Canada's National Forest Inventory
National Standards for Photo Plots
Compilation Procedures

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Version 1.4

(DRAFT)

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1. Introduction

The purpose of this document is to outline the rules that have been developed to compile the National Forest Inventory (NFI) Photo Plot data. The photo plot data include descriptions of polygon areas by land use types, ownership, protection status, and land cover; and of layer data for each land-cover polygon within a photo plot. Layer data includes detailed descriptions for each layer: tree data, layer origin, layer treatment and layer disturbance.

Compilation of photo plot layer data involves amalgamating the layer attributes into one set of attributes for a land-cover polygon. The result of the compilation is a set of average or per-hectare value for each land-cover polygon within a plot.

Section 2 provides a list and definition of the desired attributes to be compiled. Sections 3, 4, 5 and 6 outline the aggregation methods for trees, stand origin, stand treatment, and natural disturbance, respectively; example computations are also included.

2. Compiled Attributes

Polygon-level attributes to be derived by aggregating the individual layer data are listed in Tables 1, 2, 3, and 4, for trees, layer origin, layer treatment and layer disturbance, respectively. The definitions of these attributes are based on the descriptions outlined in the NFI document "*National Standards for Photo Plots Data Dictionary*". Variable names are suggested in cases where the variables are not in the database tables.

Table 1. Photo Plot polygon-level summary attributes – Tree attributes.

Item	*Attribute (Units)*	*Suggested Variable Name*
1	Total volume 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 (m^3/ha). This attribute is not photo interpreted; it is derived from models.	VOL
2	Total biomass for all trees (>1.3m tall). Biomass includes bark, main stem, stump and top (tons/ha). This attribute is not photo interpreted; it is derived from the Biomass project subroutine models.	BIOMASS
3	The percentage of ground area covered by the vertical projection of tree crown areas (%).	CLOSURE
4	The age of the leading species in the polygon, where AGE is the age of the GENUS (years).	SITE_AGE
5	The height of the leading species in the polygon, where HEIGHT is the age of the GENUS (m).	SITE_HEIGHT
6	An expression of forest site quality based on the height, at a base age of 50 years, of the dominant and codominant trees (site trees). Expressed in m.	SITE_INDEX
7	Percentage of the major species in the polygon determined by quantitative criteria used to rank species occurrence (% by species).	PERCENT

Table 2. Photo Plot polygon-level summary attributes – Stand origin.

Item	*Attribute (Units)*	*Suggested Variable Name*
1	Area with vegetation originating from aforestation (ha)	ORIG_AFOR
2	Area with vegetation originating from secondary succession (ha)	ORIG_SUCC
3	Area with vegetation originating after harvest (ha)	ORIG_HARV
4	Area with vegetation originating after other disturbance (ha)	ORIG_DIST
5	Area with vegetation regenerated through natural regeneration (ha)	REGEN_NAT
6	Area with vegetation regenerated through natural regeneration with supplemental planting (ha)	REGEN_SUP
7	Area with vegetation regenerated through planting (ha)	REGEN_PLA
8	Area with vegetation regenerated through seeding (ha)	REGEN_SOW

Table 3. Photo Plot polygon-level summary attributes – Stand treatment

Item	*Attribute (Units)*	*Suggested Variable Name*
1	Area that has been harvested in full (>80% (ha)	CC
2	Area that has been harvested in part (≤80%) (ha)	PC
3	Area that has been deforested (ha)	DC
4	Area that has undergone cleaning, including brushing and weeding (ha)	CL
5	Area that has been juvenile spaced (ha)	SP
6	Area that has been pruned (ha)	PR
7	Area that has been pre-commercially thinned (ha)	PT
8	Area that has been commercially thinned (ha)	CT
9	Area that has been fertilized (ha)	FT
10	Area where mechanical site preparation has taken place (ha)	MP
11	Area where prescribed burning has occurred (ha)	PB
12	Area where other treatments have occurred (ha)	OT

Table 4. Photo Plot polygon-level summary attributes – Stand disturbance

Item	*Attribute (Units)*	*Suggested Variable Name*
1	Area that has experienced significant fire (ha)	AREA_FIRE
2	Area that has experienced wind throw (ha)	AREA_WIND
3	Area that has experienced significant snow damage (ha)	AREA_SNOW
4	Area that has experienced significant insect attack (ha)	AREA_INSECT
5	Area that has experienced significant disease outbreak (ha)	AREA_DISEASE
6	Area that has had significant tree cover removed over a large area (ha)	AREA_EROSION
7	Area that has experienced ice damage (ha)	AREA_ICE
8	Area that has experienced significant disturbances (ha)	AREA_OTHER
9	Severity (extent of tree mortality) of fire disturbance (%)	SEVER_FIRE

Item	*Attribute (Units)*	*Suggested Variable Name*
10	Severity (extent of tree mortality) of wind throw (%)	SEVER_WIND
11	Severity (extent of tree mortality) of snow damage (%)	SEVER_SNOW
12	Severity (extent of tree mortality) of insect attack (%)	SEVER_INSECT
13	Severity (extent of tree mortality) of disease outbreak (%)	SEVER_DISEASE
14	Severity (extent of tree mortality) of erosion (%)	SEVER_EROSION
15	Severity (extent of tree mortality) of ice damage (%)	SEVER_ICE
16	Severity (extent of tree mortality) of other disturbances (%)	SEVER_OTHER

3. Compilation methods: Tree attributes

Approximate methods to obtain each of the summary attributes listed in Table 1 are described below. These descriptions include inputs, aggregation, outputs, and rationale (where necessary) for aggregation method for each summary attribute. Please refer to Table 9 of NFI design document. Example calculations, based on photo plot data from Nova Scotia, are provided for each attribute.

VOL

Inputs
POLY_ID, LAYER_ID, LAYER_VOL (m^3/ha)

Computations
Volume aggregation involves summing the individual layer volume estimates as follows:

1) Look up the estimated total volume of each layer: LAYER_VOL (LAYER_ID) (m^3/ha)

2) Sum the individual layer volume estimates, with summation over all the layers in a polygon:

VOL (m^3/ha) = Sum [LAYER_VOL (LAYER_ID)]

Output
VOL

Example

POLY_ID	LAYER_ ID	LAYER_VOL
Data:		
1005761-0104	1	0
1005761-0104	2	25
VOL		*25*

Data:		
1005761-0110	1	46
1005761-0110	2	0
VOL		*46*

BIOMASS

Inputs
POLY_ID, LAYER_ID, SPECIES; LAYER_VOL (m3/ha)

Computations
Biomass aggregation involves summing the individual layer biomass estimates as follows:

1) Look up the estimated total volume of each layer: LAYER_VOL (LAYER_ID) (m^3/ha)

2) Sum the individual layer volume estimates to get polygon total volume:

VOL (m3/ha) = Sum [LAYER_VOL (LAYER_ID)]

3) Look up from existing equations, the biomass LAYER_BIOMASS (tons/ha) corresponding to the VOL.

Output
BIOMASS

CLOSURE

Inputs
POLY_ID; LAYER_ID; CLOSURE (%).

Computations
Crown closure aggregation involves summing the individual layer crown closures as follows:

1) Look up the crown closure of all the layers:
CLOSURE (LAYER_ID) (%)

2) Sum the layer crown closures:

CLOSURE_SUM = Sum [CLOSURE (LAYER_ID)]

3) Then the polygon crown closure is obtained as:

CLOSURE (%) = Minimum [100, CLOSURE_SUM]

This formulation also ensured that the polygon crown closure always exceeded that of each layer, but never 100%.

Output
CLOSURE

Example

POLY_ID	LAYER_ID	CLOSURE (%)
Data:		
1005766-0101	1	40
1005766-0101	2	20
CLOSURE_SUM		*60*
CLOSURE		*60*
Data:		
1005766-0070	1	50
1005766-0070	2	10
CLOSURE_SUM		*60*
CLOSURE		*60*

SITE_AGE

Inputs
POLY_ID; LAYER_ID; LAYER_RK; LEAD_SP_AGE (yrs).

Computations
The polygon age is the age of the leading species corresponding to the LAYER_RK = '1'.

SITE_AGE = LEAD_SP_AGE (LAYER_RK = '1')

Output
SITE_AGE

Example

POLY_ID	LAYER_ID	LAYER_RK	LEAD_SP_AGE
Data:			
1005766-0101	1	1	98
1005766-0101	2	2	53
SITE_AGE			*98*
Data:			
1005766-0070	1	1	82
1005766-0070	2	2	53
SITE_AGE			*82*

SITE_HEIGHT

Inputs
POLY_ID; LAYER_ID; LAYER_RK; HEIGHT (yrs) (Table 9a).

Computations
The polygon height is the height of the leading species corresponding to the LAYER_RK = '1'.

SITE_HEIGHT = HEIGHT (LAYER_RK = '1')

Output
SITE_HEIGHT

Example

POLY_ID	LAYER_ID	LAYER_RK	HEIGHT
Data:			
1005766-0101	1	1	20
1005766-0101	2	2	13
SITE_HEIGHT			*20*
Data:			
1005766-0070	1	1	18
1005766-0070	2	2	13
SITE_HEIGHT			*18*

SITE_INDEX

Inputs
SITE_AGE; SITE_HEIGHT; SPECIES; SPECIES_NUM; LAYER_RK.

Site index equations: (list of all provincial, territorial site index equations) (Annex ??)

Computations
1) Determine the tree SPECIES which SPECIES_NUM = 1 and the LAYER_RK = 1.
2) Enter the site index equations using POLY_SITE_AGE, POLY_SITE_HEIGHT and SPECIES to estimate site index at base age 50:

SITE_INDEX = *f* (POLY_SITE_AGE; POLY_SITE_HEIGHT; SPECIES)

Output
SITE_INDEX

Example

POLY_ID	LAYER_ID	LAYER_RK	HEIGHT	AGE	SPECIES	LAND CAPABILITY CLASS*
Data:						
1005766-0101	1	1	20	98	PINUS	

POLY_ID	LAYER_ID	LAYER_RK	HEIGHT	AGE	SPECIES	LAND CAPABILITY CLASS*
1005766-0101	2	2	13	53	ABIES	
AGE				*98*		
HEIGHT			*20*			
SITE_INDEX	*1*	*1*	*20*	*98*	*PINUS*	*5*
Data:						
1005766-0070	1	1	18	82	PINUS	5
1005766-0070	2	2	13	53	ABIES	
AGE				*82*		
HEIGHT			*18*			
SITE_INDEX			*18*	*82*	*PINUS*	*5*

* Based on Nova Scotia's height-age-MAI curves for softwoods. (Please see Forest Research Report No. 22, 1990, Figure 2 in http://www.gov.ns.ca/natr/forestry/reports/report22.pdf.)

PERCENT

Inputs

POLY_ID; LAYER_ID; LAYER_RK; LEAD_CRITR; CLOSURE; SPECIES; PERCENT (LAYER).

Computations

1) Determine the LEAD_CRITR (CLOSURE, VOLUME, basal area, or number of stems) value for each species within each layer:

LEAD_CRITRV (LAYER_ID, SPECIES) = PERCENT (LAYER, SPECIES) * LEAD_CRITRV (POLY_ID)

2) Sum the LEAD_CRITRV for all layers in the polygon by species:

LEAD_CRITRV (POLY_ID, SPECIES) = Sum [LEAD_CRITRV (LAYER_ID, SPECIES)]

3) Calculate the percent species composition for each species over entire polygon as:

PERCENT (SPECIES) % = LEAD_CRITRV (SPECIES)*100/[LEAD_CRITRV (POLY_ID)]

Output

PERCENT (%)

Example

Polygon #: 1005766-0101

LAYER_ID	LEAD_CRITR (= Crown Closure, %) by SPECIES					
	AVER	*PINU*	*BETU*	*ABIE*	*PICE*	*TOTAL*
1	28	15	7	-	-	50
2	-	-	-	5	5	10
Total	*28*	*15*	*7*	*5*	*5*	*60*
PERCENT (%)	*46*	*30*	*14*	*10*	*10*	*100*

4. Compilation methods: Stand origin

Approximate methods to obtain the summary attributes listed in Table 2 are described below. Please refer to Table 9b of the NFI design document (Appendix VI) for definition of the inputs.

Stand origin area

Inputs
POLY_ID; LAYER_ID; STAND_ORIG; POLY_AREA.

Computations
1) Let indicator variable I = 1 if a given stand origin (STAND_ORIG) occurs in any of the polygon layerS, and I = 0 otherwise.
2) The stand origin area then corresponds to the polygon area:

ORIG_AFOR = I * POLY_AREA
ORIG_DIST = I * POLY_AREA
ORIG_HARV = I * POLY_AREA
ORIG_SUCC = I * POLY_AREA

That is, the area of the stand origin is the *whole* polygon area, irrespective of the number of layers in the polygon showing the same origin type.

Output
ORIG_AFOR, ORIG_DIST, ORIG_HARV, ORIG_SUCC.

Example
Polygon # 1005766-0101: Area = 0.064 ha

LAYER_ID	STAND_ORIG	POLY_ORIG area (ha)
Data		
1	SUCC	
2	SUCC	
ORIG_SUCC	*SUCC*	*0.064*

In this example, all other origin areas are equal to 0 ha.

Polygon # 881956-0059: Area = 0.801 ha

LAYER_ID	STAND_ORIG	POLY_ORIG area (ha)
Data		
1	AFOR	
2	SUCC	
ORIG_AFOR		*0.801*
ORIG_SUCC	*SUCC*	*0.801*

In this example, too, all other origin areas are equal to 0 ha.

Regeneration area

Inputs
POLY_ID; LAYER_ID; REGEN_TYPE_1; REGEN_TYPE_2; POLY_AREA.

Computations
1) Let indicator variable I = 1 if a given type of regeneration occurring in any of the polygon layers for REGEN_TYPE_1 or REGEN-TYPE_2, and I = 0 otherwise.
2) The regeneration area corresponds to the polygon area:

REGEN_NAT = I * POLY_AREA
REGEN_SUP = I * POLY_AREA
REGEN_PLA = I * POLY_AREA
REGEN_SOW = I * POLY_AREA

That is, the area of the regeneration is the *whole* polygon area, irrespective of the number of layers in the polygon showing the same type of regeneration.

Output
REGEN_NAT, REGEN_SUP, REGEN_PLA, REGEN_SOW.

Example
Polygon # 1005766-0101: Area = 0.064 ha

LAYER_ID	REGEN_TYPE_1	POLY_REGEN area (ha)
Data		
1	NAT	
2	NAT	
REGEN_NAT	*NAT*	*0.064*

In this example, all other regeneration types areas are equal to 0 ha.

Polygon # 881956-0059; polygon area = 0.801 ha

LAYER_ID	REGEN_TYPE_1	POLY_REGEN area (ha)
Data		
1	NAT	
2	NAT	
REGEN_NAT	*NAT*	*0.801*

In this example, all other regeneration types areas are equal to 0 ha.

5. Compilation methods: Stand treatment

Approximate methods to obtain the summary attributes listed in Table 3 are described below. Please refer to Table 9c of the NFI design document (Appendix VI) for a definition of the inputs.

Inputs

POLY_ID; LAYER_ID; TREAT_TYPE; TREAT_PERCT; POLY_AREA.

Computations
1) For a given type of treatment (TREAT_TYPE) obtain the TREAT_PERCT each layer from the database.
2) Estimate percent treatment area for a given polygon:

TREAT_PERCT (TREAT_TYPE) = Min {100, Sum [TREAT_PERCT (LAYER_ID)]}

That is, we assume that treatment spatial overlaps among layers are negligible, and ensure that treatment percentages do not exceed 100.

3) Then treated area (for given treatment) is the polygon area multiplied by the percent treatment, e.g. for treatment type CC:

CC = TREAT_PERCT (TREAT_TYPE)* POLY_AREA

The treated areas for the remaining treatments are calculated in a similar fashion.

Output
CC; PC; DC; CL; SP; PR; PT; CT; FT; MP; PB; OT.

Example
Polygon #1005766-0101; polygon area = 1.506 ha

POLY_ID	LAYER_ID	TREAT_TYPE	TREAT_YR	TREAT_PERCT (%)	TREAT area (ha)
Data:					
1005766-0101	1	CC	2000	100	100*1.506/100 = 1.506
1005766-0101	1	PC	2000	100	100*1.506/100 = 1.506
CC		*CC*			*1.506*
PC		*PC*			*1.506*

In this example, all other treatment areas are equal to 0 ha.

6. Compilation methods: Stand disturbance

Approximate methods to obtain the summary attributes listed in Table 3 are described below. Please refer to Table 9d of the NFI design document (Appendix VI) for definition of the inputs.

Disturbance Area

Inputs
POLY_ID; LAYER_ID; DIST_AGENT; DIST_PERCT; POLY_AREA.

Computations
1) For a given type of disturbance (DIST_AGENT) obtain the DIST_PERCT for each layer from the database.
2) Estimate percent disturbance area for a given polygon:

DIST_PERCT (DIST_AGENT) = Min {100, Sum [DIST_PERCT (LAYER_ID)]}

That is, we assume that percent spatial overlaps among layers are negligible, and ensure that disturbance percentages do not exceed 100.

3) Then disturbance area (for given type of disturbance) is the polygon area multiplied by the percent disturbance, e.g. for disturbance type FIRE:

AREA_FIRE = DIST_PERCT DIST_AGENT * POLY_AREA

The disturbance areas for the remaining disturbance agents are calculated in a similar fashion.

Output
AREA_FIRE; AREA_WIND; AREA_INSECT; AREA_DISEASE; AREA_EROSION; AREA_ICE; AREA_OTHER.

Example
Polygon #1005756-0026; polygon area = 0.174 ha

POLY_ID	LAYER_ID	DIST_AGENT	DIST_PERCT (%)	DIST area (ha)
Data:				
1005756-026	1	INSECT	100	100*0.174/100 = 0.174
AREA_INSECT		*INSECT*		*0.174*

In this example all other disturbance areas are equal to 0 ha.

Disturbance Severity

Inputs
POLY_ID; LAYER_ID; DIST_AGENT; MORT_PERCT.

Computations
1) For a given disturbance agent (DIST_AGENT) obtain the MORT_PERCT for each layer from the database.
2) Estimate severity (percent mortality extent) for a given disturbance agent in the polygon as, e.g., for FIRE:

SEVER_FIRE = Min {100, Sum [MORT_PERCT (LAYER_ID)]}

That is, we assume that mortality spatial overlaps among layers are negligible, and ensure that disturbance mortality extents do not exceed 100.

The disturbance severities for the remaining disturbance agents are calculated in a similar fashion.

Output
SEVER_FIRE; SEVER_WIND; SEVER_INSECT; SEVER_DISEASE; SEVER_EROSION; SEVER_ICE; SEVER_OTHER.

Example

Polygon #1005756-0026; polygon area = 0.174 ha

POLY_ID	LAYER_ID	DIST_AGENT	MORT_PERCT (%)
Data:			
1005756-026	1	INSECT	62
SEVER_INSECT		*INSECT*	*62*

In this example, all other disturbance mortality percentages are equal to 0%.