

A Plot-based National Forest Inventory Design For Canada

An interagency partnership project

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Introduction

A national forest inventory for Canada is based on contributions of forest resource data from a host of agencies. Traditionally the provinces have been the main providers of data for the national inventory. This follows from the fact that it is the provinces who have the jurisdiction for managing and monitoring their forest lands and forest resources. The federal government does not conduct a national forest inventory, it relies on available data for national and international summaries. National forest inventories of the future may evolve towards a partnership between federal, provincial, territorial governments, industry, first nations, and non-government agencies, all with a keen interest in the sustainable development of our forests.

Canada's forest inventory through the eighties and nineties was a compilation of existing provincial and territorial forest inventories (for most recent example see Lowe et al. 1996). It was clear that this format could not meet increasing demands for additional forest resource attributes, for policy, national and international reporting, and for reports on indicators of sustainable forest management (CCFM 1996). A new approach was needed (Bonnor et. al. 1996). A technical subcommittee of the Canadian Forest Inventory Committee (CFIC) discussed alternative design options. The design presented here is, by and large, derived from the recommendations of this committee (Morgan et al. 1995). In the fall of 1997 the Canadian Forest Service and the Canadian Forest Inventory Committee co-hosted a workshop to "... reach consensus on the technical details of a new plot-based inventory that is nationally consistent...". Consensus was achieved amongst the members. Provinces with an inventory design that already meets or exceeds the standards proposed in the new design will simply integrate their inventory information into the design favored by most provinces and territories. This report describes the 'consensus' design and its components.

While the consensus design covers a core set of reportable attributes, it is not limited to these only. Rather, it is understood that the design offers the opportunity for other agencies to participate and accommodate an inventory of additional attributes of importance to these agencies. The inventory agencies in each province and the territories will arrange for these partnerships by augmenting their inventories to include the desired attributes within the overall design framework of the national forest inventory. The details of these partnerships will vary from case to case.

Definitions and terms of the NFI design are provided in Appendix I.

A vision for the national forest inventory

The purpose of the National Forest Inventory (NFI) is to "...assess and monitor the extent, state and sustainable development of Canada's forests in a timely and accurate manner". More specifically, it should provide data for the Criteria & Indicators processes to monitor sustainable development, and data to support policy, national and international inquiries (for example, FAO/ECE Forest Resource Assessments), and for reports on climate change (e.g., Kyoto Protocol). The NFI should also provide a framework for collecting data on other criteria and indicators (e.g. socio-economic indicators), and for studying the factors affecting forest health (e.g. insect attack, disease infestation, pollutant deposition) and productivity. Finally, it should be sufficiently flexible that the implementing agencies (the provinces, territories or their assigned delegates) can integrate the design into their existing or planned inventories in a cost effective manner.

Overview of the Design

The guiding principle in developing the inventory design is that, while the design must be flexible, the data resulting from the inventory must be consistent: the same attributes must be measured, using the same standards, in a statistically defensible manner, at an acceptable level of precision.

The required data consistency and design flexibility is achieved by developing a simple core design and by permitting variations in implementing that design.

The core design has the following essential elements:

1. A network (grid) of sampling points across the population (Canada);
2. Stratification of the sampling points, with varying sampling intensity among the strata;
3. Estimation of some attributes from remote sensing sources on a primary (large) sample;
4. Estimation of wood volumes and other detailed data from a (small) ground based sub-sample;
5. Estimation of changes in (3) and (4) from repeated measurements;
6. Compilation of NFI attributes.

The CFIC has agreed on a set of 25 key attributes that will be reported in the NFI. Individual provinces and territories may decide to include additional attributes. New attributes may be added as a result of other agencies participating in the inventory. Table 1 lists the 25 key attributes to be included in the NFI.

A set of basic attributes tailored towards the 25 key NFI attributes has been developed. These basic attributes are described in Appendices II, III, V, VI, VII, VIII, and IX. Appendix II describes the land cover classification, which has been adopted and modified from the British Columbia Land Cover Classification system.

Table 1. Key NFI attributes. (The list may be expanded as new data needs emerge)

NFI Attribute	C&I ¹ (Montreal)	C&I ² (CCFM)
Total forest area	1	1.1.1
Area by forest type	1	1.1.1
Area of forest type by age class	1	1.1.2
Area of forest types by protection status	1	1.1.3
Area of other wooded land by protection status and type		
Area of age classes by protection status	1	(1.1.3)
Area and percent of forest land managed primarily for protective functions (watersheds, flood protection, avalanche protection, riparian zones)	3	3.2.1.
Regeneration and afforestation area by type		(2.2.2)
Area of surface water in forests		4.5.1
Area of forests undisturbed by man		
Area of other wooded land undisturbed by man		
Number of forest dependent species	1	-
Number of native and exotic species in forests		
Origin (local/non-local) of seedlings in regenerating areas	(1)	(1.3)
Area available for timber production	2	5.1.2
Area converted to non-forest use	(1)	3.1.2
Area and severity of insect attack	(2)	2.1.1
Area and severity of disease infestation	(2)	2.1.2
Area and severity of fire damage	(2)	2.1.3
Area of forest disturbance		4.1.7
Area and percent of forest land with significant soil erosion	3	(3.1.1)
Total biomass by forest type, age, succession stage	5	(4.1.1-4.1.4)
Total volume of all species on timber prod. Land	2	(4.1.1)
Area/volume of plantations (native/exotic)	2	-
Current volume growth (annual) of forest (gross, net)		

Details of the Design

1. The Network (Grid)

- the population of the inventory is all of Canada;
- **all potential sample locations reside on a national 4 x 4 km network. The preferred sampling intensity is a 20 x 20 km grid of sampling points** (the 20 x 20 km grid is nested within the national 4 x 4 km grid). The 4 x 4 km network is intended for selections of sample locations (systematically or at random) for NFI reporting;
- the grid of sampling points may be replaced by other statistically defensible sampling systems (e.g., stratified random sampling) for large areas (e.g., a province or a stratum), as long as the required data will be obtained. This option makes it possible for provinces or territories which already have statistically based re-measurable inventories (Quebec, Nova Scotia, British Columbia) to use them for the NFI, possibly with some modifications.

2. Stratification

¹ listed by criterion, the Montreal process has no indexing of indicators

² numbers refer to indicators in the CCFM list of Canadian Indicators of sustainable development

- The population will be stratified and reported by Terrestrial Ecozone. Sampling intensity will vary in the ecozones: it may be decreased in some ecozones that have little or no vegetation, and increased in ecozones of particular significance or subject to significant changes.
 - some (arctic) strata may not be sampled, only areas given;
 - the population will be stratified by province/territory but will not be reported by province/territory unless approved by the province/territory.
- Stratification by province/territory is necessary since considerable variation can be expected among provincial and territorial designs and sampling intensities. Thus, the strata of the NFI are likely to be combinations of ecozones and provincial/territorial boundaries. This is not expected to present a significant compilation problem.

3. Estimation of areas from remote sensing sources

- where the grid network is used, sample locations will be selected from the 4 km grid (the most common is the 20 km grid, every 5th point along the rows and columns of the grid). Sample size may be varied with stratum to make the inventory cost efficient;
- where the grid network is not used, some other statistically defensible method of sample selection will be employed;
- remote sensing data sources (air photos or satellite imagery) will be obtained of the sample units and used to obtain some of the required attributes (the others will be obtained in the field samples);
- air photos will be used in treed and other vegetated areas;
- satellite imagery will be used in (arctic) areas with little or no vegetation;
- the air photo sample units will be 2 x 2-km square and will sample about 1% of the surface area. The estimation method for attributes within sampling units will be either polygon based or grid based;
- air photos should have a scale of 1:20 000 or larger; the scale should be such that the required attributes can be obtained;
- existing air photos or satellite images of recent vintage may be used. Actual age will vary, depending on expected changes in the area. New photos/images are recommended if it can be expected that more than 10% of the area of an observational unit will have changed from one land class to another, and if any non-predictable attribute can be expected to have changed by 10% or more;
- instead of using satellite imagery and air photos, existing GIS based maps may be “drilled” to get the required data, as long as the mapped data are of recent vintage and the map locations are accurate to within 50 m;
- double sampling may be used: for some attributes (e.g., wood volume), estimates are obtained for a large air photo sample and a small field sample, and a statistical correlation is derived. The intent is to increase sample precision but, unless the correlation between the photo and field estimates is good³, the method may not be cost effective;

4. Estimation of wood volumes and other detailed data

- where the grid network is used, a random sub-sample of one or more of the photo (or satellite) sample units (delineated polygons) are selected for field sampling (thus creating a two-stage cluster sampling). Required attributes are measured for the selected sub-units; the location of field plots inside selected ‘polygons’ is random (by say angle and distance from centroid). Locations that are not and will likely never have tree cover are excluded from sampling, areas where tree cover has been temporarily removed must be sampled.
- where statistically defensible sampling systems exist, they may be used in replacement of the above general approach;
- the characteristics of the field sample unit (size, shape, type and number of plots) will be determined by each province/territory, but will be such that the NFI attributes can be acquired; appendix IX suggests a suitable design;
- sample units that are dangerous to visit in the field will be placed in a separate stratum and a different approach to data acquisition will be developed (e.g., use of large scale air photos).

³ the inventory group at CFS, Victoria will determine whether the statistical properties of the association warrants double sampling.

5. Estimation of changes

- the general approach is to have an on-going national forest inventory (as opposed to, for example, a periodic inventory where all plots are measured in a given year(s)). For an inventory with a 10 year cycle: 1/10 of all sample units (remote sensing and field) is re-measured every year. The required attributes are re-measured, differences between the estimates made on the two occasions are compiled, and appropriate statistics are calculated;
- where no significant change has taken place (based on best available estimates) or where the changes can be predicted effectively (in terms of prediction error), no re-measurement is required. For example, if air photos show ‘no change’⁴, field sampling may be omitted;
- slow-changing areas. Canada has many areas where a 20 year measurement cycle may be more appropriate than a 10 year measurement cycle;
- data from other sources are required for NFI attributes on change (Table 1) and must be obtained separately.

6. Compilation of NFI attributes

- each province and territory will compile per-ha statistics for the sample units and submit to the CFS together with other relevant statistics (area of strata etc.);
- a data model for these purposes will be developed by the CFS;
- the CFS will compile stratum and population statistics (means, totals, variances) for the attributes;
- the first national summary based on this design will be ready by 2005.

NFI design components

The NFI network of sample locations

The NFI network of sample locations (a core 4 x 4 km grid) constitute the preferred pool of sample locations. Each region of Canada, however, will decide on a ‘best’ design, that may include samples located on a subset of the NFI sample locations or samples selected by a different statistically valid design. A 20 x 20 km network of plot locations will, for most part of the managed forest, be the preferred network. More intense sampling when the supporting agencies require data for regional-level reporting; less intensive for non-forest, non-managed areas.

The core NFI net has a nominal spacing of 4 x 4 km. From this core net, a series of seven alternative nets with fewer sample locations have been extracted. The spacing of sample locations in these nets are: 8 x 8 km, 12 x 12 km, 16 x 16 km, 20 x 20 km, 40 x 40 km, 60 x 60 km, and 80 x 80 km. Figure 1 shows the 80 x 80 km network overlaid on an outline of Canada. Technical details of the net(s) are given in Appendix IV. The number of sample locations by province/territory and Terrestrial Ecozone for the 4 x 4 km net, the 12 x 12 km net, and the 20 x 20 km net is given in Tables 2a and 2b.

Table 2a. Number of sample locations in various NFI nets by province and territory

PROVINCE	4 x 4 km	12 x 12 km	20 x 20 km
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⁴ the ‘no-change’ threshold will be context/attribute specific. Consistent application guidelines need to be developed in each case by the responsible inventory agency.

BC	59099	46566	2370
AB	41438	4606	1656
SK	40740	4530	1628
MB	40504	4496	1619
ON	67731	7541	2704
QC	94602	10518	3781
NB	4630	511	188
NS	3506	392	142
PE	367	39	12
NF	25503	2820	1026
Tot. PROV	378120	82019	15126
NT	232632	25852	9284
YT	30996	3450	1236
Tot. Canada	641748	111321	25646
Outside	907628	101263	36730
Total net	1549376	212584	62376

Table 2b. Number of NFI sample locations in various NFI nets by Terrestrial Ecozone

Ecozone #	4 x 4 km	12 x 12 km	20 x 20 km
15	22669	2521	909
14	30943	3446	1245
13	13237	1475	527
12	29447	3271	1183
11	17033	1889	683
10	29939	3328	1201
9	46243	5139	1841
8	8513	955	345
7	12836	1432	511
6	119605	13280	4786
5	86891	9641	3479
4	42038	4665	1674
3	54066	6023	2167
Tot. non-arctic	513460	57065	20551
2	106396	11820	4225
1	17168	1910	687
16 (Misc water)	4724	526	183
Total	641748	71321	25646

The net distances are nominal target values. Due to the spherical nature of the earth it has not been possible to construct a perfect grid across Canada. The extent of linear distortions of the net ranged from more than -10% in the far north to -1% to +1% in most of Canada. For most of Canada the distortion is less than 1%. Area distortions are approximately twice the linear distortions. The impact of this

distortion is on the statistical analysis where the actual area of each observational unit must be known. Most distortions (< 2%) can be safely ignored, their impact will be negligible.

Ground plots

The NFI design recommends a minimum of 50 forested NFI ground plots per ecozone⁵. No sampling is planned for the arctic ecozones. In general, precision targets determine sampling intensity. However, given the multitude of attributes and agencies involved in the NFI it has not been possible to be more specific at this point. Results from ongoing pilot tests will assist in the development of more specific recommendations. More intensive sampling may be needed to meet regional accuracy requirements. Allocation of these plots to sample locations is done by selecting the locations at random from the available grid nodes on the adopted network of photo plots used for the ecozone (for example a 20 x 20 km grid for the managed forest). Whenever the random allocation is a permanently non-treed location it should be 'rejected' and a substitute drawn by choosing a new location at random from the list of available ground sample locations. This procedure is repeated until the 50 sample locations have been allocated. The 'rejected' locations of NFI ground plots, however, maintain their status as de facto NFI ground plots although no field measurements are required (unless they become treed). The number of available grid locations may be exhausted by this procedure. This can be avoided by adopting a denser grid. It is essential that the procedure for selecting sample locations is documented and that rejected plots are retained in the analysis (they contain no data, but the rejection is subject to interpretation; it is a null record important to the statistical analysis).

NFI ground plots, however, are not limited to the locations specified by the grid alone. Additional new and existing ground plots can be used by the national forest inventory on the condition that i) they are located within or close to one of the fully interpreted photo plots, ii) the measurements are synchronized with the interpretation of the photo-plots, and iii) the exact location of the plot is known. This requirement ensures that the statistical representation of the ground plots can be computed. There is no other spatial constraint on the location of ground plots within an interpreted area of a photo plot than it should be 'random' within the photo-plot. A plot location at the center of the photo-plot may be preferred for new plots; it does improve relocation, support the notion of a random location and the issue of representation is simplified.

Attributes and data collected in ground plots will complement and enhance the attributes and data from the photo plots. Sample sizes permitting, the ground plots can also be used to calibrate photo-estimates. The NFI design proposes a ground sampling intensity of about 1 in 10 photo plots. A core set of 'NFI' ground plots should be permanent and preferably located centrally at the nodes of the national grid used in a region. However, NFI will also strive to the extent possible make use of existing permanent and temporary plots within the above outlined conditions. Permanent sample locations must be marked by metal stakes to ensure proper relocation⁶. Maps of stake locations must be detailed enough to minimize re-location efforts. Ground plots can follow a number of designs (fixed area plots, variable radius plots, or combinations thereof). Plot size should be tailored to the size of the trees to be measured. A sample size of 30 trees per plot is frequently sufficient to estimate critical attributes with confidence (assuming a trait coefficient of variation of 50% within the plot this would give a standard error of the mean value of an attribute of ~ 10%). No major component of a ground plot should inventory less than 100 m². See NFI definitions for clarification of terms.

⁵ the suggested sample size is linked to the assumption of a coefficient of variation of quantitative trait values (say volume) of at least 70% and a 'desired' (federal) target precision (standard error) of at most 10%.

⁶ To ensure a minimum of 90% overlap of plot areas on subsequent measurements the location errors must be held below 0.5m for a 100m² plot, 0.7m for a 200m² plot, and below 1.5m for a 500m² plot

The following attributes (outlined in more detail in Appendix V) are to be obtained for each ground plot, consistency of definitions and application of the definitions is essential:

- plot location
- network label and polygon identification
- year of measurement
- plot design and size
- disturbance
- land cover (Appendix II)
- tree species
- age
- tree cover origin
- regeneration
- forest structure
- understory vegetation
- small tree species
- mortality
- soil erosion
- biomass (tree, stump, shrub, herb and coarse woody debris)
- total tree volume
- five-year volume increment
- land use (Appendix III)
- ownership (Auxiliary attributes)
- harvest activities (Auxiliary attributes)
- exotics (Auxiliary attributes)
- protection status (Auxiliary attributes)
- conversion of forest land (Auxiliary attributes)
- access and human influence (Auxiliary attributes)

NFI Photo plots

Photo interpreted attributes constitute the core data set in the NFI. To provide reliable area statistics the objective is to survey about 1% of Canada's land mass (the 1% follows from the general recommendations of a 20 x 20 km grid and 2 x 2 km observational (photo) units). For photo plots located on a 20 x 20 km grid, it means that an area of 2 x 2 km around each node is interpreted in full according to the land cover classification system in Appendix II, the land use classes in Appendix III and existing procedures for deriving other forest stand attributes. Aerial photos should be on a scale of 1:20,000 or larger. The shape of the photo-plots is square, but their size depends on the chosen NFI network. The following recommendations are based on a constant survey of 1% of the area:

Network	Size of square photo-plots
80 x 80 km	8 x 8 km
60 x 60 km	6 x 6 km
40 x 40 km	4 x 4 km
20 x 20 km	2 x 2 km
16 x 16 km	1.6 x 1.6 km
12 x 12 km	1.2 x 1.2 km
8 x 8 km	0.8 x 0.8 km
4 x 4 km	0.4 x 0.4 km

All photo plots must have the same geographic orientation to ensure consistency over time and among plots. Photo plots are centered on the node of the national network (grid). The entire area in a photo-plot is classified into ‘polygons’ according to the land classification given in Appendix II or by a compatible system (i.e., one or more classes in an alternate classification scheme relate to one and only one class in the national scheme). It is an essential requirement that the entire area of a photo-plot is classified. Photo-plots straddling provincial/territorial boundaries, national borders and coastlines will invariably have areas not covered by the land cover classes in Appendix II. These ‘non-classified’ areas should be labeled using one of the land use classes in Appendix III.

Allocation of photo plots to sample locations within an inventoried region is done according to the adopted design for a region. If one of the NFI grids is chosen (with spacing of 4, 8, 12, 16, 20, 40, 60, and 80 km) the locations are ‘fixed’ but the number of points to be included in the sample can still be selected randomly or systematically. It is essential to document all aspects of the sampling design.

The actual location of the photo plot needs to be determined accurately. Corner coordinates of square photo plots will be produced by CFS.

The following attributes are registered for each polygon in a photo plot:

- polygon number
- polygon area
- disturbance
- land cover (see Appendix II)
- land use (see Appendix III)
- tree species
- age
- tree cover origin
- regeneration
- forest structure
- mortality
- soil erosion
- total stand volume
- ownership (Auxiliary attributes)
- harvest activities (Auxiliary attributes)
- exotics (Auxiliary attributes)
- protection status (Auxiliary attributes)
- conversion of forest land (Auxiliary attributes)

- access and human influence (Auxiliary attributes)

A data model for attributes from NFI photo-plots are given in Appendix VI.

NFI satellite plots

Satellite imagery will contribute significantly to the national forest inventory by providing attribute data for areas otherwise not covered by either photo or ground plots. These areas will mainly be concentrated in Canada's north and in areas where access poses a real challenge. Satellite imagery will also be used to assess the extent of change and need to revisit past surveyed plots. Extended use of satellite imagery over larger contiguous regions can be used to confirm the inventory - are the photo and ground samples biased in some way? The attributes to be gathered from satellite imagery are listed in Appendix VII (they assume a classification based on multiple dates and use of spatial context information⁷). They may be more 'broad banded' than corresponding ground or photo based attributes. As well, resolution and quality of images may impose additional limits on interpretation of attributes. The additional attributes to be gathered from satellite plots include:

- image date
- wavelengths
- cloud cover
- pixel size
- image classification
- entropy

Attributes derived by satellite imagery should comply as much as possible with the attributes and spatial specifications of the photo plots. They must fall within the hierarchy of the classification system to maintain a common denominator. As for photo-plots, the expected minimum sampling intensity is a survey of about 1% of Canada's land area attained by, for example, sampling of 2 x 2 km 'windows' on a 20 x 20 km net. Alternative 'windows' and net spacing providing the same overall sampling intensity are tabled in the photo plot section. Opportunities to map entire regions by classification of satellite images should be pursued where feasible.

Auxiliary NFI attributes from management records and other data sources

Attributes related to land-use, ownership, protection status, access, human influence, conversion of forest lands, and the origin of exotic trees are best collected from management records, other data sources, and maps. For each sample location (ground, photo, and satellite imagery) the following attributes are reportable for the NFI:

- land use (see Appendix III)
- land ownership
- harvest volume
- exotics
- protection status
- land use conversion
- access/human influence

The auxiliary NFI attributes are described in Appendix VIII.

⁷ spatial context information can be based on variograms, segmentation analysis, 'expert rules', and fuzzy logic

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Appendix I. Definitions of NFI terms, excluding terms defined and used in the land cover classification system (Appendix II).

Term	Definition
Aforestation	Reforestation where no forest has grown for some time. (Source: NFI)
Age	The mean age of the leading species (up to three) of the trees in the plot estimated from the dominant, co-dominant and high intermediate crown positions. Age can be defined as years since germination, years since establishment or years since achieving 1.3 m in height. (Source: NFI)
Age class	The 20-year age interval containing the age of a forest stand or tree (0-20, 21-40, 41-60, etc). (Source: NFI)
Area available for timber production	Forest where any legal, economic, or specific environmental restrictions do not have a significant impact on the wood supply. (Source: FAO)
Biomass	Tree biomass: Total above ground biomass in tonnes per hectare of trees > 1.3 m tall. Stump biomass: Total above ground biomass in tonnes per hectare of stumps. Shrub biomass: Total above ground biomass in tonnes per hectare of shrubs and trees <1.3 m tall. Herb biomass: Total above ground biomass in kg per hectare of herbs and grasses.
Deforestation	Clearing an area of forest for another long-term use. (Source: CCFM)
Disturbance	A discrete force that has caused significant change in structure and/or composition of the forest during the last 10 years (e.g., a change resulting in the normal growth pattern of the forest being significantly reduced (>50%).
Disturbance extent	Extent of disturbance: Low (<20%), moderate (21-50%) and severe (>50%). (Source: NFI)
Exotic (introduced) tree species	Tree species occurring outside their natural vegetation zone, area or region. (Source: FAO).
Forest dependent species	Species that can not complete a full life-cycle outside the forest. (Source: NFI).
Forest land	Land at least 10 percent stocked by trees of any size, including land that formerly had tree cover and that will be naturally or artificially restocked. Trees should be able to reach a minimum height of 5 m at maturity. (Source: FAO)
Forest structure	The structure of the prevailing forest cover. Can be even aged or single storied, uneven aged, or two or more distinct canopy layers. (Source: NFI)
Forest type	A group of forested areas or stands of similar composition which

	differentiates it from other such groups. Examples are softwood, mixedwood and hardwood. (Source: CANFI 1991)
Forests undisturbed by man	Forest land which shows natural forest dynamics, such as natural tree competition, occurrence of dead wood, natural age structure, and natural regeneration processes, the area of which is large enough to maintain its natural characteristics and where there has been no known significant human intervention or where the last known human intervention was long enough ago to have allowed the natural species composition and processes to have become established. (Source: FAO)
Increment (volume growth)	Current volume growth: The increment for a given year. (Source: CFIC) Mean Annual Increment: The average annual increment for the total age. (Source: CFIC) Net Annual Increment: The average annual increment for the total age, less natural mortality. (Source: CFIC)
Mortality	Dead trees in the plot since last measurement, or during the last five years if no previous measurement. (Source: NFI)
Native (indigenous) tree species	Tree species which have evolved in the same area, region or biotope where the forest stand is growing and are adapted to the specific ecological conditions predominant at the time of the establishment of the stand. (Source: MP)
Network label	The National Forest Inventory 20 km network label that identifies the point on the network associated with the sample plot. (Source: NFI)
Origin of seedlings in regenerating areas	The geographic location (eco-region, eco-district) of origin (either "local", or a descriptive name identifying the origin of the planted material). (Source: NFI)
Other wooded land	Land either with a tree crown cover (or equivalent stocking level) of 5-10 percent of trees able to reach 5 m at maturity or a crown cover (or equivalent stocking level) of more than 10 percent of trees not able to reach 5 m at maturity. (Source: FAO)
Polygon identification	The unique number assigned to each vegetated or non-vegetated polygon after it is delineated. (Source: NFI)
Protection status	The International Union for Conservation of Nature categories are: I. a. Strict Nature Reserve: protected for science. I. b. Wilderness Area: protected for wilderness. II. National Park: for ecosystem protection and recreation. III. Natural Monument: for conservation of specific natural features. IV. Habitat/Species Management Areas: for maintaining habitats. V. Protected Landscape/Seascape: for conservation and recreation. VI. Managed Resource Protected Area: for sustainable use of natural ecosystems.

Protective functions	The role of the land in providing protection/non-timber services is clearly defined and determines management practices/intervention of land with a specific protective function. Examples of protective function are water supply, erosion, avalanches, stream protection, fisheries, riparian protection. (Source: NFI)
Regeneration	The renewal of a forest stand after disturbance, by natural or artificial means. (Source: CCFM)
Significant soil erosion	Soil erosion affecting more than 30% of the plot. (Source: NFI)
Succession	Changes in the species composition of an ecosystem over time, often in a predictable order. (Source: CCFM)
Successional stage	Pioneer, Young (early, mid, late), Stable (mature or climax). (Source: Canada/Provincial ecosystem classification field guides)
Surface water in forests	Lakes, rivers, streams, swamps.
Tree	For the purposes of this inventory a tree is defined as a woody plant, >1.3 m in height/length, with roots attached to the bole, larger than 4.0 cm DBH, usually with a single trunk and a definite crown. The definition includes live standing, live fallen, dead standing (roots attached) and dead fallen (roots attached). Trees smaller than 1.3 m and 4.0 cm DBH are tallied separately in the subplot. (Source: NFI)
Tree species	Species listed in the National Forest Inventory tree list found in Appendix X.
Tree volume	Total volume: Volume inside bark of the main stem, including stump and top as well as defective and decayed wood, of trees or stands. (Source: CFIC) Gross merch. volume: Volume inside bark of the main stem, excluding stump and top but including defective and decayed wood, of trees or stands. (Source: CFIC) Net merch. volume: Volume inside bark of the main stem, excluding stump and top as well as defective and decayed wood, of trees or stands. (Source: CFIC)

Appendix II. National Forest Inventory Land Cover Classification Scheme (adopted from the B.C. Land Cover Classification Scheme, 1999).

Appendix III NFI Land-use classification system

Appendix IV Technical specifications of the NFI sample locations.

The basic 4 x 4 km net was created with ARC/INFO (version 7.0 for UNIX) via the command `<generate>` using the `<fishnet>` option. This created a line coverage and the `<nodepoint>` command was used to create unique points and their labels. The 4 x 4 km net consists of a mesh of 1,549,376 points covering the entire Canadian land-mass and offshore territory. The orientation of the rows in the net are not directly east-west, rather it is tilted to the south (Figure 1).

The origin or southwest hand corner of the net was chosen to maximize the number of points falling on Canada's land mass. Each point has a unique number (see attributes below). Numbering of net nodes was done in a row-wise fashion, starting with "1" at the upper northwest of the net and proceeding across the columns (eastward) of each row. The last point on the grid is "1549376" at the southeast corner.

A Lambert conformal conic projection was chosen as the most appropriate for the project. A Lambert conformal conic projection is suited for the range of latitudes covering Canada's managed forests. All angles between neighboring grid points are multiples of 90 degrees (planar). Local angles are accurate throughout.

The net coverage was then projected onto a Geographic Reference System. Latitude and longitude values were calculated to the nearest 0.00001° (~1 m) using the Arc/Info `<addxy>` command. This accuracy is consistent with the UTM coordinates given to the nearest 1m.

The net was also projected onto the UTM projection system to obtain northing and easting of each net node. This was done for each of Canada's 16 UTM zones (zones 7 - 22).

More projection details:

- Projection	Lambert conformal conic
- Units	metres
- 1st standard parallel	51.00 degrees
- 2nd standard parallel	58.00 degrees
- Central meridian ⁸	-126.00 degrees
- Latitude of projections origin	48.00 degrees
- False easting	1000000 metres
- False northing	0 metres
- North American datum of 1983 (NAD83)	
(using the Canadian national transformation, CNT)	

The Following attributes have been calculated and added to each sampling location:

- (#) - an internal ARC/INFO record number
- (id) - a second internal ARC/INFO identifier
- Label - a unique number assigned to each and every point
- Lat - Latitude in decimal degrees to 5 decimal places
- Lon - Longitude in decimal degrees to 5 decimal places
- UTM-zone - Universal Transverse Mercator coordinate system zone number
- UTM-north - northing in meter of UTM coordinate system (nearest meter)
- UTM-east - easting in meter of UTM coordinate system (nearest meter)
- PROV - Provincial identifier code based on 1:2,000,000 scale data of Canada - Source: Geomatics Canada, National Atlas Digital Data, Geo Access Division using symbols from Canada Post

⁸ this meridian runs through Vancouver Island (approximately through its geographic 'center')

- Ecozone-identifier - based on 1:7,500,000 scale data from Agriculture and Agrifood Canada terrestrial ecozones 1995⁹ [1 = Arctic cordillera, 2 = Northern arctic, 3 = Southern arctic, 4 = Taiga plains, 5 = Taiga shield, 6 = Boreal shield, 7 = Atlantic maritime, 8 = Mixed wood plains, 9 = Boreal plains, 10 = Prairies, 11 = Taiga cordillera, 12 = Boreal cordillera, 13 = Pacific maritime, 14 = Montane cordillera, 15 = Hudson plains, 16 = designation for the area of the Great Lakes which is within Canada's International Boundary¹⁰]
- NTS - national topographic map series number of NTS map sheet containing the node (provides orientation aide for inventory planning)
- PROVMAP - The number or letter designation of provincial map sheets (not yet completed for all provinces and territories)
- GRID8, GRID12, GRID16, GRID20, GRID40, GRID60 and GRID80 - Each 4 km x 4 km point has been given a value of "one" if it is a subset of any one of the above grids. Selecting GRID20 = 1, for example, will select all 4 km x 4 km points that fall on the 20 km x 20 km net.

Note: Provinces have been 'cut' out of the national grid via the PROV identifier. Provincial/territorial outlines are those of the 1:2,000,000 digital atlas of Canada. Minor discrepancies may surface when plot locations are transferred to other map-scales.

⁹ zone boundaries were modified to match 1 : 2,000,000 scale data of Canadian boundaries and coastline

¹⁰ this is not an officially designated ecozone

Appendix V NFI attributes from ground plots

Introduction

NFI attributes from ground plots will be compiled by the provinces and territories prior to submitting to the CFS for summary. Each agency has its own measurement and compilation protocols and it is not the intent of this document to instruct on how to measure a plot or compile plot data. It is expected that an auditor, using the same protocols, will arrive at the same answer.

Objectives

- To provide a list of NFI attributes from ground plots.
- To facilitate a standard format for national compilation.
- To provide definitions, measurement criteria, standards, reporting instructions and examples of input formats.

Standards

The standards in this Appendix describe the acceptable tolerance for each attribute. In addition standards are described, where appropriate, under “measurement criteria” for data elements that need to be measured to derive the attribute.

Attribute	Plot location
Definition	<ul style="list-style-type: none"> • Location around which detailed ground sample information will be collected. • All measurement attributes are attached to the plot location. • For example: In a 5-point plot cluster, the plot location would be found at the center of the cluster.
Measurement criteria	These plots are permanent. GPS should be used to establish plot location where practical.
Standard	<ul style="list-style-type: none"> • To the nearest 20 meters for Lat. and Long.
Reporting instructions	<ul style="list-style-type: none"> • Location reported in decimal degrees of Latitude and Longitude.
Input format	49.20668,102.33714;

Attribute	Network label
Definition	<ul style="list-style-type: none"> • The National Forest Inventory 20 km network label that identifies the point on the network associated with the ground sample plot.
Measurement criteria	
Standard	Authorized number only. No errors, 100% of time.
Reporting instructions	Provided by CFS.
Input format	3568

Attribute	Polygon identification
Definition	<ul style="list-style-type: none"> • A unique number assigned to each vegetated or non-vegetated polygon after it is delineated. • A unique polygon number will be assigned to each polygon in the National Forest Inventory. • Identifies the polygon containing the plot location of the ground plot.
Measurement	

criteria	
Standard	No duplication polygon numbers are allowed. No errors, 100% of time.
Reporting instructions	Recorded as a combination of network label and polygon identifier
Input format	3568,32

Attribute	Year of measurement
Definition	<ul style="list-style-type: none"> The year the ground sample measurements were acquired in the field.
Measurement criteria	
Standard	Correct year, 100% of time.
Reporting instructions	
Input format	2001

Attribute	Plot design
Definition	<ul style="list-style-type: none"> Description of the ground plot design used to collect sample measurements.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> Assigned as: <ul style="list-style-type: none"> FCP: fixed area circular plot. FAP: fixed area non-circular plot. VRP: variable radius plot. VRPC: variable radius plot with VRP clusters. LIS: line intersect sampling. For complex design combine the appropriate components
Input format	FCP; FCP.VRPC; FCP.VRPC.LIS

Attribute	Plot size
Definition	<ul style="list-style-type: none"> The number and size of each component of the ground sample plot.
Measurement criteria	All distances (plot radius, plot side lengths and LIS) to be within +- 2% of horizontal distance.
Standard	Correct plot size, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> Reported as: <ul style="list-style-type: none"> Area in square meters for FCP plots. Side lengths in meters for FAP plots. Basal area factor for VRP plots. Line length in meters for LIS.
Input format	General format is: Number of units.size of unit (repeat for each design component). For example: 1.FCP.200,4.VRPC.12,1.LIS.24 = a combination of one fixed circular plot of 200 square meters, four variable radius plots (a cluster) with basal area factor of 12, and one line intersect plot of 24 meters.

Attribute	Disturbance
Definition	<ul style="list-style-type: none"> A discreet force that has caused significant change in structure and/or composition of the forest during the last 10 years (e.g., a change resulting in the normal growth pattern of the forest being significantly reduced (>50%). Disturbance interventions could result from: <ul style="list-style-type: none"> Natural physical events: <ul style="list-style-type: none"> Fire Flood Windthrow

	<ul style="list-style-type: none"> - Mortality caused by insect or disease outbreaks - Human-caused events <ul style="list-style-type: none"> ▪ Harvest - Other
Measurement criteria	
Standard	Disturbance correctly identified, 95% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - DIST.Y: Significant disturbance present. - DIST.N: No significant disturbance.
Input format	DIST.Y; DIST.N

Attribute	Disturbance agent
Definition	Agent of disturbance.
Measurement criteria	
Standard	Disturbance agent correctly identified, 95% of time.
Reporting instructions	Reported as agent of disturbance. Assigned as: <ul style="list-style-type: none"> - DIST.HARVFULL: Stand has been harvested in full (>80% by crown area of previous forest cover has been removed). - DIST.HARVPART: Stand has been harvested in part (<80% by crown area of previous forest cover remains). - DIST.FIRE: Plot has experienced a significant fire. - DIST.WIND: Trees in plot have experienced windthrow. - DIST.SNOW: Trees in plot have experienced significant snow damage. - DIST.INSECT: Trees in plot have experienced significant insect attack. (Note: It can take several years of defoliation to do permanent damage to a tree. The threshold for significant defoliation varies depending on pest). - DIST.DISEASE: Trees in plot have experienced a significant disease outbreak. - DIST.OTHER: Plot has experienced other disturbances during the last 10 years. Replace OTHER by a word that better describes the type of disturbance agent.
Input format	DIST.HARVPART,DIST.WIND;

Attribute	Disturbance extent
Definition	Extent of disturbance in classes.
Measurement criteria	<ul style="list-style-type: none"> • Low: <20% • Medium: 21-50% • Severe: >50%
Standard	Extent to be within correct class, 95% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - DIST.LOW: Low - DIST.MED: Medium - DIST.SEV: Severe
Input format	DIST.LOW;DIST.MED;

Attribute	Disturbance basis
Definition	Basis for assigning disturbance extent.
Measurement criteria	
Standard	Correct basis, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Basis for disturbance extent assigned as: <ul style="list-style-type: none"> - DIST.VOL: Volume - DIST.BA: Basal area

	<ul style="list-style-type: none"> - DIST.CA: Crown area - DIST.ST: Stem numbers - DIST.AR: Area
Input format	DIST.AR,DIST.CA;

Attribute	Disturbance year
Definition	<ul style="list-style-type: none"> • An estimate of the first year of the recorded disturbance.
Measurement criteria	
Standard	Disturbance year must be related to disturbance agent.
Reporting instructions	<ul style="list-style-type: none"> • An estimate of year of disturbance is recorded for each disturbance agent. • Multiple disturbances listed in order of occurrence.
Input format	DIST.1988,DIST.1994; Using the same example as in “Disturbance type”, the stand was harvested in part in 1988 and experienced windthrow in 1994.

Attribute	Land base
Definition	<ul style="list-style-type: none"> • First level of the Land Cover Classification System (Appendix 11). • Presence or absence of vegetation within the boundaries of the plot.
Measurement criteria	A measured estimate (ex. paced), not a guess.
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - V: vegetated. - N: non-vegetated
Input format	V; N

Attribute	Land cover
Definition	<ul style="list-style-type: none"> • Second level of the Land Cover Classification System (Appendix 11). • Presence or absence of trees for vegetated plots. • Land or water for non-vegetated plots.
Measurement criteria	A measured estimate.
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated plots: <ul style="list-style-type: none"> ▪ T: treed ▪ N: non-treed - For non-vegetated plots: <ul style="list-style-type: none"> ▪ L: land ▪ W: water
Input format	T/N; L/W

Attribute	Landscape position
Definition	<ul style="list-style-type: none"> • Third level of Land Cover Classification System (Appendix 11). • Location of the plot relative to elevation and drainage.
Measurement criteria	Estimate
Standard	No errors, 95% of time to allow for transition, otherwise no errors, 100% of time.

Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - A: alpine - W: wetland - U: upland
Input format	A;W;U

Attribute	Vegetation type
Definition	<ul style="list-style-type: none"> • Fourth Level of Land Cover Classification System (Appendix 11). • The distinct type of vegetation or non-vegetated condition of the land base within the plot.
Measurement criteria	A measured estimate.
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated, treed plots: <ul style="list-style-type: none"> ▪ TC: coniferous ▪ TB: broadleaf ▪ TM: mixed - For vegetated, non-treed plots: <ul style="list-style-type: none"> ▪ ST: shrub tall ▪ SL: shrub low ▪ HE: Herb, HF: Herb Forb, HG: Herb Graminoid . ▪ BY: Bryoid, BM: Bryoid Moss, BL: Bryoid Lichen. - For non-vegetated plots: <ul style="list-style-type: none"> ▪ SI: snow/ice ▪ RO: rock/rubble ▪ EL: exposed land
Input format	TC/TB/TM; ST/SL/HE/BY; SI/RO/EL

Attribute	Density class
Definition	<ul style="list-style-type: none"> • Fifth level of Land Classification System (Appendix 11). • Vegetation densities for vegetated plots and a further classification of non-vegetated plots.
Measurement criteria	A measured estimate.
Standard	No errors, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated plots: <ul style="list-style-type: none"> ▪ DE: Dense ▪ OP: Open ▪ SP: Sparse - For non-vegetated plots: <ul style="list-style-type: none"> ▪ SI (Snow/Ice) from Level 4 is further classified. ▪ RO (Rock/Rubble) from Level 4 is further classified. ▪ EL (Exposed Land) from Level 4 is further classified.
Input format	DE/OP/SP; etc.

Attribute	Tree species
Definition	<ul style="list-style-type: none"> • For the purposes of this inventory a tree is defined as a woody plant, >1.3 m in height/length, with the roots attached to the bole, larger than 4.0 cm DBH, capable of reaching 5 m in height at maturity, usually with a single trunk and a definite crown.

	<ul style="list-style-type: none"> The tree definition includes live standing, live fallen, dead standing (roots attached), dead fallen (roots attached). Note: dead fallen (roots attached) is a tree and also coarse woody debris (CWD). Dead standing (without roots) and dead fallen (without roots) is not a tree, but is CWD. Refer to NFI tree list in Appendix X for authoritative names.
Measurement criteria	List all species. If unsure of species, use SPP (do not guess). SPP is a correct call when audited.
Standard	No errors in tree count, 100% of time. No errors in genus, 100% of time. No errors in species, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> Reported in descending order by quantitative criteria (see Leading Species Criteria). Recorded using first four letters of the scientific <i>genus</i> name and first three letters of the scientific <i>species</i> name. Unidentified species recorded as SPP.
Input format	PICE.MAR,PICE.GLA, BETU.PAP,SALI.SPP

Attribute	Leading species criteria
Definition	<ul style="list-style-type: none"> Quantitative criteria used to rank species occurrence.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> Assigned as: <ul style="list-style-type: none"> CA: Crown area. VOL: Volume. BA: Basal area. COUNT: Stem numbers
Input format	CA; VOL; BA; COUNT;

Attribute	Leading species percent
Definition	<ul style="list-style-type: none"> Percentage of each species in the plot determined by quantitative criteria used to rank species occurrence.
Measurement criteria	
Standard	No errors in rank, 100% of time.
Reporting instructions	Record to the nearest percent.
Input format	43,19,17,8

Attribute	Age
Definition	The mean age of the trees in the plot.
Measurement criteria	Age of leading species (up to three) in the plot using local procedures.
Standard	
Reporting instructions	<ul style="list-style-type: none"> Recorded to the nearest year. Age is estimated: <ul style="list-style-type: none"> For even aged stands: <ul style="list-style-type: none"> From the dominant, co-dominant and high intermediate crown positions. For multi layered stands: <ul style="list-style-type: none"> From the dominant, co-dominant and high intermediate trees in each layer. For uneven aged stands:

	<ul style="list-style-type: none"> ▪ From the youngest and oldest to create an age range and median. • Assigned as : <ul style="list-style-type: none"> - EVEN: Even aged stand. - UNEVEN: Uneven aged stand. - MULTI: Multi layered stand.
Input format	EVEN.90; UNEVEN.40-70-120; MULTI.30,50,90;

Attribute	Age determination
Definition	<ul style="list-style-type: none"> • Method used to determine age.
Measurement criteria	
Standard	No errors in method, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - CBH: Coring at breast height. - COUNT: Counting techniques (whorls). - EST: Estimate (trees with rotten centers). - REC: Management records
Input format	CBH; COUNT; EST; REC

Attribute	Age definition
Definition	<ul style="list-style-type: none"> • Definition of age.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - ABH: Age at breast height. - AFS: Age from seed. - AES: Age from establishment
Input format	ABH; AFS; AES

Attribute	Tree cover origin
Definition	<ul style="list-style-type: none"> • Origin of the prevailing tree cover in the plot.
Measurement criteria	
Standard	No errors in origin, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - HARV: Regeneration after harvest. - DIST: Regeneration after other disturbance. - AFOR: Regeneration – conversion of previously non-forested land to forest (afforestation).
Input format	HARV; DIST;

Attribute	Regeneration
Definition	Renewal of the forest by natural or artificial means.
Measurement criteria	
Standard	No errors in regeneration, 95% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - NAT: Natural regeneration. - SUP: Natural regeneration with supplementary planting (<50%). - PLA: Planted regeneration. - SOW: Seeded regeneration.
Input format	NAT; SUP;

Attribute	Forest structure
Definition	<ul style="list-style-type: none"> The structure of the prevailing forest cover in the plot (if treed).
Measurement criteria	
Standard	No errors in category, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> Assigned as: <ul style="list-style-type: none"> EVEN: Even aged or single storied. UNEVEN: Uneven aged. MULTI: Two or more distinct canopy layers
Input format	EVEN; UNEVEN; MULTI;

Attribute	Small tree species
Definition	Tree species <1.3 m tall or smaller than 4.0 cm DBH.
Measurement criteria	<ul style="list-style-type: none"> Use understory vegetation plot for small trees.
Standard	<ul style="list-style-type: none"> No errors in trees genus, 96% of time. No errors in tree species, 90% of time.
Reporting instructions	<ul style="list-style-type: none"> Record trees <1.3 m tall and >10 cm. tall. Ranked in order based on number of stems per hectare. Recorded using first four letters of scientific <i>genus</i> name and first three letters of scientific <i>species</i> name. Refer to NFI tree list in Appendix X for authoritative names.
Input format	TSUG.HET.300,THUJ.PLI.50;

Attribute	Small tree plot size
Definition	<ul style="list-style-type: none"> The size in square meters of the small tree plot.
Measurement criteria	Plot radius or plot side lengths to be within +/- 2% of horizontal distance.
Standard	No errors in size, 100% of time.
Reporting instructions	
Input format	STP.10

Attribute	Understory vegetation
Definition	<ul style="list-style-type: none"> Non-tree species.
Measurement criteria	
Standard	<ul style="list-style-type: none"> No errors in genus, 94% of time. No errors in species, 88% of time.
Reporting instructions	<ul style="list-style-type: none"> Recorded by layer (refer to Appendix I for description of vegetation layers) as: <ul style="list-style-type: none"> B1: Tall shrubs > 2m tall. B2: Low shrubs < 2m tall. C: Herbs, graminoids, forbs. D: Bryoids (mosses, lichens, liverworts). Ranked in order by layer, based on area of plant cover in plot. Recorded by layer using first four letters of scientific <i>genus</i> name and first three letters of scientific <i>species</i> name. Percentage of plot area by layer covered by listed species is entered with suffix .C## where ## is cover in %. Unidentified genus recorded by layer as: <ul style="list-style-type: none"> S#: Shrubs H#: Herbs

	<ul style="list-style-type: none"> - B#: Bryoids where # is the total number. • Unidentified species recorded by layer as SPP# where # is the total number.
Input format	B1.VACC.OVA.C60,GAUL.SHA.C20; B2.RUBU.LAS.C10;

Attribute	Understory vegetation plot size
Definition	<ul style="list-style-type: none"> • The size of the understory vegetation plot.
Measurement criteria	Plot radius or plot side lengths to be within +- 2% of horizontal distance.
Standard	No errors in size, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Record area in square meters.
Input format	UVP.10

Attribute	Mortality
Definition	<ul style="list-style-type: none"> • Dead trees in the plot since last measurement, or during the last five years if no previous measurement.
Measurement criteria	
Standard	<ul style="list-style-type: none"> • No errors in cause of mortality, 90% of time.
Reporting instructions	Cause of mortality assigned as: <ul style="list-style-type: none"> - MORT.FIRE - MORT.WIND - MORT.DISEASE - MORT.INSECT - MORT.OTHER
Input format	MORT.DISEASE;

Attribute	Mortality extent
Definition	Extent of mortality in %
Measurement criteria	
Standard	Extent to be within +- 10%, 100% of time.
Reporting instructions	Report to nearest %
Input format	MORT.40

Attribute	Mortality basis
Definition	Basis for mortality extent.
Measurement criteria	
Standard	Correct basis, 100% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - MORT.VOL: Volume - MORT.BA: Basal area - MORT.CA: Crown area - MORT.ST: Stem numbers - MORT.AR: Area
Input format	MORT.BA;

Attribute	Soil erosion
Definition	<ul style="list-style-type: none"> • Significant soil erosion affecting more than 30% of the plot.

Measurement criteria	Measured estimate.
Standard	<ul style="list-style-type: none"> • No errors in causal agent, 97% of time. .
Reporting instructions	<ul style="list-style-type: none"> • Causal agent assigned as: • Assigned as: <ul style="list-style-type: none"> - SOIL.NATURAL: Natural erosion caused by soil instability. - SOIL.RUNOFF: Erosion caused by surface water runoff. - SOIL.AVALANCHE: Erosion caused by avalanches. - SOIL.HARVEST: Erosion caused by harvesting operations (includes roads) within the last 10 years. - SOIL.TRAFFIC: Erosion caused by heavy equipment traffic. - SOIL.ROAD: Erosion caused by road construction (other than harvest roads) within the last 10 years. - SOIL.MINE: Erosion caused by mining within the last 10 years. - SOIL.OTHER: Other causes of erosion or causes not understood.
Input format	SOIL.HARVEST; SOIL.ROAD

Attribute	Soil erosion extent
Definition	Extent of soil erosion in % (more than 30%).
Measurement criteria	
Standard	Extent to be within +- 10%, 100% of time.
Reporting instructions	Report to nearest %.
Input format	SOIL.43

Attribute	Tree biomass
Definition	<ul style="list-style-type: none"> • Total above ground biomass in kg per hectare of trees >1.3 m tall.
Measurement criteria	
Standard	
Reporting instructions	Assigned as BT followed by weight
Input format	BT.861

Attribute	Stump biomass
Definition	<ul style="list-style-type: none"> • Total above ground biomass in kg per hectare of stumps.
Measurement criteria	<ul style="list-style-type: none"> • Measure self-supporting stumps less than or equal to 1.3 m in length and 4.0 cm top diameter or greater. • Stems greater than 1.3 meters in length are measured as trees. • Stumps with roots detached from the ground are coarse woody debris.
Standard	
Reporting instructions	Assigned as BST followed by weight.
Input format	BST.95

Attribute	Shrub biomass
Definition	<ul style="list-style-type: none"> • Total above ground biomass in kg per hectare of shrubs and trees <1.3m tall.
Measurement criteria	
Standard	
Reporting instructions	Assigned as BS followed by weight

Input format	BS.255
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Attribute	Herb biomass
Definition	<ul style="list-style-type: none"> Total above ground biomass in kg per hectare of herbs and grasses.
Measurement criteria	
Standard	
Reporting instructions	Assigned as BH followed by weight
Input format	BH.103

Attribute	Coarse woody debris biomass
Definition	<ul style="list-style-type: none"> Total above ground biomass in kg per hectare of coarse woody debris (CWD). CWD is defined as dead woody material located above the soil in various stages of decomposition.
Measurement criteria	<ul style="list-style-type: none"> CWD must be larger than 7.5 cm. at line transect crossing point, or the portion of the piece greater than 7.5 cm. in a fixed area plot. CWD is not self- supporting. Trees and stumps, intact in the ground are considered self –supporting. CWD can be in the form of felled and bucked logs and log decks. A fallen tree with roots in the ground and still alive, is not CWD. There is overlap between a tree and CWD. For example a dead fallen tree with roots attached is classed as a tree and CWD.
Standard	
Reporting instructions	Assigned as CWD followed by weight
Input format	CWD.927

Attribute	Biomass calculation
Definition	<ul style="list-style-type: none"> Description of biomass estimation procedures.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> Assigned as: <ul style="list-style-type: none"> TREE.EQS: Tree biomass converted from total volume of a tree to total above ground biomass of a tree by conversion factors. STAND.EQS: Total tree biomass obtained from stand level models relating stand attributes to stand biomass. TREE.MASS: Sub-samples of biomass taken and tree biomass weighed after drying to constant weight. SHRUB.MASS: Shrub layer biomass estimated from sub-samples by weighing. SHRUB.EQS: Shrub layer biomass estimated from model. HERB.MASS: Herb layer biomass estimated from sub-samples by weighing. HERB.EQS: Herb layer biomass estimated from model. ####.OTHER: Other biomass estimating procedures.
Input format	TREE.EQS; SHRUB.MASS; HERB.OTHER

Attribute	Biomass plot size
Definition	<ul style="list-style-type: none"> Size of plot(s) used to estimate biomass.
Measurement criteria	
Standard	No errors, 100% of time.

Reporting instructions	<ul style="list-style-type: none"> • Size in square meters or transect length in meters. • Plot type assigned as: <ul style="list-style-type: none"> - ST: Stumps. - S: Shrubs and trees <1.3m tall. - H: Herbs and grasses. - CWD: Coarse woody debris. Note: trees are same as main plot. • Plot design assigned as: <ul style="list-style-type: none"> - FAP: Fixed area plot - LIS: Line intersect
Input format	ST.FAP.30,S.FAP.5,H.FAP.5,CWD.LIS.24;

Attribute	Total tree volume
Definition	<ul style="list-style-type: none"> • Total volume in cubic meters per hectares for all trees (>1.3m tall). • Volume inside bark of the main stem, including stump and top as well as dead and decayed wood. • Includes dead windfalls (with roots attached) that are also CWD.
Measurement criteria	<ul style="list-style-type: none"> • Breast height: 1.3m above high side, +- 5% (or 6.5 cm) • Diameter at breast height: Average absolute variation of all dbh's checked must be within +- 2%. • Height/length: Average absolute variation of all heights checked must be within +- 5%.
Standard	+_10 m3/ha for volumes <50 m3/ha, +- 10% for volumes >50 m3/ha.
Reporting instructions	Report top diameter and stump height. <ul style="list-style-type: none"> - T: Top diameter. - S: Stump height.
Input format	T10.S30.V350. Plot volume is 350 cubic meters per hectare to a 10 cm top and 30 cm high stump.

Attribute	Volume increment
Definition	<ul style="list-style-type: none"> • Five year volume growth in m3 per hectare.
Measurement criteria	
Standard	Correct method of volume growth estimation, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Method of volume growth estimation assigned as: <ul style="list-style-type: none"> - REM: Difference between periodic measurements. - MOD: Model predictions - RGR: Basal area growth rates determined from increment cores. - EST: Estimate
Input format	12.MOD: Five year growth of 12 m3/ha, determined from a model. 10.EST: Five year growth of 10 m3/ha, estimated.

Soil attributes

1. Soil features

Attribute	Surficial material
Definition	Soil parent materials.
Measurement criteria	Classified according to their mode of formation.
Standard	No errors, 100% of time.
Reporting instructions	Reported as: <ul style="list-style-type: none"> - A: Anthropogenic

	<ul style="list-style-type: none"> - C: Colluvium - E: Eolian - F: Fluvial - FG: Glaciofluvial - L: Lacustrine - M: Morainal "Till" - O: Organic - R: Bedrock - V: Volcanic - W: Marine
Input format	E; F; W;

Attribute	Depth to soil features
Definition	Observed depth in cm to soil features.
Measurement criteria	<ul style="list-style-type: none"> • Measure from "zero depth" to soil feature. • "Zero depth" is mineral soil surface for mineral soils, and ground surface for organic soils.
Standard	<ul style="list-style-type: none"> • No errors in soil features, 100% of time. • Depth to be +/- 10%, 100% of time.
Reporting instructions	Soil features assigned as: <ul style="list-style-type: none"> - W: Water table or seepage - M: Mottles (not applicable in organic soils) - R: Root-restricting pan - B: Bedrock - F: Frozen layer - C: Carbonates - N: Not observable (glacier, lake, paved surface).
Input format	R.28; W.20; B.47;

Attribute	Humus form
Definition	Form of the organic and organic-enriched mineral horizons at the soil surface.
Measurement criteria	
Standard	No errors in humus form, 90% of time.
Reporting instructions	Humus form assigned as: <ul style="list-style-type: none"> - MO: Mor - MM: Mormoder - MD: Moder - MR: Mullmoder - MU: Mull - NA: Not applicable.
Input format	MO; MD; NA;

Attribute	Soil color
Definition	General color of the rooting-zone mineral soil.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	Color assigned as: <ul style="list-style-type: none"> - D: Dark - M: medium - L: Light - N: Not applicable (bedrock, no soil).
Input format	

2. Soil description

Attribute	Soil horizon
Definition	A profile of visually discernable organic and mineral layers of soil approximately parallel to the land surface.
Measurement criteria	
Standard	No errors, 95% of time.
Reporting instructions	The main types of organic and mineral soil horizons assigned as: - L, F, H, Ah, Ae, B, C, Of, Om, Oh, R Refer to the <i>Canadian System of Soil Classification</i> (ECSS 1987) for descriptions of the horizons and subordinate horizons.
Input format	A; B; C; L; F; H;

Attribute	Horizon depth
Definition	Average distance from “zero depth” in cm for each horizon in the profile.
Measurement criteria	<ul style="list-style-type: none"> For organic soils, “zero depth” is the top of the organic material. For mineral soils, “zero depth” for forest floor horizons (L,F,H) and mineral horizons (A,B,C) is the boundary between the forest floor and mineral horizons.
Standard	Depth to be within +/-10%, 100% of time.
Reporting instructions	
Input format	A.0.3; B.3.10; C.10.60; L.10.9; F.9.6; H.6.0;

Attribute	Mineral soil texture
Definition	<ul style="list-style-type: none"> Texture of each mineral soil horizon.
Measurement criteria	<ul style="list-style-type: none"> Grains 2 mm and less.
Standard	Correct class, 70% of time, and 90% of time in correct and adjacent class.
Reporting instructions	Soil texture assigned as: - C: Clay - SC: Sandy clay - SCL: Sandy clay loam - CL: Clay loam - Si: Silt - SiS: Silty sand - SiL: Silt loam - SiCL: Silty clay loam - L: Loam - SL: Sandy loam - LS: Loamy sand - S: Sand - Vfs: Very fine sand - fS: Fine sand - mS: Medium sand - cS: Coarse sand - vcS: Very coarse sand
Input format	SiCL; Vfs;

Attribute	Coarse fragments
Definition	<ul style="list-style-type: none"> Percent of the total volume of soil material occupied by mineral particles larger than 2 mm in diameter.

	<ul style="list-style-type: none"> • For each mineral soil horizon.
Measurement criteria	<ul style="list-style-type: none"> • Break total down into two categories: <ul style="list-style-type: none"> - Gravel: Greater than 2 mm and less than 7.5 cm. - Cobbles and stones: Greater than or equal to 7.5 cm.
Standard	<ul style="list-style-type: none"> • Correct category, 95% of time. • Percent gravel to be within +/-10%, 100 % of time. • Percent cobbles/stones to be within +/-10%, 100% of time.
Reporting instructions	Reported as: <ul style="list-style-type: none"> - Gr: Gravel - Co: Cobbles and stones
Input format	Ah.Gr.20.Co.15; B2.Gr.30

3. Soil Classification

Attribute	Order, Great Group and Subgroup
Definition	The highest three levels of generalization
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	Refer to the <i>Canadian System of soil classification (ECSS 1987)</i> for reporting instructions. The magnitude of the hierarchy is as follows: <ul style="list-style-type: none"> - Brunisolic (four Great Groups and eighteen Subgroups). - Chernozemic (four Great groups and eighteen Subgroups) - Cryosolic (three Great Groups and fifteen Subgroups) - Gleysolic (Three Great Groups and thirteen Subgroups) - Luvisolic (two Great groups and eighteen Subgroups) - Organic (four Great groups and thirty one Subgroups) - Podsollic (three Great Groups and twenty five Subgroups) - Regosolic (Two great groups and eight Subgroups) - Solonetzic (Three Great groups and twenty seven Subgroups)
Input format	O.HFP: Podzolic order, Humo-Ferric Podzol Great Group and Ortho Humo-Ferric Podzol Subgroup

Attribute	Family
Definition	The fourth level of soil classification
Measurement criteria	Derived from mineral soil texture
Standard	No errors, 95% of time
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - Fr: Fragmental - Ss: Sandy-skeletal - Ls: Loamy-sand - Cs: Clayey-skeletal - S: Sandy - L: Loamy - C: Clayey
Input format	Fr; Cs; L;

Appendix VI NFI Attributes from photo polygons

Objectives

- To provide a list of NFI attributes from photo plots.
- To facilitate a standard format for national compilation.
- To provide definitions, measurement criteria, standards, reporting instructions and examples of input formats.

Standards

The attributes from photo polygons are interpreted and therefore are only estimates. The competence of the interpreter is important. The interpreter must perform sufficient ground checks of the area to be interpreted, to become familiar with the various forest conditions that will be encountered. Interpreters must be consistent and the work must be corrected with ground truthing.

The standards in this Appendix describe the acceptable tolerance for each attribute. In addition, standards are described where appropriate, under “measurement criteria” for data elements that need to be measured to derive the attribute.

1. Photo plot attributes

Attribute	Plot location
Definition	<ul style="list-style-type: none"> • Center point of the photo plot. • Location around which photo attributes will be estimated.
Measurement criteria	<ul style="list-style-type: none"> • The photo plots are permanent. Plot locations can come from photographs if there are a minimum of two ground control points, or from a controlled base map.
Standard	<ul style="list-style-type: none"> • Correct location on map within +/- 2 mm, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Location reported in decimal degrees of Latitude and Longitude.
Input format	49.20668,102.33714;

Attribute	Network label
Definition	<ul style="list-style-type: none"> • The label that identifies the location of the photo plot on the National Forest Inventory 20 km network.
Measurement Criteria	
Standard	Authorized number only. No errors, 100% of time.
Reporting instructions	Provided by CFS.
Input format	3568

Attribute	Plot size
Definition	<ul style="list-style-type: none"> • Actual area of photo plot in square kilometers.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	Report to the nearest square meter.
Input format	PS4.000

Attribute	Year of photography
Definition	<ul style="list-style-type: none"> The year the aerial photography was acquired.
Measurement criteria	<ul style="list-style-type: none"> Photography no older than five years.
Standard	<ul style="list-style-type: none"> Actual year. No errors, 100% of time.
Reporting instructions	
Input format	1999

Attribute	Scale of photography
Definition	Approximate (nominal) scale of photography
Measurement criteria	Mid scale photography (1:10,000 to 1:20,000 scale).
Standard	Nominal scale, no errors, 100% of time.
Reporting instructions	
Input format	1: 15,000

2. Photo polygon attributes

Attribute	Polygon number
Definition	<ul style="list-style-type: none"> A unique number assigned to each vegetated or non-vegetated polygon delineated on the photo plot.
Measurement criteria	<ul style="list-style-type: none"> A unique polygon number will be assigned to each polygon in the National Forest Inventory. No duplicate polygon numbers are allowed
Standard	No errors, 100% of time.
Reporting instructions	Recorded as a combination of network label and polygon identifier
Input format	3568,18

Attribute	Polygon area
Definition	<ul style="list-style-type: none"> Area of the polygon in square meters.
Measurement criteria	<ul style="list-style-type: none"> No polygon may be less than 5,000 square meters (0.5 hectare). “Drilling” can be smaller. No polygon may be narrower than 40 meters (2.0 mm at 1:20,000).
Standard	<ul style="list-style-type: none"> Individual polygon area to be accurate. Sum of all polygons to equal area of plot (with 0.5 hectare allowance for roundoff in compilation).
Reporting instructions	Report to the nearest square meter.
Input format	PA20670

Attribute	Disturbance
Definition	<ul style="list-style-type: none"> A discreet force that has caused significant change in structure and/or composition of the forest during the last 10 years (e.g., a change resulting in the normal growth pattern of the forest being significantly reduced (>50%). Disturbance interventions could result from: <ul style="list-style-type: none"> Natural physical events: <ul style="list-style-type: none"> Fire Flood Windthrow Mortality caused by insect or disease outbreaks

	<ul style="list-style-type: none"> - Human-caused events <ul style="list-style-type: none"> ▪ Harvest - Other
Measurement criteria	
Standard	Disturbance must agree with quality assurance audit, 90% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - DIST.Y: Significant disturbance present. - DIST.N: No significant disturbance.
Input format	DIST.Y; DIST.N;

Attribute	Disturbance agent
Definition	Agent of disturbance.
Measurement criteria	
Standard	Disturbance agent must agree with quality assurance audit, 85% of time.
Reporting instructions	Reported as agent of disturbance. Assigned as: <ul style="list-style-type: none"> - DIST.HARVFULL: Stand has been harvested in full (>80% by crown area of previous forest cover has been removed). - DIST.HARVPART: Stand has been harvested in part (<80% by crown area of previous forest cover remains). - DIST.FIRE: Plot has experienced a significant fire. - DIST.WIND: Trees in plot have experienced windthrow. - DIST.SNOW: Trees in plot have experienced significant snow damage. - DIST.INSECT: Trees in plot have experienced significant insect attack. (Note: It can take several years of defoliation to do permanent damage to a tree. The threshold for significant defoliation varies with pest). - DIST.DISEASE: Trees in plot have experienced a significant disease outbreak. - DIST.OTHER: Plot has experienced other disturbances during the last 10 years. Replace OTHER by a word that better describes the type of disturbance agent.
Input format	DIST.HARVPART,DIST.WIND;

Attribute	Disturbance extent
Definition	Extent of disturbance in classes.
Measurement criteria	<ul style="list-style-type: none"> • Low: <20% • Medium: 21-50% • Severe: >50%
Standard	Extent to be within correct class, 95% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - DIST.LOW: Low - DIST.MED: Medium - DIST.SEV: Severe
Input format	DIST.LOW; DIST.MED;

Attribute	Disturbance basis
Definition	Basis for assigning disturbance extent.
Measurement criteria	
Standard	Correct basis, 100% of time.
Reporting instructions	Basis for disturbance extent assigned as: <ul style="list-style-type: none"> - DIST.VOL: Volume - DIST.BA: Basal area - DIST.CA: Crown area

	- DIST.ST: Stem numbers - DIST.AR: Plot area
Input format	DIST.AR,DIST.CA;

Attribute	Disturbance year
Definition	<ul style="list-style-type: none"> An estimate of the first year of the recorded disturbance.
Measurement criteria	
Standard	Disturbance year must be related to disturbance agent.
Reporting instructions	<ul style="list-style-type: none"> An estimate of year of disturbance is recorded for each disturbance agent Multiple disturbances listed in order of occurrence.
Input format	DIST.1988,DIST.1994;

Attribute	Land base
Definition	<ul style="list-style-type: none"> First level of the Land Cover Classification System (Appendix 11). Presence or absence of vegetation within the boundaries of a polygon.
Measurement criteria	Photo interpreted estimate.
Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> Assigned as: <ul style="list-style-type: none"> V: vegetated. N: non-vegetated
Input format	V; N

Attribute	Land cover
Definition	<ul style="list-style-type: none"> Second level of the Land Cover Classification System (Appendix 11). Presence or absence of trees for vegetated polygons. Land or water for non-vegetated polygons.
Measurement criteria	Photo interpreted estimate.
Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> Assigned as: <ul style="list-style-type: none"> For vegetated plots: <ul style="list-style-type: none"> T: treed N: non-treed For non-vegetated plots: <ul style="list-style-type: none"> L: land W: water
Input format	T/N; L/W

Attribute	Landscape position
Definition	<ul style="list-style-type: none"> Third level of Land Cover Classification System (Appendix 11). Location of the polygon relative to elevation and drainage
Measurement criteria	Photo interpreted estimate.
Standard	Must agree with quality assurance audit, 97% of time.
Reporting instructions	<ul style="list-style-type: none"> Assigned as: <ul style="list-style-type: none"> A: alpine W: wetland U: upland
Input format	A;W;U

Attribute	Vegetation type
Definition	<ul style="list-style-type: none"> • Fourth Level of Land Cover Classification System (Appendix 11). • The distinct type of vegetation or non-vegetated condition of the land base within the polygon
Measurement criteria	Photo interpreted estimate.
Standard	<ul style="list-style-type: none"> • For treed plots, must agree with quality assurance audit, 97% of time. • For non-treed plots, must agree with quality assurance audit, 85% of time. • For non-vegetated plots, must agree with quality assurance audit, 97% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated, treed plots: <ul style="list-style-type: none"> ▪ TC: coniferous ▪ TB: broadleaf ▪ TM: mixed - For vegetated, non-treed plots: <ul style="list-style-type: none"> ▪ ST: shrub tall ▪ SL: shrub low ▪ HE: Herb, HF: Herb Forb, HG: Herb Graminoid . ▪ BY: Bryoid, BM: Bryoid Moss, BL: Bryoid Lichen. - For non-vegetated plots: <ul style="list-style-type: none"> ▪ SI: snow/ice ▪ RO: rock/rubble ▪ EL: exposed land
Input format	TC/TB/TM; ST/SL/HE/BY; SI/RO/EL

Attribute	Density class
Definition	<ul style="list-style-type: none"> • Fifth level of Land Classification System (Appendix 11). • Vegetation densities for vegetated polygons and a further classification of non-vegetated polygons.
Measurement criteria	Photo interpreted estimate.
Standard	Must agree with quality assurance audit, 90% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated plots: <ul style="list-style-type: none"> ▪ DE: Dense ▪ OP: Open ▪ SP: Sparse - For non-vegetated plots: <ul style="list-style-type: none"> ▪ SI (Snow/Ice) from Level 4 is further classified. ▪ RO (Rock/Rubble) from Level 4 is further classified. ▪ EL (Exposed Land) from Level 4 is further classified.
Input format	DE/OP/SP; etc.

Attribute	Tree species
Definition	<ul style="list-style-type: none"> • For the purposes of this inventory a tree is defined as a woody plant, >1.3 m in height/length, with the roots attached to the bole, larger than 4.0 cm DBH, capable of reaching 5 m in height at maturity, usually with a single trunk and a definite crown. • The tree definition includes live standing, live fallen, dead standing (roots attached) and dead fallen (roots attached). Note: dead fallen (roots attached) is a tree and also coarse woody debris (CWD). • Refer to NFI tree list in Appendix X for authoritative names.
Measurement	<ul style="list-style-type: none"> • List the three leading species.

criteria	<ul style="list-style-type: none"> • If unsure of species, use SPP (do not guess). SPP is a correct call when audited.
Standard	<ul style="list-style-type: none"> • Genus must agree with quality assurance audit, 95% of time. • Species must agree with quality assurance audit, 80% of time. • Only species from the NFI tree list.
Reporting instructions	<ul style="list-style-type: none"> • Reported in descending order by quantitative criteria (see Leading Species Criteria). • Recorded using first four letters of the scientific <i>genus</i> name and first three letters of the scientific <i>species</i> name. • Unidentified species recorded as SPP.
Input format	PICE.MAR,PICE.GLA, BETU.PAP,SALI.SPP

Attribute	Leading species criteria
Definition	<ul style="list-style-type: none"> • Quantitative criteria used to rank species occurrence.
Measurement criteria	
Standard	Correct criteria, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - CA: Crown area. - VOL: Volume. - BA: Basal area. - COUNT: Stem numbers
Input format	CA; VOL; BA; COUNT;

Attribute	Leading species percent
Definition	<ul style="list-style-type: none"> • Percentage of the three leading species in the polygon determined by quantitative criteria used to rank species occurrence.
Measurement criteria	
Standard	<ul style="list-style-type: none"> • Leading species agree with quality assurance audit, 100% of time. • Second species in correct order, 90% of time.
Reporting instructions	<ul style="list-style-type: none"> • Record to the nearest percent.
Input format	47,22,19,

Attribute	Age
Definition	Age of leading species and second species in the polygon.
Measurement criteria	
Standard	<ul style="list-style-type: none"> • Ages to be within +- 5 years of quality assurance audit value for tree layers less than 41 years of age. • Ages to be within +-20 years of the quality assurance audit value for tree layers between 41 and 250 years of age. • Ages to be within +- 100 years of the quality assurance audit value for tree layers greater than 250 years of age.
Reporting instructions	<ul style="list-style-type: none"> • Recorded to the nearest year. • Age is estimated: <ul style="list-style-type: none"> - For even aged stands: <ul style="list-style-type: none"> ▪ From the dominant, co-dominant and high intermediate crown positions. - For multi layered stands: <ul style="list-style-type: none"> ▪ From the dominant, co-dominant and high intermediate trees in each layer. - For uneven aged stands: <ul style="list-style-type: none"> ▪ From the youngest and oldest to create an age range.

	<ul style="list-style-type: none"> • Assigned as : <ul style="list-style-type: none"> - EVEN: Even aged stand. - MULTI: Multi layered stand. - UNEVEN: Uneven aged stand.
Input format	EVEN.90; UNEVEN.40-70-120,MULTI.30,50,90;

Attribute	Age determination
Definition	<ul style="list-style-type: none"> • Method used to determine age.
Measurement criteria	
Standard	No errors in method, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - OCC: Ocular estimate. - REC: Management records
Input format	OCC; REC

Attribute	Age definition
Definition	<ul style="list-style-type: none"> • Definition of age.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - ABH: Age at breast height. - AFS: Age from seed. - AES: Age from establishment
Input format	ABH; AFS; AES

Attribute	Age class
Definition	<ul style="list-style-type: none"> • If age has been grouped into classes, then age class is the width of the class in years.
Measurement criteria	
Standard	No errors in age class width, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - AW.1: No age grouping. - AW.##: Width of class.
Input format	AW.1; AW.10; AW.20

Attribute	Tree cover origin
Definition	<ul style="list-style-type: none"> • Origin of the prevailing tree cover in the polygon.
Measurement criteria	Management records or other historic evidence.
Standard	Must agree with the quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - HARV: Regeneration after harvest. - DIST: Regeneration after other disturbance. - AFOR: Regeneration- conversion of previously non-forested land to forest (afforestation).
Input format	HARV; DIST;

Attribute	Regeneration
Definition	Renewal of the forest by natural or artificial means.
Measurement	Management records or other historic evidence.

criteria	
Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - NAT: Natural regeneration. - SUP: Natural regeneration with supplementary planting (<50%). - PLA: Planted regeneration. - SOW: Seeded regeneration.
Input format	NAT; SUP;

Attribute	Forest structure
Definition	<ul style="list-style-type: none"> • The structure of the prevailing forest cover in the polygon (if treed).
Measurement criteria	
Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - EVEN: Even aged or single storied. - UNEVEN: Uneven aged. - MULTI: Two or more distinct canopy layers.
Input format	EVEN; UNEVEN; MULTI;

Attribute	Mortality
Definition	<ul style="list-style-type: none"> • Dead trees in the polygon since last measurement, or during the last five years if no previous measurement.
Measurement criteria	Estimate likely cause of mortality.
Standard	<ul style="list-style-type: none"> • Cause of mortality must agree with quality assurance audit, 90% of time.
Reporting instructions	Cause of mortality assigned as: <ul style="list-style-type: none"> - MORT.FIRE - MORT.WIND - MORT.DISEASE - MORT.INSECT - MORT.OTHER
Input format	MORT.DISEASE;

Attribute	Mortality extent
Definition	Extent of mortality in %.
Measurement criteria	
Standard	Extent to be within +- 15% of quality assurance audit, 100% of time.
Reporting instructions	Report to nearest %.
Input format	MORT.40

Attribute	Mortality basis
Definition	Basis for mortality extent.
Measurement criteria	
Standard	Correct basis, 100% of time.
Reporting instructions	Mortality extent assigned as: <ul style="list-style-type: none"> - MORT.VOL: Volume - MORT.BA: Basal area - MORT.CA: Crown area - MORT.ST: Stem numbers

	- MORT.AR: Plot area
Input format	MORT.CA;

Attribute	Soil erosion
Definition	<ul style="list-style-type: none"> • Significant soil erosion affecting more than 0.5 hectare in the polygon.
Measurement criteria	
Standard	<ul style="list-style-type: none"> • Causal agent must agree with quality assurance audit, 90% of time.
Reporting instructions	<ul style="list-style-type: none"> • Causal agent assigned as: <ul style="list-style-type: none"> - SOIL.NATURAL: Natural erosion caused by soil instability. - SOIL.RUNOFF: Erosion caused by surface water runoff. - SOIL.AVALANCHE: Erosion caused by avalanches. - SOIL.HARVEST: Erosion caused by harvesting operations (includes roads) within the last 10 years. - SOIL.TRAFFIC: Erosion caused by heavy equipment traffic. - SOIL.ROAD: Erosion caused by road construction (other than harvest roads) within the last 10 years. - SOIL.MINE: Erosion caused by mining within the last 10 years. - SOIL.OTHER: Other causes of erosion or causes not understood.
Input format	SOIL.NATURAL; SOIL.MINE;

Attribute	Soil erosion extent
Definition	Extent of soil erosion in %.
Measurement criteria	
Standard	Extent of soil erosion must be within +/- 10% of quality assurance audit, 100% of time.
Reporting instructions	Report extent of polygon area affected to nearest 10%.
Input format	Soil.40;

Attribute	Total stand volume
Definition	<ul style="list-style-type: none"> • Total volume in m3 per hectares for all trees (>1.3m tall). • Volume inside bark of the main stem, including stump and top as well as dead and decayed wood. • Includes dead windfalls (with roots attached) that are also CWD.
Measurement criteria	Derived from photo estimates of species, height, basal area, etc. and appropriate volume equations/models. Can use relationship from ground plots to determine volume of smaller trees and windfalls.
Standard	
Reporting instructions	
Input format	V350: Polygon volume is 350 cubic meters per hectare.

Appendix VII NFI Attributes from remote sensing plots

Objectives

- To provide a list of NFI attributes from satellite imagery.
- To facilitate a standard format for national compilation.
- To provide definitions, measurement criteria, standards, reporting instructions and examples of input formats.

Standards

The attributes from photo polygons are interpreted and therefore are only estimates. The competence of the interpreter is important. The interpreter must perform sufficient ground checks of the area to be interpreted, to become familiar with the various forest conditions that will be encountered. Interpreters must be consistent and the work must be corrected with ground truthing.

The standards in this Appendix describe the acceptable tolerance for each attribute. In addition, standards are described where appropriate, under “measurement criteria” for data elements that need to be measured to derive the attribute.

1. Photo plot attributes

Attribute	Plot location
Definition	<ul style="list-style-type: none"> • Center point of the photo plot. • Location around which photo attributes will be estimated.
Measurement criteria	<ul style="list-style-type: none"> • The photo plots are permanent. Plot locations can come from photographs if there are a minimum of two ground control points, or from a controlled base map.
Standard	<ul style="list-style-type: none"> • Correct location on map within +/- 2 mm, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Location reported in decimal degrees of Latitude and Longitude.
Input format	49.20668,102.33714;

Attribute	Network label
Definition	<ul style="list-style-type: none"> • The label that identifies the location of the photo plot on the National Forest Inventory 20 km network.
Measurement Criteria	
Standard	Authorized number only. No errors, 100% of time.
Reporting instructions	Provided by CFS.
Input format	3568

Attribute	Plot size
Definition	<ul style="list-style-type: none"> • Actual area of photo plot in square kilometers.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	Report to the nearest square meter.
Input format	PS4.000

Attribute	Image date
Definition	<ul style="list-style-type: none"> The date the satellite data was acquired.
Measurement criteria	<ul style="list-style-type: none">
Standard	<ul style="list-style-type: none"> Actual date. No errors, 100% of time.
Reporting instructions	YYYY.MM.DD
Input format	1999.03.31

Attribute	Satellite
Definition	Name of satellite
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	
Input format	LANDSAT7

Attribute	Wavelengths
Definition	<ul style="list-style-type: none"> The wavelength (nm) ranges (minimum-maximum) of the image channels used for classification of plot attributes.
Measurement criteria	<ul style="list-style-type: none"> Nm
Standard	No errors, 100% of time.
Reporting instructions	Minimum-Maximum
Input format	630-690, 1550-1750, 2080-2350

Attribute	Cloud Cover
Definition	<ul style="list-style-type: none"> The average cloud cover over the plot.
Measurement criteria	<ul style="list-style-type: none"> Expressed as a percent of plot area.
Standard	<ul style="list-style-type: none">
Reporting instructions	Report to the nearest percent.
Input format	CC10 = 10% cloud cover

Attribute	Pixel Size
Definition	<ul style="list-style-type: none"> The average ground equivalent size of a pixel in the image.
Measurement criteria	
Standard	
Reporting instructions	Report to the nearest meter.
Input format	PS30

Attribute	Image Classification
Definition	<ul style="list-style-type: none"> A brief description/descriptive name of the method employed in the classification of the image. Sequential methods are entered in the order they have been applied.
Measurement criteria	

Standard	
Reporting instructions	<ul style="list-style-type: none"> - Separate each classification compound by a comma. - Terms and keywords can be found in standard textbooks on classification of remotely sensed images.
Input format	FUZZY.CLASS,MAXIMUM.LIKELIHOOD,NEURAL.NETS

Attribute	Disturbance
Definition	<ul style="list-style-type: none"> • A discreet force that has caused significant change in structure and/or composition of the forest during the last 10 years (e.g., a change resulting in the normal growth pattern of the forest being significantly reduced (>50%). • Disturbance interventions could result from: <ul style="list-style-type: none"> - Natural physical events: <ul style="list-style-type: none"> ▪ Fire ▪ Flood ▪ Windthrow - Mortality caused by insect or disease outbreaks - Human-caused events <ul style="list-style-type: none"> ▪ Harvest - Other
Measurement criteria	
Standard	Disturbance must agree with quality assurance audit, 90% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - DIST.Y: Significant disturbance present. - DIST.N: No significant disturbance.
Input format	DIST.Y; DIST.N;

Attribute	Disturbance agent
Definition	Agent of disturbance.
Measurement criteria	
Standard	Disturbance agent must agree with quality assurance audit, 85% of time.
Reporting instructions	Reported as agent of disturbance. Assigned as: <ul style="list-style-type: none"> - DIST.HARVFULL: Stand has been harvested in full (>80% by crown area of previous forest cover has been removed). - DIST.HARVPART: Stand has been harvested in part (<80% by crown area of previous forest cover remains). - DIST.FIRE: Plot has experienced a significant fire. - DIST.WIND: Trees in plot have experienced windthrow. - DIST.SNOW: Trees in plot have experienced significant snow damage. - DIST.INSECT: Trees in plot have experienced significant insect attack. (Note: It can take several years of defoliation to do permanent damage to a tree. The threshold for significant defoliation varies with pest). - DIST.DISEASE: Trees in plot have experienced a significant disease outbreak. - DIST.OTHER: Plot has experienced other disturbances during the last 10 years. Replace OTHER by a word that better describes the type of disturbance agent.
Input format	DIST.HARVPART,DIST.WIND;

Attribute	Disturbance extent
Definition	Extent of disturbance in classes.
Measurement criteria	<ul style="list-style-type: none"> • Low: <20% • Medium: 21-50% • Severe: >50%
Standard	Extent to be within correct class, 95% of time.

Reporting instructions	Assigned as: <ul style="list-style-type: none"> - DIST.LOW: Low - DIST.MED: Medium - DIST.SEV: Severe
Input format	DIST.LOW; DIST.MED;

Attribute	Disturbance basis
Definition	Basis for assigning disturbance extent.
Measurement criteria	
Standard	Correct basis, 100% of time.
Reporting instructions	Basis for disturbance extent assigned as: <ul style="list-style-type: none"> - DIST.VOL: Volume - DIST.BA: Basal area - DIST.CA: Crown area - DIST.ST: Stem numbers - DIST.AR: Plot area
Input format	DIST.AR,DIST.CA;

Attribute	Disturbance year
Definition	<ul style="list-style-type: none"> • An estimate of the first year of the recorded disturbance.
Measurement criteria	
Standard	Disturbance year must be related to disturbance agent.
Reporting instructions	<ul style="list-style-type: none"> • An estimate of year of disturbance is recorded for each disturbance agent • Multiple disturbances listed in order of occurrence.
Input format	DIST.1988,DIST.1994;

Attribute	Land base
Definition	<ul style="list-style-type: none"> • First level of the Land Cover Classification System (Appendix 11). • Presence or absence of vegetation within the boundaries of a polygon.
Measurement criteria	Photo interpreted estimate.
Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - V: vegetated. - N: non-vegetated
Input format	V; N

Attribute	Land cover
Definition	<ul style="list-style-type: none"> • Second level of the Land Cover Classification System (Appendix 11). • Presence or absence of trees for vegetated polygons. • Land or water for non-vegetated polygons.
Measurement criteria	Photo interpreted estimate.

Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated plots: <ul style="list-style-type: none"> ▪ T: treed ▪ N: non-treed - For non-vegetated plots: <ul style="list-style-type: none"> ▪ L: land ▪ W: water
Input format	T/N; L/W

Attribute	Landscape position
Definition	<ul style="list-style-type: none"> • Third level of Land Cover Classification System (Appendix 11). • Location of the polygon relative to elevation and drainage
Measurement criteria	Photo interpreted estimate.
Standard	Must agree with quality assurance audit, 97% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - A: alpine - W: wetland - U: upland
Input format	A;W;U

Attribute	Vegetation type
Definition	<ul style="list-style-type: none"> • Fourth Level of Land Cover Classification System (Appendix 11). • The distinct type of vegetation or non-vegetated condition of the land base within the polygon
Measurement criteria	Photo interpreted estimate.
Standard	<ul style="list-style-type: none"> • For treed plots, must agree with quality assurance audit, 97% of time. • For non-treed plots, must agree with quality assurance audit, 85% of time. • For non-vegetated plots, must agree with quality assurance audit, 97% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated, treed plots: <ul style="list-style-type: none"> ▪ TC: coniferous ▪ TB: broadleaf ▪ TM: mixed - For vegetated, non-treed plots: <ul style="list-style-type: none"> ▪ ST: shrub tall ▪ SL: shrub low ▪ HE: Herb, HF: Herb Forb, HG: Herb Graminoid . ▪ BY: Bryoid, BM: Bryoid Moss, BL: Bryoid Lichen. - For non-vegetated plots: <ul style="list-style-type: none"> ▪ SI: snow/ice ▪ RO: rock/rubble ▪ EL: exposed land
Input format	TC/TB/TM; ST/SL/HE/BY; SI/RO/EL

Attribute	Density class
Definition	<ul style="list-style-type: none"> • Fifth level of Land Classification System (Appendix 11). • Vegetation densities for vegetated polygons and a further classification of non-vegetated polygons.
Measurement criteria	Photo interpreted estimate.

Standard	Must agree with quality assurance audit, 90% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - For vegetated plots: <ul style="list-style-type: none"> ▪ DE: Dense ▪ OP: Open ▪ SP: Sparse - For non-vegetated plots: <ul style="list-style-type: none"> ▪ SI (Snow/Ice) from Level 4 is further classified. ▪ RO (Rock/Rubble) from Level 4 is further classified. ▪ EL (Exposed Land) from Level 4 is further classified.
Input format	DE/OP/SP; etc.

Attribute	Tree species
Definition	<ul style="list-style-type: none"> • For the purposes of this inventory a tree is defined as a woody plant, >1.3 m in height/length, with the roots attached to the bole, larger than 4.0 cm DBH, capable of reaching 5 m in height at maturity, usually with a single trunk and a definite crown. • The tree definition includes live standing, live fallen, dead standing (roots attached) and dead fallen (roots attached). Note: dead fallen (roots attached) is a tree and also coarse woody debris (CWD). • Refer to NFI tree list in Appendix X for authoritative names.
Measurement criteria	<ul style="list-style-type: none"> • List the three leading species. • If unsure of species, use SPP (do not guess). SPP is a correct call when audited.
Standard	<ul style="list-style-type: none"> • Genus must agree with quality assurance audit, 95% of time. • Species must agree with quality assurance audit, 80% of time. • Only species from the NFI tree list.
Reporting instructions	<ul style="list-style-type: none"> • Reported in descending order by quantitative criteria (see Leading Species Criteria). • Recorded using first four letters of the scientific <i>genus</i> name and first three letters of the scientific <i>species</i> name. • Unidentified species recorded as SPP.
Input format	PICE.MAR,PICE.GLA, BETU.PAP,SALI.SPP

Attribute	Leading species criteria
Definition	<ul style="list-style-type: none"> • Quantitative criteria used to rank species occurrence.
Measurement criteria	
Standard	Correct criteria, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - CA: Crown area. - VOL: Volume. - BA: Basal area. - COUNT: Stem numbers
Input format	CA; VOL; BA; COUNT;

Attribute	Leading species percent
Definition	<ul style="list-style-type: none"> • Percentage of the three leading species in the polygon determined by quantitative criteria used to rank species occurrence.
Measurement criteria	
Standard	<ul style="list-style-type: none"> • Leading species agree with quality assurance audit, 100% of time. • Second species in correct order, 90% of time.
Reporting	<ul style="list-style-type: none"> • Record to the nearest percent.

instructions	
Input format	47,22,19,

Attribute	Age
Definition	Age of leading species and second species in the polygon.
Measurement criteria	
Standard	<ul style="list-style-type: none"> • Ages to be within +- 5 years of quality assurance audit value for tree layers less than 41 years of age. • Ages to be within +-20 years of the quality assurance audit value for tree layers between 41 and 250 years of age. • Ages to be within +- 100 years of the quality assurance audit value for tree layers greater than 250 years of age.
Reporting instructions	<ul style="list-style-type: none"> • Recorded to the nearest year. • Age is estimated: <ul style="list-style-type: none"> - For even aged stands: <ul style="list-style-type: none"> ▪ From the dominant, co-dominant and high intermediate crown positions. - For multi layered stands: <ul style="list-style-type: none"> ▪ From the dominant, co-dominant and high intermediate trees in each layer. - For uneven aged stands: <ul style="list-style-type: none"> ▪ From the youngest and oldest to create an age range. • Assigned as : <ul style="list-style-type: none"> - EVEN: Even aged stand. - MULTI: Multi layered stand. - UNEVEN: Uneven aged stand.
Input format	EVEN.90; UNEVEN.40-70-120,MULTI.30,50,90;

Attribute	Age determination
Definition	<ul style="list-style-type: none"> • Method used to determine age.
Measurement criteria	
Standard	No errors in method, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - OCC: Ocular estimate. - REC: Management records
Input format	OCC; REC

Attribute	Age definition
Definition	<ul style="list-style-type: none"> • Definition of age.
Measurement criteria	
Standard	No errors, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - ABH: Age at breast height. - AFS: Age from seed. - AES: Age from establishment
Input format	ABH; AFS; AES

Attribute	Age class
Definition	<ul style="list-style-type: none"> • If age has been grouped into classes, then age class is the width of the class in years.

Measurement criteria	
Standard	No errors in age class width, 100% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - AW.1: No age grouping. - AW.##: Width of class.
Input format	AW.1; AW.10; AW.20

Attribute	Tree cover origin
Definition	<ul style="list-style-type: none"> • Origin of the prevailing tree cover in the polygon.
Measurement criteria	Management records or other historic evidence.
Standard	Must agree with the quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - HARV: Regeneration after harvest. - DIST: Regeneration after other disturbance. - AFOR: Regeneration- conversion of previously non-forested land to forest (afforestation).
Input format	HARV; DIST;

Attribute	Regeneration
Definition	Renewal of the forest by natural or artificial means.
Measurement criteria	Management records or other historic evidence.
Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	Assigned as: <ul style="list-style-type: none"> - NAT: Natural regeneration. - SUP: Natural regeneration with supplementary planting (<50%). - PLA: Planted regeneration. - SOW: Seeded regeneration.
Input format	NAT; SUP;

Attribute	Forest structure
Definition	<ul style="list-style-type: none"> • The structure of the prevailing forest cover in the polygon (if treed).
Measurement criteria	
Standard	Must agree with quality assurance audit, 95% of time.
Reporting instructions	<ul style="list-style-type: none"> • Assigned as: <ul style="list-style-type: none"> - EVEN: Even aged or single storied. - UNEVEN: Uneven aged. - MULTI: Two or more distinct canopy layers.
Input format	EVEN; UNEVEN; MULTI;

Attribute	Mortality
Definition	<ul style="list-style-type: none"> • Dead trees in the polygon since last measurement, or during the last five years if no previous measurement.
Measurement criteria	Estimate likely cause of mortality.
Standard	<ul style="list-style-type: none"> • Cause of mortality must agree with quality assurance audit, 90% of time.
Reporting instructions	Cause of mortality assigned as: <ul style="list-style-type: none"> - MORT.FIRE - MORT.WIND

	<ul style="list-style-type: none"> - MORT.DISEASE - MORT.INSECT - MORT.OTHER
Input format	MORT.DISEASE;

Attribute	Mortality extent
Definition	Extent of mortality in %.
Measurement criteria	
Standard	Extent to be within +/- 15% of quality assurance audit, 100% of time.
Reporting instructions	Report to nearest %.
Input format	MORT.40

Attribute	Mortality basis
Definition	Basis for mortality extent.
Measurement criteria	
Standard	Correct basis, 100% of time.
Reporting instructions	Mortality extent assigned as: <ul style="list-style-type: none"> - MORT.VOL: Volume - MORT.BA: Basal area - MORT.CA: Crown area - MORT.ST: Stem numbers - MORT.AR: Plot area
Input format	MORT.CA;

Attribute	Soil erosion
Definition	<ul style="list-style-type: none"> • Significant soil erosion affecting more than 0.5 hectare in the polygon.
Measurement criteria	
Standard	<ul style="list-style-type: none"> • Causal agent must agree with quality assurance audit, 90% of time.
Reporting instructions	<ul style="list-style-type: none"> • Causal agent assigned as: <ul style="list-style-type: none"> - SOIL.NATURAL: Natural erosion caused by soil instability. - SOIL.RUNOFF: Erosion caused by surface water runoff. - SOIL.AVALANCHE: Erosion caused by avalanches. - SOIL.HARVEST: Erosion caused by harvesting operations (includes roads) within the last 10 years. - SOIL.TRAFFIC: Erosion caused by heavy equipment traffic. - SOIL.ROAD: Erosion caused by road construction (other than harvest roads) within the last 10 years. - SOIL.MINE: Erosion caused by mining within the last 10 years. - SOIL.OTHER: Other causes of erosion or causes not understood.
Input format	SOIL.NATURAL; SOIL.MINE;

Attribute	Soil erosion extent
Definition	Extent of soil erosion in %.
Measurement criteria	
Standard	Extent of soil erosion must be within +/- 10% of quality assurance audit, 100% of time.
Reporting instructions	Report extent of polygon area affected to nearest 10%.
Input format	Soil.40;

Attribute	Total stand volume
Definition	<ul style="list-style-type: none"> • Total volume in m³ per hectares for all trees (>1.3m tall). • Volume inside bark of the main stem, including stump and top as well as dead and decayed wood. • Includes dead windfalls (with roots attached) that are also CWD.
Measurement criteria	Derived from photo estimates of species, height, basal area, etc. and appropriate volume equations/models. Can use relationship from ground plots to determine volume of smaller trees and windfalls.
Standard	
Reporting instructions	
Input format	V350: Polygon volume is 350 cubic meters per hectare.

Attribute	Entropy
Definition	<ul style="list-style-type: none"> •
Measurement criteria	
Standard	
Reporting instructions	
Input format	

Appendix VIII, auxiliary data attributes for NFI ground plots, polygons in photo plots and remote sensing plots.

Attribute	Plot location
Definition	<ul style="list-style-type: none"> Center point of the plot. Location around which attributes will be estimated. All attributes are attached to the plot location.
Measurement criteria	These plots are permanent. GPS should be used to establish ground plot location where practical. Plot locations can come from photographs if there are a minimum of two ground control points, or from a controlled base map.
Standard	
Reporting instructions	<ul style="list-style-type: none"> Location reported in decimal degrees of Latitude and Longitude.
Input format	49.20668,102.33714;

Attribute	Network label
Definition	<ul style="list-style-type: none"> The label that identifies the location of the plot on the National Forest Inventory 20 km network.
Measurement criteria	
Standard	Authorized number only. No errors, 100% of time.
Reporting instructions	Provided by CFS.
Input format	3568

Attribute	Owner
Definition	<ul style="list-style-type: none"> Ownership profile in percent of the ground covered by the plot.
Measurement criteria	
Standard	
Reporting instructions	Reported as: <ul style="list-style-type: none"> CL: Crown PR: Private FED: Federal TERR: Territories MUN: Municipal ABOR: Aboriginal OUT: Out of Province/Territory
Input format	CL85,PR15;

Attribute	Harvest volume
Definition	<ul style="list-style-type: none"> Total stem volume in m3 harvested from the plot during the last ten years.
Measurement criteria	Estimate
Standard	
Reporting instructions	
Input format	HV2500;

Attribute	Exotics
Definition	<ul style="list-style-type: none"> • Exotic tree species growing on plot. • Includes non-local seed sources.
Measurement criteria	
Standard	
Reporting instructions	Report: <ul style="list-style-type: none"> - Species - Percentage of area of plot occupied. - Origin of exotics and non-local provenances.
Input format	PINU.PON,20,BC; PICE.ABI.30,NORWAY;

Attribute	Protection status
Definition	<ul style="list-style-type: none"> • Percentage of plot under some form of protection status.
Measurement criteria	
Standard	
Reporting instruction	Reported as: <ul style="list-style-type: none"> - IUCN Categories I – VI (Refer to Appendix , Glossary) - Other categories not covered by IUCN such as policy, water conservation, soil protection, avalanche, other.
Input format	IUCN3.20; SOIL. 45;

Attribute	Land use
Definition	<ul style="list-style-type: none"> • Land-use classes provided in Appendix III.
Measurement criteria	
Standard	
Reporting instruction	Enter land-use codes appropriate for the plot followed by the percentage of the plot area in each land-use category.
Input format	FOR.50,AGR.20,URB.30;

Attribute	Land use conversion
Definition	Change in land-use pattern in the last ten years.
Measurement criteria	
Standard	
Reporting instructions	Report current class, past class and percentage of plot that has changed.
Input format	EXP.FOR.30; Thirty percent of plot has been converted to mining/exploration from forestry.

Attribute	Access and human influence
Definition	This attribute measures the “naturalness” of the plot.
Measurement criteria	
Standard	
Reporting instructions	The measure of “remoteness” applies as a proxy. Report access as: <ul style="list-style-type: none"> - PV: Paved road - GV: Gravel road - T: Trail - WW: Water way - WR: Winter road

	and how much of the plot (in percent) has been influenced by humans in the last ten years. (A significant human influence is one that significantly alters one or more ecosystem processes for a year or more).
Input format	PV.HI30; paved road access, human influence on 30% of the plot.

Appendix IX. Ground Sampling Plot – Design, Standards and Procedures

Appendix X. National Forest Inventory tree list

1. NATIVE CONIFERS			
Common Name		Scientific Name	Code
English	French		
amabilis fir	sapin gracieux	<i>Abies amabilis</i>	ABIE.AMA
balsam fir	sapin baumier	<i>Abies balsamea</i>	ABIE.BAL
grand fir	sapin grandissime	<i>Abies grandis</i>	ABIE.GRA
alpine fir	sapin subalpin	<i>Abies lasiocarpa</i>	ABIE.LAS
yellow-cedar	chamaecyparis jaune	<i>Chamaecyparis nootkatensis</i>	CHAM.NOO
Rocky mountain juniper	genevrier des Rocheuses	<i>Juniperus scopulorum</i>	JUNI.SCO
Eastern red cedar	genevrier de Virginie	<i>Juniperus virginiana</i>	JUNI.VIR
tamarack	meleze laricin	<i>Larix laricina</i>	LARI.LAR
alpine larch	meleze subalpin	<i>Larix lyallii</i>	LARI.LYA
Western larch	meleze de l'Ouest	<i>Larix occidentalis</i>	LARI.OCC
Englemann x white		<i>Picea engelmann x glauca</i>	PICE.ENG. GLA
Engelmann spruce	epinette d'Engelmann	<i>Picea engelmannii</i>	PICE.ENG
white spruce	epinette blanche	<i>Picea glauca</i>	PICE.GLA
black spruce	epinette noire	<i>Picea mariana</i>	PICE.MAR
red spruce	epinette rouge	<i>Picea rubens</i>	PICE.RUB
Sitka spruce	epinette de Sitka	<i>Picea sitchensis</i>	PICE.SIT
Sitka x unknown		<i>Picea sitchensis x ?</i>	PICE.SIT.X
Sitka x white		<i>Picea x lutzii</i>	PICE.x.LUT
whitebark pine	pin a blanche ecorce	<i>Pinus albicaulis</i>	PINU.ALB
jack pine	pin gris	<i>Pinus banksiana</i>	PINU.BAN
lodgepole pine		<i>Pinus contorta</i>	PINU.CON
shore pine	pin tordu	<i>Pinus contorta var. contorta</i>	PINU.CON. CON
lodgepole pine	pin tordu latifolie	<i>Pinus contorta var. latifolia</i>	PINU.CON. LAT
limber pine	pin flexible	<i>Pinus flexilis</i>	PINU.FLEX
Western white pine	Pin argente	<i>Pinus monticola</i>	PINU.MON
Ponderosa pine	pin ponderosa	<i>Pinus ponderosa</i>	PINU.PON
red pine	pin rouge	<i>Pinus resinosa</i>	PINU.RES
pitch pine	pin rigide	<i>Pinus rigida</i>	PINU.RIG
Eastern white pine	pin blanc	<i>Pinus strobus</i>	PINU.STR
lodgepole x jack pine hybrid	pin tordu x gris	<i>Pinus x murraybanksiana</i>	PINU.x.MUR
Coastal Douglas-fir	Douglas vert	<i>Pseudotsuga menziesii var. menziesii</i>	PSEU.MEN. MEN
Douglas-fir		<i>Pseudotsuga menziesii</i>	PSEU.MEN
Interior Douglas-fir	Douglas bleu	<i>Pseudotsuga menziesii var. glauca</i>	PSEU.MEN. GLA
Western yew	if de l'Ouest	<i>Taxus brevifolia</i>	TAXU.BRE
Eastern white-cedar	thuya occidental	<i>Thuja occidentalis</i>	THUJ.OCC
Western redcedar	thuya geant	<i>Thuja plicata</i>	THUJ.PLI
Eastern hemlock	pruche du Canada	<i>Tsuga canadensis</i>	TSUG.CAN
Western hemlock	pruche de l'Ouest	<i>Tsuga heterophylla</i>	TSUG.HET
mountain hemlock	pruche subalpine	<i>Tsuga mertensiana</i>	TSUG.MER
mountain x western hemlock hybrid		<i>Tsuga mertensiana x heterophylla</i>	TSUG.MER. HET

2. NATIVE HARDWOODS			
Common Name		Scientific Name	Code
English	French		
vine maple	erable circine	<i>Acer circinatum</i>	ACER.CIR
bigleaf maple	erable a grandes feuilles	<i>Acer macrophyllum</i>	ACER.MAC
Manitoba maple (boxelder)	erable a feuilles composees	<i>Acer negundo</i>	ACER.NEG
striped maple	erable de Pennsylvanie	<i>Acer pensylvanicum</i>	ACER.PEN
red maple	erable rouge	<i>Acer rubrum</i>	ACER.RUB
silver maple	erable a argente	<i>Acer saccharinum</i>	ACER.SAC
sugar maple	erable a sucre	<i>Acer saccharum</i>	ACER.SAH
mountain maple	erable a epis	<i>Acer spicatum</i>	ACER.SPI
green alder	aulne crispe	<i>Alnus crispa</i>	ACER.CRI
mountain alder	aulne a feuilles minces	<i>Alnus incana ssp. tenuifolia</i>	ALNU.INC.TEN
speckled alder	aulne rugueux	<i>Alnus incana ssp. rugosa</i>	ALNU.INC.RUG
red alder	aulne rouge	<i>Alnus rubra</i>	ALNU.RUB
Sitka alder	aulne de Sitka	<i>Alnus sinuata</i>	ALNU.SIN
serviceberry (shadbush)	amelanchier	<i>Amelanchier ssp</i>	AMEL.SSP
arbutus	arbousier d' Amerique	<i>Arbutus menziesii</i>	ARBU.MEN
pawpaw	asiminier trilobe	<i>Asimina triloba</i>	ASIM.TRI
yellow birch	bouleau jaune	<i>Betula alleghaniensis</i>	BETU.ALL
mountain paper birch	bouleau a feuilles cordees	<i>Betula cordifolia</i>	BETU.COR
swamp birch	bouleau	<i>Betula glandulifera</i>	BETU.GLA
bog birch	bouleau	<i>Betula glandulosa</i>	BETU.GLL
Alaska paper birch	bouleau d' Alaska	<i>Betula neoalaskana</i>	BETU.NEO
water birch	bouleau fontinal	<i>Betula occidentalis</i>	BETU.OCC
paper birch	bouleau a papier	<i>Betula papyrifera</i>	BETU.PAP
gray birch	bouleau gris	<i>Betula populifolia</i>	BETU.POP
dwarf birch	bouleau	<i>Betula pumila</i>	BETU.PUM
Alaska x paper birch hybrid	bouleau	<i>Betula x winteri</i>	BETU.x.WIN
blue-beech	charme de caroline	<i>Carpinus caroliniana</i>	CARP.CAR
bitternut hickory	caryer cordiforme	<i>Carya cordiformis</i>	CARY.COR
shagbark hickory	caryer a fruits	<i>Carya ovata</i>	CARY.OVA
American chestnut	chataignier d' Amerique	<i>Castanea dentata</i>	CAST.DEN
hackberry	micocoulier occidental	<i>Celtis occidentalis</i>	CELT.OCC
alternate-leaf dogwood	cornouiller a feuilles alternes	<i>Cornus alternifolia</i>	CORN.ALT
Pacific dogwood	cornouiller de nuttall	<i>Cornus nuttallii</i>	CORN.NUT
	cornouiller stolonifere	<i>Cornus stolonifera</i>	CORN.STO
beaked hazel	noisetier a long bec	<i>Corylus cornuta</i>	CORY.COR
hawthorn	aubepine	<i>Crataegus spp.</i>	CRAT.SPP
American beech	hetre a grandes feuilles	<i>Fagus grandifolia</i>	FAGU.GRA
white ash	frene d' amerique	<i>Fraxinus americana</i>	FRAX.AME
black ash	frene noir	<i>Fraxinus nigra</i>	FRAX.NIG
red ash	frene de Pennsylvanie	<i>Fraxinus pennsylvanica</i>	FRAX.PEN
green ash	frene vert	<i>Fraxinus pennsylvanica var. subintegerrima</i>	FRAX.PEN.SUB
honey locust	fevier epineux	<i>Gleditsia triacanthos</i>	GLED.TRI
common winterberry	houx verticille	<i>Ilex verticillata</i>	ILEX.VER
butternut	noyer cendre	<i>Juglans cinerea</i>	JUGL.CIN

black walnut	noyer noir	<i>Juglans nigra</i>	JUGL.NIG
tulip-tree	tulipier de Virginie	<i>Liriodendron tulipifera</i>	LIRI.TUL
Pacific crab apple	pommier du Pacifique	<i>Malus fusca</i>	MALU.FUS
apple	pommier	<i>Malus spp.</i>	MALU.SPP
mountain holly	nemopanthe mucrone	<i>Nemopanthus mucromatus</i>	NEMO.MUC
black-gum	nyssa sylvestre	<i>Nyssa sylvatica</i>	NYSS.SYL
ironwood (hop-hornbeam)	ostoyer de Verginie	<i>Ostrya virginiana</i>	OSTR.VIR
sycamore	platane occidental	<i>Platanus occidentalis</i>	PLAT.OCC
narrowleaf cottonwood	peuplier a feuilles etroites	<i>Populus agustifolia</i>	POPU.AGU
balsam poplar	peuplier baumier	<i>Populus balsamifera</i>	POPU.BAL
Eastern cottonwood	peuplier deltoide	<i>Populus deltoides</i>	POPU.DEL
largetooth aspen	peuplier a grandes dents	<i>Populus grandidentata</i>	POPU.GRA
hybrid poplars	peuplier hybride	<i>Populus spp.</i>	POPU.SPP
trembling aspen	peuplier faux tremble	<i>Populus tremuloides</i>	POPU.TRE
black cottonwood	peuplier de l'Ouest	<i>Populus trichocarpa</i>	POPU.TRI
bitter cherry	cerisier amer	<i>Prunus emarginata</i>	PRUN.EMA
pin cherry	cerisier de Pennsylvanie	<i>Prunus pensylvanica</i>	PRUN.PEN
black cherry	cerisier tardif	<i>Prunus serotina</i>	PRUN.SER
choke cherry	ceresier de Virginie	<i>Prunus virginiana</i>	PRUN.VIR
white oak	chene blanc	<i>Quercus alba</i>	QUER.ALB
swamp white oak	chene bicolore	<i>Quercus bicolor</i>	QUER.BIC
Garry oak	chene de Garry	<i>Quercus garryana</i>	QUER.GAR
bur oak	chene a gros fruits	<i>Quercus macrocarpa</i>	QUER.MAC
red oak	chene rouge	<i>Quercus rubra</i>	QUER.RUB
cascara	nerprun cascara	<i>Rhamnus purshiana</i>	RHAM.PUR
staghorn sumac	sumac vinaigrier	<i>Rhus typhina</i>	RHUS.TYP
black locust	robinier faux-acacia	<i>Robinia psedoacacia</i>	ROBL.PSE
peachleaf willow	saule a feuilles de pecher	<i>Salix amygdaloides</i>	SALI.AMY
Bebb's willow	saule de Bebb	<i>Salix bebbiana</i>	SALI.BEB
pussy willow	saule discolore	<i>Salix discolor</i>	SALI.DIS
Pacific willow	saule du Pacifique	<i>Salix lucida ssp. lasiandra</i>	SALI.LUC. SSP.LAS
shining willow	saule brillant	<i>Salix lucida ssp. lucida</i>	SALI.LUC. SSP.LUC
black willow	saule noir	<i>Salix nigra</i>	SALI.NIG
Scouler's willow	saule de Scouler	<i>Salix scouleriana</i>	SALI.SCO
Sitka willow	saule de Sitka	<i>Salix sitchensis</i>	SALI.SIT
sassafras	sassafras officinal	<i>Sassafras albidum</i>	SASS.ALB
American mountain ash	sorbier d'Amerique	<i>Sorbus americana</i>	SORB.AME
showy mountain ash	sorbier des montagnes	<i>Sorbus decora</i>	SORB.DEC
mountain ash	sorbier	<i>Sorbus spp.</i>	SORB.SSP
basswood (American linden)	tilleul d'Amerique	<i>Tilia americana</i>	TILI.AME
white elm	orme d'Amerique	<i>Ulmus americana</i>	ULMU.AME
red elm	orme rouge	<i>Ulmus rubra</i>	ULMU.RUB
rock elm	orme de thomas	<i>Ulmus thomasii</i>	ULMU.THO
vibenum	viorne	<i>Vibenum spp.</i>	VIBE.SSP

3. EXOTICS			
Common Name		Scientific Name	Code
English	French		
white fir	Sapin argente	<i>Abies concolor</i>	ABIE.CON
Shasta fir		<i>Abies magnifica var. shastensis</i>	ABIE.MAG.v.SH A
noble fir		<i>Abies procera</i>	ABIE.PRO
Norway maple		<i>Acer platanoides</i>	ACER.PLA
sycamore maple		<i>Acer pseudoplatanus</i>	ACER.PSE
European white birch		<i>Betula pendula</i>	BETU.PEN
silver birch		<i>Betula pubescens</i>	BETU.PUB
incense cedar		<i>Calocedrus decurrens</i>	CALO.DEC
Port Orford cedar		<i>Chamaecyparis lawsoniana</i>	CHAM.LAW
Oregon ash		<i>Fraxinus latifolia</i>	FRAX.LAT
European larch	meleze European	<i>Larix decidua</i>	LARI.DEC
Japanese larch	meleze Japonais	<i>Larix kaempferi</i>	LARI.KAE
Norway spruce	epinette de Norvege	<i>Picea abies</i>	PICE.ABI
sugar pine		<i>Pinus lambertiana</i>	PINU.LAM
Austrian pine		<i>Pinus nigra</i>	PINU.NIG
Monterey pine		<i>Pinus radiata</i>	PINU.RAD
Scots pine	pin sylvestre	<i>Pinus sylvestris</i>	PINU.SYL
Southern (or plains) cottonwood	peuplier deltoide de l'Ouest	<i>Populus deltoides spp. monilifera</i>	POPU.DEL. SPP.MON
sweet cherry		<i>Prunus avium</i>	PRUN.AVI
common pear		<i>Pyrus communis</i>	PRUN.COM
English oak	chene pedoncule	<i>Quercus robur</i>	QUER.ROB
coast redwood		<i>Sequoia sempervirens</i>	SEQU.SEM
giant sequoia		<i>Sequoiadendron giganteum</i>	SEQU.GIG
European mountain ash		<i>Sorbus aucuparia</i>	SORB.AUC
Siberian elm		<i>Ulmus pumila</i>	ULMU.PUM