wood volume compared to net growth

Criterion 3: Maintenance of Forest Ecosystem Health and Vitality

7. Area of forest land affected by potentially damaging agents

Criterion 4: Conservation and Maintenance of Soil and Water Resources

8. Soil quality on forested land
9. Area of forest land adjacent to surface water and forested land by watershed
10. Water quality in forested areas

Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

11. Forest ecosystem biomass and forest carbon pools

Criterion 6: Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

12. Wood and wood products production, consumption, and trade
13. Outdoor recreational participation and facilities
14. Investments in forest health, management, research, and wood processing
15. Forest ownership, land use, and specially designated areas
16. Employment and wages in forest-related sectors

Criterion 7: Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

17. Forest management standards/guidelines
18. Forest-related planning, assessment, policy, and law

[4] No priority is implied in the numeric listing of the criteria and indicators.

Appendix I. C&I Work Group/Steering Committee

Constance Carpenter, USDA Forest Service, Northeastern Area State and Private Forestry

Dan Devlin, Pennsylvania Bureau of Forestry

Susan Francher, New Hampshire Division of Forests and Lands

Jeff Horan (2004 to present), Maryland Forest Service

Margaret Miller-Weeks, USDA Forest Service, Northeastern Area State and Private Forestry

Jon Nelson, Minnesota Division of Forestry

Larry Pedersen, Michigan Forest, Mineral, and Fire Management Division

Sherri Wormstead, USDA Forest Service, Northeastern Area State and Private Forestry

(Donald Mansius, Maine Forest Service, also served on the C&I work group from 2000 to 2002.)

NAASF Liaisons

Gerald Thiede (2000-2001), Michigan Forest, Mineral, and Fire Management Division

Austin Short (2001-2006), Delaware Department of Agriculture, Forestry Section

Appendix II. Base Indicators of Forest Sustainability for the Northern United States and Associated Metrics, Data Sources, and Scale of Data

Indicator and associated metrics	Data source agency/organization	Scale of data
1. Area of total land, forest land, and reserved forest land		
1.1 Forest and total land area	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
1.2 Forest density	USDA Forest Service, Forest Inventory and Analysis	Region
1.3 Forest land and population	USDA Forest Service, Forest Inventory and Analysis	Region, State
	U.S. DOC, Census Bureau	
1.4 Reserved forest land	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
1.5 Urban forest	USDA Forest Service, Northeastern Research Station, Urban Forestry Unit	Region, State
2. Forest type, size class, age class, and successional stage		
2.1 Forest cover type groups	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
2.2 Size class	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
2.3 Age group	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
3. Extent of forest land conversion, fragmentation, and parcelization		
3.1 Fragmentation	Links to resources (no data reported)	N/A
3.2 Forest land developed	USDA Natural Resources Conservation Service, Natural Resources Inventory	Region
3.3 Net change in forest land	USDA Natural Resources Conservation Service, Natural Resources Inventory	Region
3.4 Additions to and conversions from forest land	USDA Natural Resources Conservation Service, Natural Resources Inventory	Region
3.5 Forest parcel sizes	USDA Forest Service, National Woodland Owner Survey	Region, State
4. Status of forest/woodland communities and associated species of concern		
4.1 Forest and woodland communities	NatureServe	Region, State, ecological province
4.2 Forest-associated and all species	NatureServe	Region, State
4.3 Forest-associated species of concern by taxonomic group	NatureServe	Region, State
4.4 Bird populations	USGS, Patuxent Wildlife Research Center, North American Breeding Bird Survey	Region, State
5. Area of timberland		
5.1 Amount of timberland	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
6. Annual removal of merchantable wood volume compared to net growth		
6.1 Net growth and removals	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
6.2 Type of removals	USDA Forest Service, Forest Inventory and Analysis	Region, State
7. Area of forest land affected by potentially damaging agents		
7.1 Tree mortality and damage type	USDA Forest Service, Forest Inventory and Analysis (mortality data)	Region, State, ecological province
	Links to the Aerial Survey Viewer provided by the USDA Forest Service, Northeastern Area State and Private Forestry, Forest Health Protection	N/A
7.2 Wildfire	USDA Forest Service, Fire and Aviation Management	Region, State
7.3 Drought	U.S. DOC, NOAA, National Climatic Data Center	Region, climatic division
7.4 Insects, diseases, plants, and animals	USDA Forest Service Northeastern Area State and Private Forestry, Forest Health Protection	Region
8. Soil quality on forest land		

8.1 Soil pH	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
8.2 Total soil carbon	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
8.3 Estimated bare soil	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
8.4 Bulk density	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
8.5 Calcium-aluminum ratio	USDA Forest Service, Forest Inventory and Analysis	Region, State, ecological province
9. Area of forest land adjacent to surface water and forest land by watershed		
9.1 Forested riparian area	Multi-Resolution Land Characteristics, National Land Cover Data; USGS National Hydrography Dataset (GIS analysis by NA S&PF)	Region, State, HUC[5], ecological province
9.2 Forest land by watershed	Multi-Resolution Land Characteristics National Land Cover Data; USGS 8-digit HUCs[5] (GIS analysis by NA S&PF)	Region, State, HUC[5]
10. Water quality in forested areas		
10.1 Water quality in forested areas	Links to various resources (no data reported)	N/A
10.2 Stream miles impaired by percentage of watershed forested	U.S. Environmental Protection Agency, 303(d) Impaired Waters List (GIS Analysis by NA S&PF)	Region, State, HUC[5]
11. Forest ecosystem biomass and forest carbon pools		
11.1 Forest ecosystem biomass	USDA Forest Service, Northeastern Research Station, Forest Carbon Dynamics and Estimation Unit	Region, State
11.2 Forest carbon pools	USDA Forest Service, Northeastern Research Station, Forest Carbon Dynamics and Estimation Unit	Region, State, ecological province
11.3 Forest carbon by forest type	USDA Forest Service, Northeastern Research Station, Forest Carbon Dynamics and Estimation Unit	Region, State
11.4 Change in forest carbon	USDA Forest Service, Northeastern Research Station, Forest Carbon Dynamics and Estimation Unit	Region
12. Wood and wood products production, consumption, and trade		
12.1 Value of wood-related products	U.S. DOC, Census Bureau, Economic Census	Region, State
12.2 Production of roundwood	USDA Forest Service, Timber Product Output Database	Region, State
12.3 Production and consumption of roundwood equivalent	USDA Forest Service, Forest Products Laboratory	Region
12.4 Recovered paper	American Forest & Paper Association	Region
12.5 Bioenergy	Links to various resources (no data reported)	N/A
13. Outdoor recreational participation and facilities		
13.1 Participation in outdoor recreation	USDA Forest Service, Southern Research Station, National Survey on Recreation and the Environment	Region, State
	USDI Fish and Wildlife Service, National Survey of Fishing, Hunting, and Wildlife-Associated Recreation	Region, State
13.2 Federal land open to recreation	USDA Forest Service, Southern Research Station, Wilderness, Urban Forest, and Demographic Trends Unit	Region, State
13.3 Recreational facilities on State land	State forestry agencies (collected by NA S&PF/NAASF)	Region, State
13.4 Trails	State forestry agencies (collected by NA S&PF/NAASF)	Region, State
13.5 Campgrounds	Woodall Publications Corporation	Region, State
13.6 Recreational facilities in national forests	USDA Forest Service, INFRA (Infrastructure Application)	Region, national forest
14. Investments in forest health, management, research, and wood processing		
14.1 USDA Forest Service NA S&PF funding	USDA Forest Service, NA S&PF, Information Management and Analysis	Region, State
14.2 State forestry agency funding	National Association of State Foresters, State Forestry Statistics	Region, State
14.3 Funding for forestry research at universities	USDA Cooperative State Research, Education, and Extension Service	Region, State
14.4 USDA Forest Service Research funding	USDA Forest Service, Research and Development	Region (by research unit)

[5] HUC stands for Hydrologic Unit Code. Eight-digit HUC watersheds were used.

14.5 Capital expenditures by manufacturers of wood-related products	U.S. DOC, Census Bureau, Economic Census	Region, State
15. Forest ownership, land use, and specially designated areas		
15.1 Forest land ownership	USDA Forest Service, Forest Inventory and Analysis	Region, State
15.2 State lands	State forestry agencies (collected by NA S&PF/NAASF)	Region, State
15.3 Protected land	Conservation Biology Institute, Protected Areas Database (GIS Analysis by NA S&PF)	Region, State
15.4 Private land with public conservation easements	USDA Forest Service, Forest Legacy Program	Region, State
	State forestry agencies (collected by NA S&PF and NAASF)	
15.5 Forest land in tax reduction programs	State forestry agencies (collected by NA S&PF and NAASF)	Region, State
15.6 Forest certification	American Forest & Paper Association, Sustainable Forestry Initiative	Region, State
	Forest Stewardship Council	Region, State
	American Forest Foundation, American Tree Farm System	Region, State
16. Employment and wages in forest-related sectors		
16.1 Wood-related products manufacturing employees	U.S. DOC, Census Bureau, Economic Census	Region, State
16.2 State forestry employees	National Association of State Foresters, State Forestry Statistics	Region, State
16.3 USDA Forest Service employees	USDA Forest Service, Human Resources Management	Region
16.4 Wood product manufacturing payroll and wages	U.S. DOC, Census Bureau, Economic Census	Region, State
16.5 State forestry salaries	National Association of State Foresters, State Forestry Statistics	Region, State
17. Forest management standards/guidelines		
17.1 Types of forest management standards/guidelines	State forestry agencies (collected by NA S&PF and NAASF)	Region, State
17.2 Voluntary and mandatory standards/guidelines	State forestry agencies (collected by NA S&PF and NAASF)	Region, State
17.3 Monitoring of standards/guidelines	State forestry agencies (collected by NA S&PF and NAASF)	Region, State
18. Forest-related planning, assessment, policy, and law		
18.1 State forest planning	State forestry agencies (collected by NA S&PF and NAASF)	Region, State
18.2 Nonindustrial private forest planning	USDA Forest Service, Performance Measurement Accountability System	Region, State
18.3 National forest planning	USDA Forest Service, Eastern Region	Region, national forest
18.4 State forest assessments	State forestry agencies (collected by NA S&PF and NAASF)	Region, State
18.5 Forest laws and policies	State forestry agencies (collected by NA S&PF and NAASF)	State
	National Association of State Foresters, State Forestry Statistics	Region, State
18.6 State forest advisory committees	National Association of State Foresters, State Forestry Statistics	Region, State