The Evolution of Manitoba's Forest Inventory

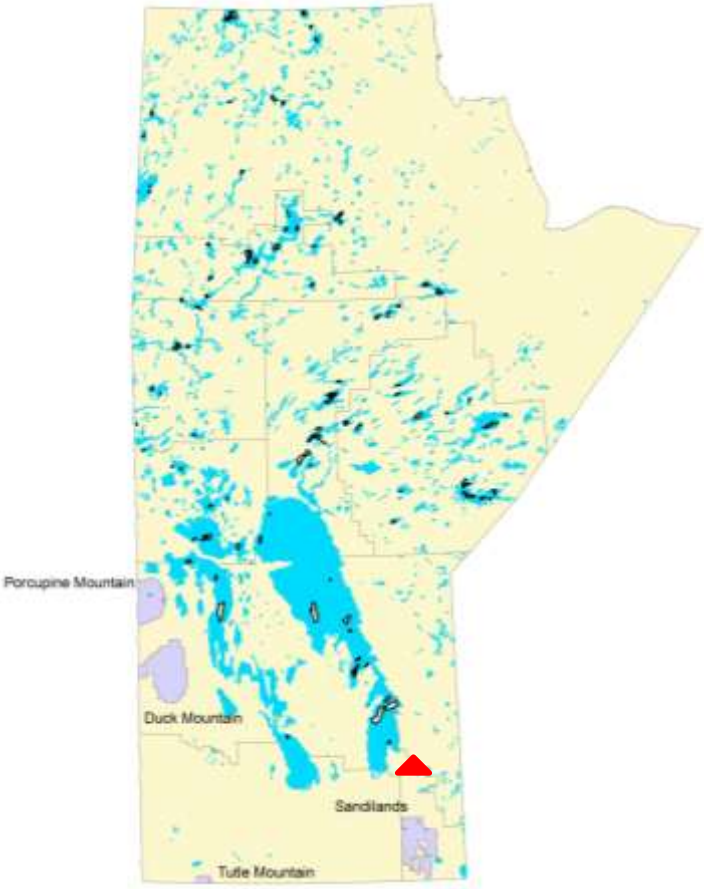
Enhanced Forest Inventory Workshop

Western Canada Aviation Museum

January 23, 2013

Manitoba

The Evolution of Manitoba's Forest Inventory



1870 The Province of Manitoba is formed following the Red River Rebellion in 1869

1900 and prior, Wood use is focused on building materials and heating and Timber reserves established and set aside (Turtle Mountain, Spruce Woods)

1906 Porcupine and Duck Mountain established as timber reserves

1912 Manitoba grows to become the "Keystone" of today

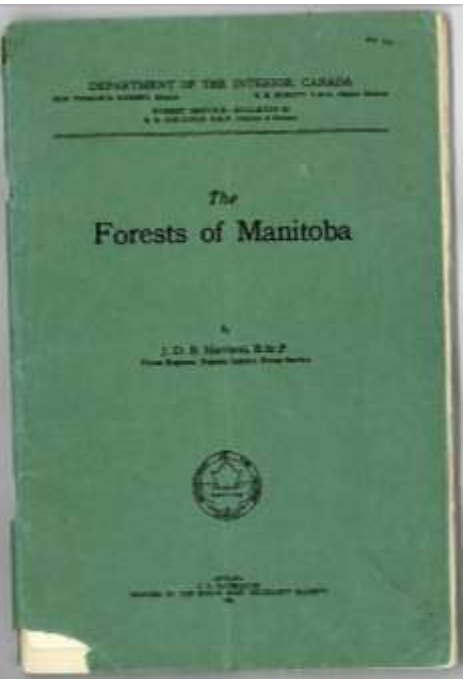
1923 The Sandilands area established as a timber reserve

1927 Manitoba Paper Company established in Pine Falls, construction begins

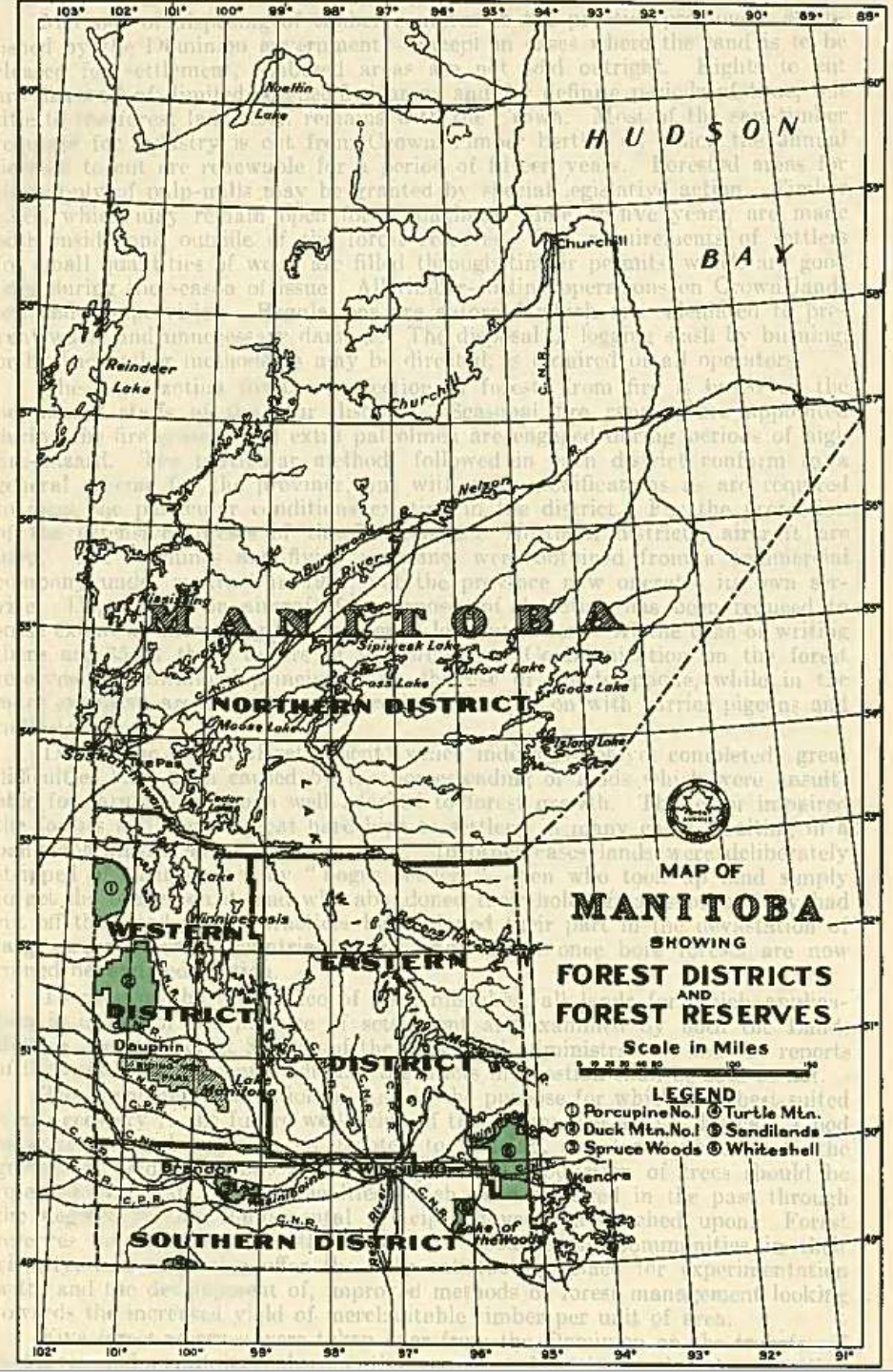
1927 to 1929 forest surveys across the "accessible areas" of the forest

1930 Transfer of natural resources from Federal to Provincial jurisdiction (July 15)

In the Beginning:



- Wood was being used primarily for building supplies and heating
- In 1931 Aerial Photography of the Province was underway, a by-product of WW 1
- J.D.B Harrison (1934) published “Bulletin No. 85”, the first report on Forestry and Forest Resources in Manitoba. Focus on the Accessible Area:
  - Forest surveys classified the forest into three “cover-types”: softwood, hardwood, mixedwood
  - Subtypes identified each sites dominant species



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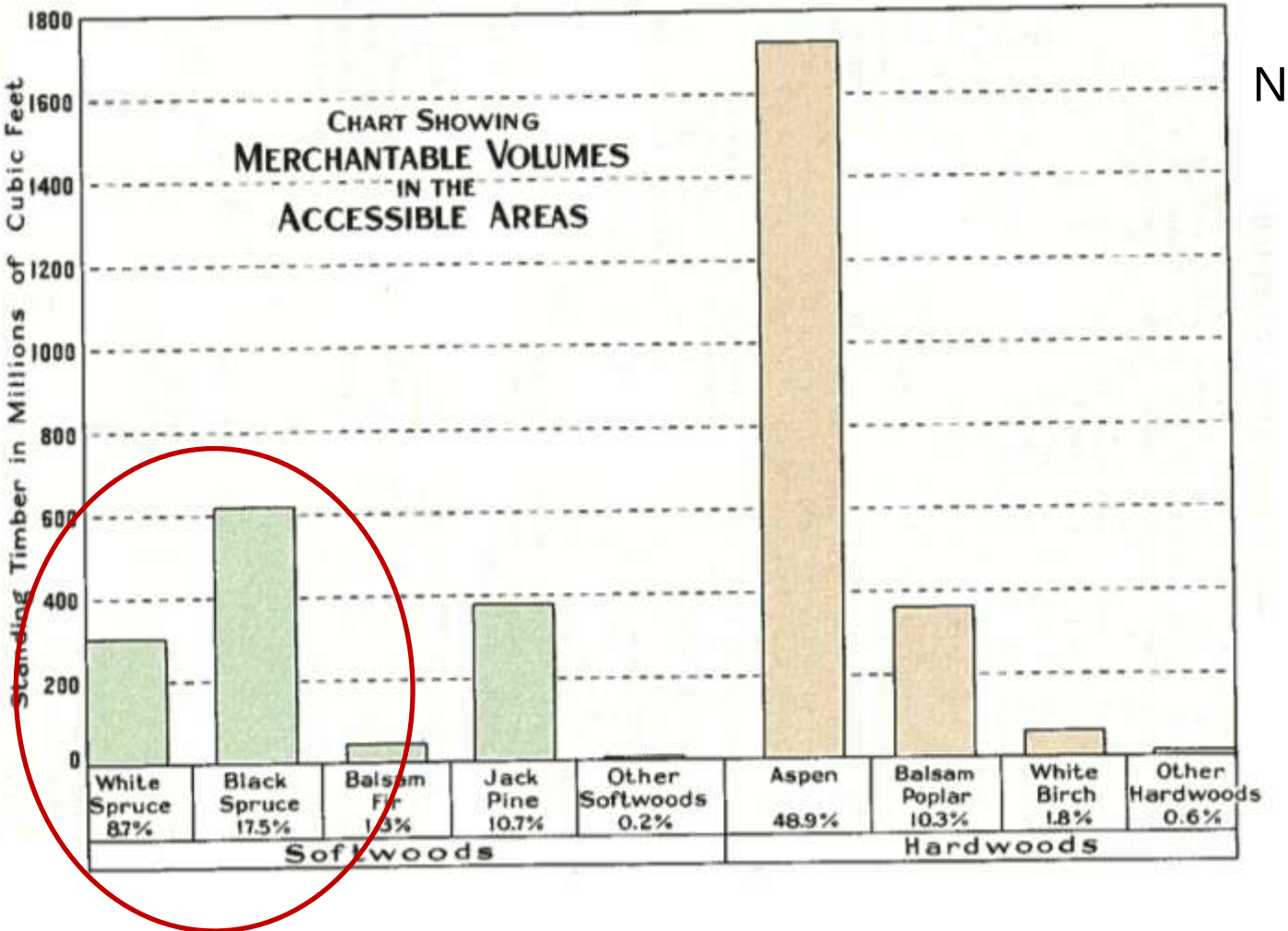
Wood Use 1934

- Districts established, the accessible forest is located primarily in the Eastern and Western Districts
- Advent of the pulp mill and the rail line change the use of softwood in the province
- Domestic use accounts for 81% of wood harvested

Softwood Use	
Lumber	27%
Pulpwood	30%
Railway ties	7%
Fuel wood	31%
Other products	5%
Hardwood Use	
Lumber	1%
Fuel wood	97%
Other products	2%

Accessible Area Inventory



Note:

Black and White Spruce make up 26.2% of the forest yet account for 64% of the softwood consumed

Losses to Fire are a huge concern

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Distribution of Land cover

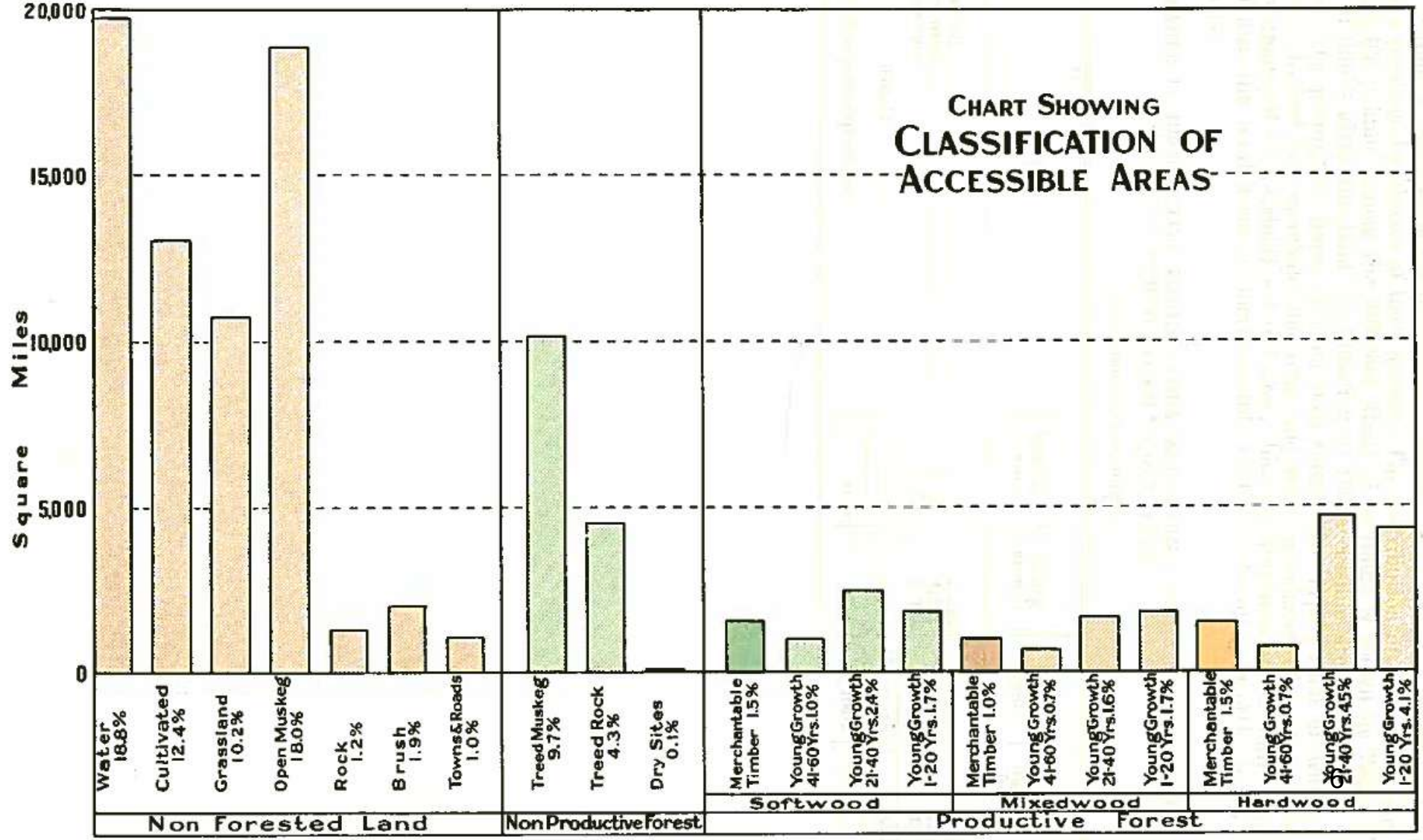

TABLE 3.—SUMMARY CLASSIFICATION OF ACCESSIBLE AREA

Areas are in square miles

Description	District								Totals	Per cent of total area
	Assiniboine	Whitemouth	Lake Winnipeg East	Lake Winnipeg	Winnipegosis	Mountain	Saskatchewan River	Upper Nelson		
Total area	27,405	5,841	14,319	17,620	12,515	6,495	8,535	12,400	105,130	100·00
Water	1,115	313	917	9,540	3,765	185	2,285	1,640	19,760	18·80
Net land	26,290	5,528	13,402	8,080	8,750	6,310	6,250	10,760	85,370	81·20
Non-Forested										Per cent of net land area
Cultivated	11,056	320	8	467	395	810	7	.....	13,063	15·30
Grass	7,795	373	.....	439	1,087	893	91	84	10,762	12·60
Muskeg	717	1,809	4,430	3,420	3,026	218	1,900	3,345	18,874	22·11
Rock	.....	16	1,112	1	.....	.....	102	83	1,314	1·54
Brush	1,218	123	28	91	201	181	59	120	2,021	2·37
Towns and roads	1,069	.....	.....	.....	.....	.....	.....	.....	1,069	1·25
Sub-total	21,855	2,641	5,587	4,418	4,709	2,102	2,159	3,632	47,103	55·17
Non-Productive Forest										
Treed muskeg	19	1,065	1,936	1,587	1,054	261	1,358	2,885	10,165	11·90
Treed rock	.....	154	2,807	2	.....	.....	293	1,288	4,544	5·32
Dry sites	82	.....	.....	.....	.....	.....	.....	.....	82	0·10
Sub-total	101	1,219	4,743	1,589	1,054	261	1,651	4,173	14,791	17·32
Productive Forest										
Softwoods—										
Merchantable	4	308	497	116	139	98	149	244	1,555	1·82
Young growth, 1 to 20 years	13	129	298	280	153	92	469	400	1,834	2·15
" " 21 to 40 "	5	330	476	216	299	296	548	301	2,471	2·89
" " 41 to 60 "	.....	114	319	132	70	53	208	125	1,021	1·20
Mixedwoods—										
Merchantable	5	152	198	188	77	270	55	86	1,031	1·21
Young growth, 1 to 20 years	0	47	281	127	422	154	251	540	1,828	2·14
" " 21 to 40 "	18	168	300	190	215	427	176	176	1,670	1·96
" " 41 to 60 "	.....	46	208	37	49	193	87	85	705	0·83
Hardwoods—										
Merchantable	317	164	109	146	309	451	33	13	1,542	1·81
Young growth, 1 to 20 years	1,618	67	85	269	596	689	307	694	4,325	5·07
" " 21 to 40 "	2,116	120	266	332	592	901	142	263	4,732	5·54
" " 41 to 60 "	232	23	35	40	66	323	15	28	762	0·89
Sub-total	4,334	1,668	3,072	2,073	2,987	3,947	2,440	2,955	23,476	27·51
Grand total	.....	.....	.....	.....	.....	.....	.....	.....	85,370	100·00

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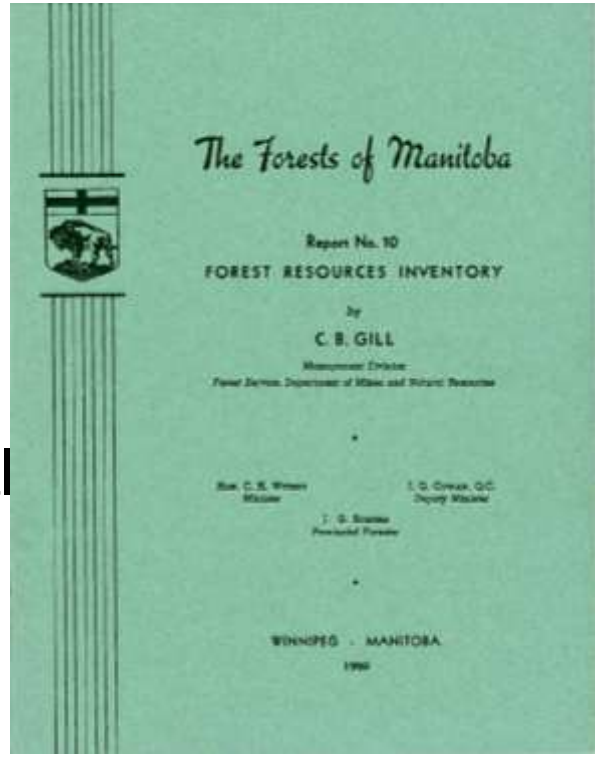
By the numbers:

- Only 3.6% of the productive forest is considered to be of Merchantable age
- Equal split between softwood and hardwood

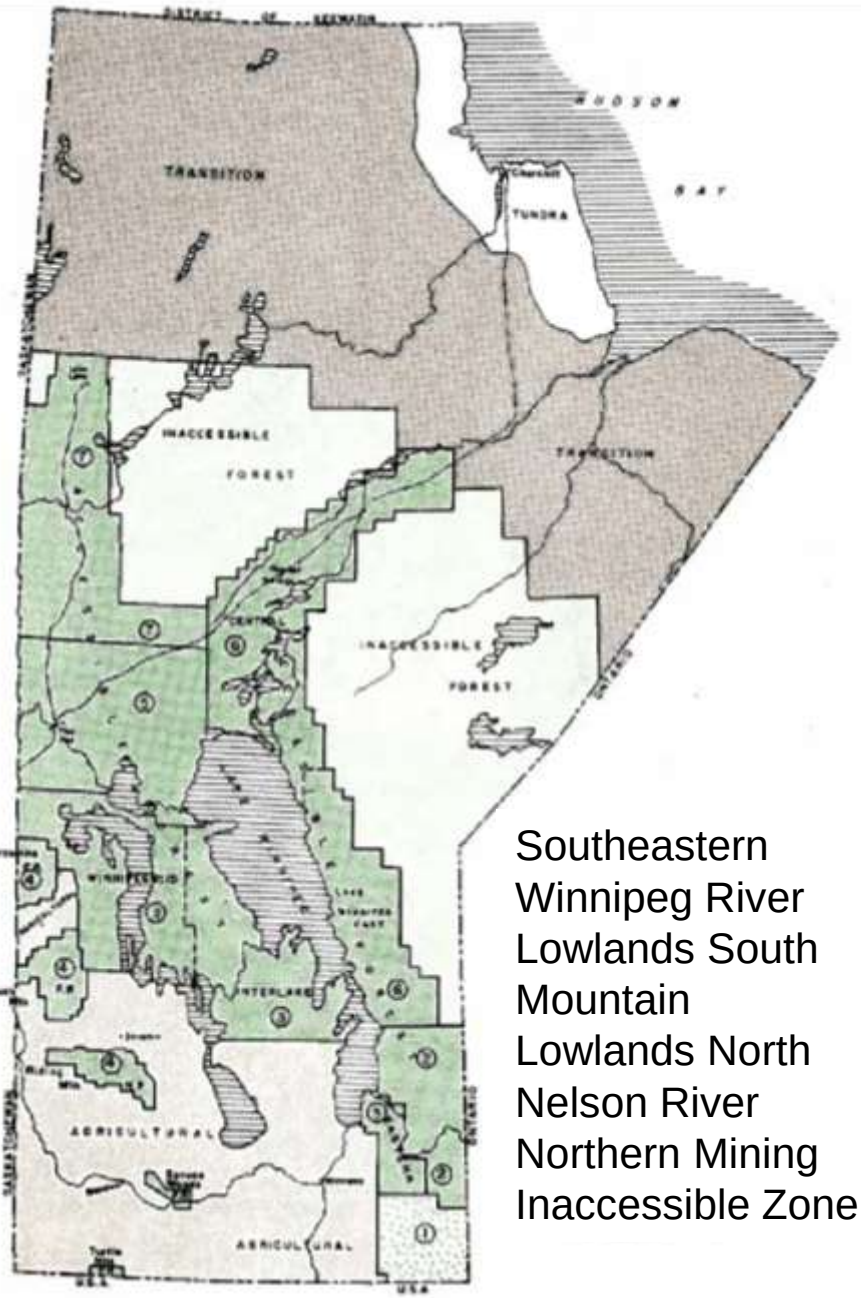
Expanding Inventory Areas

Concern about the sustainability of the resource lead to an expansion of forest inventory

- More people and the Rail line provide opportunities to expand Inventories northward
- Advent of aerial Photography allows survey crews to provide better locational accuracy



Initial Inventory survey methodologies were modeled after National surveys that were ongoing in other jurisdictions: covertype and subtype remained focal points



Southeastern	1
Winnipeg River	2
Lowlands South	3
Mountain	4
Lowlands North	5
Nelson River	6
Northern Mining	7
Inaccessible Zone	8

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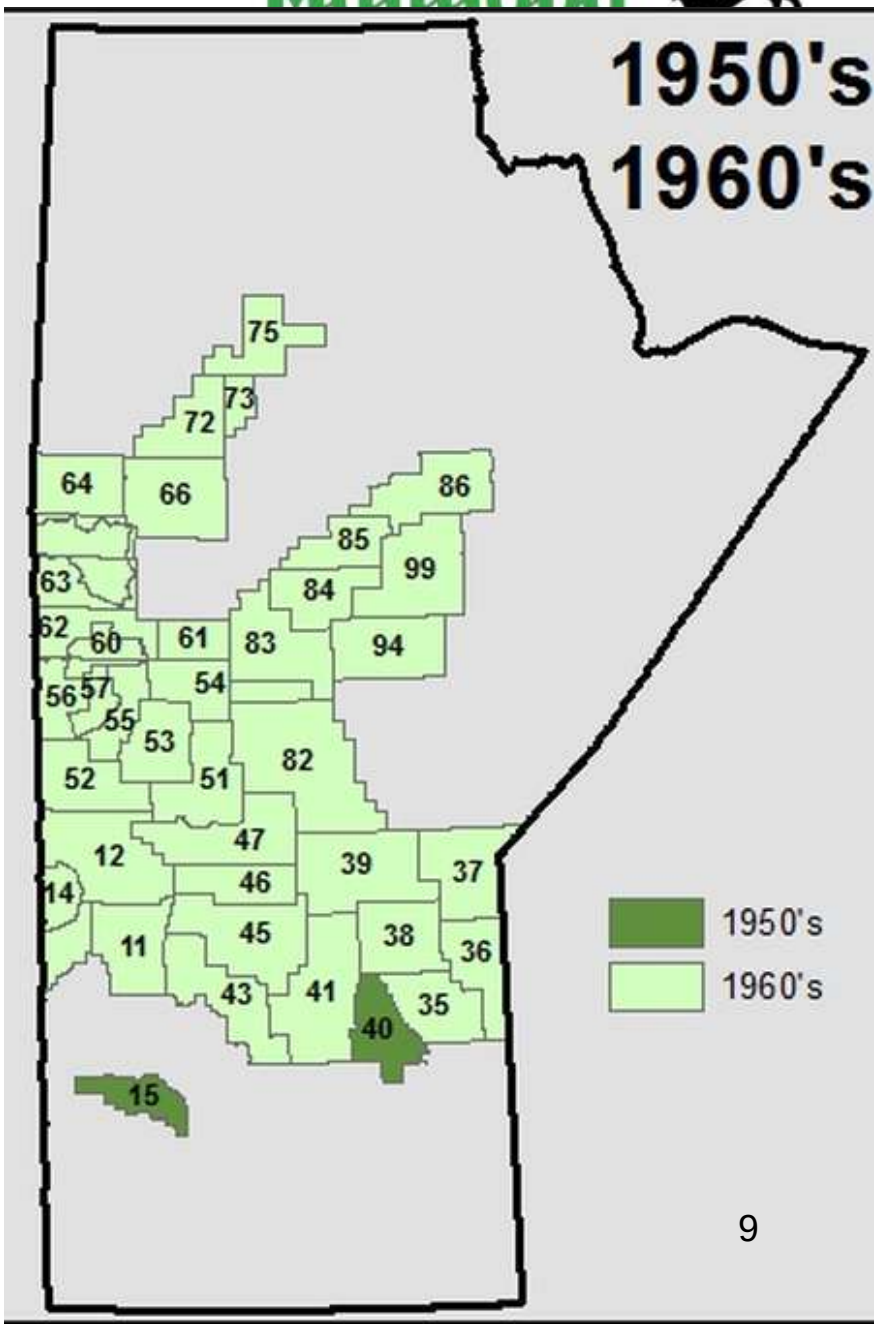


Dominion Land Survey System

- All basemaps and photography were fitted to the Township and Range grid
  - Maps were provided to field survey crews
- In the North a theoretical grid was used
- Neither represented ground coordinates very well by today's standards…

RANGE LINES RUN EAST AND WEST OF THE PRIME MERIDIAN , DRAWN AT APPROXIMATELY 98°W AT HEADINGLY NEAR WINNIPEG. (SEE FIG.7-12)

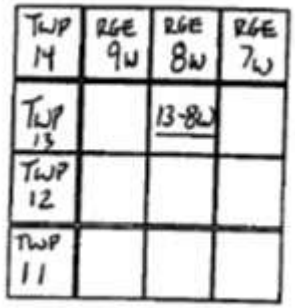
TOWNSHIPS ARE NUMBERED PROGRESSIVELY FROM THE SOUTH TO NORTH BEGINNING AT THE CANADA US BORDER. (SEE FIG.7-9)

SECTIONS ARE SUBDIVISIONS OF TOWNSHIPS. EACH TOWNSHIP CONTAINS 36 SECTIONS OF ONE SQUARE MILE. THESE SECTIONS ARE NUMBERED IN A CRIS CROSS PATTERN FROM THE SOUTH EASTERN CORNER TO THE NORTH EASTERN CORNER. (SEE FIG 7-9)

QUARTER SECTIONS ARE SUBDIVISIONS OF SECTIONS. QUARTER SECTIONS ARE DENOTED BY THE ABBREVIATIONS NW,NE,SW,SE BASED ON THEIR POSITION.

SW1/4 - 9 - 13 - 8 W

QUARTER SECTION — SECTION — TOWNSHIP — RANGE



Photogrammetric Technique

- Slotted Template equipment for doing radial line triangulation (2D)
- Assumptions: vertical, frame imagery

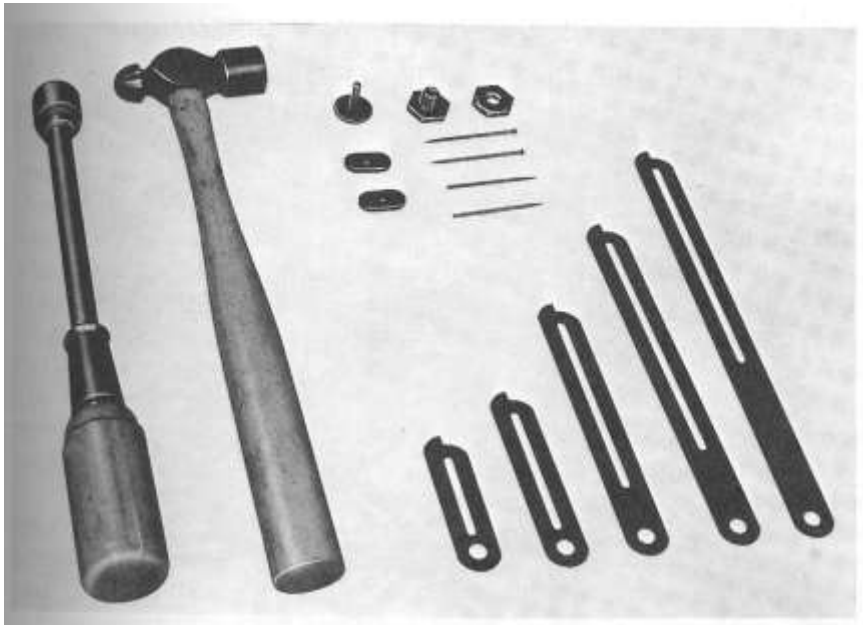
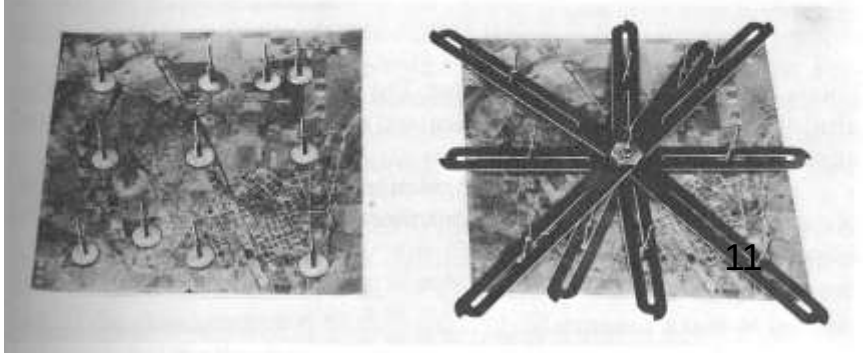
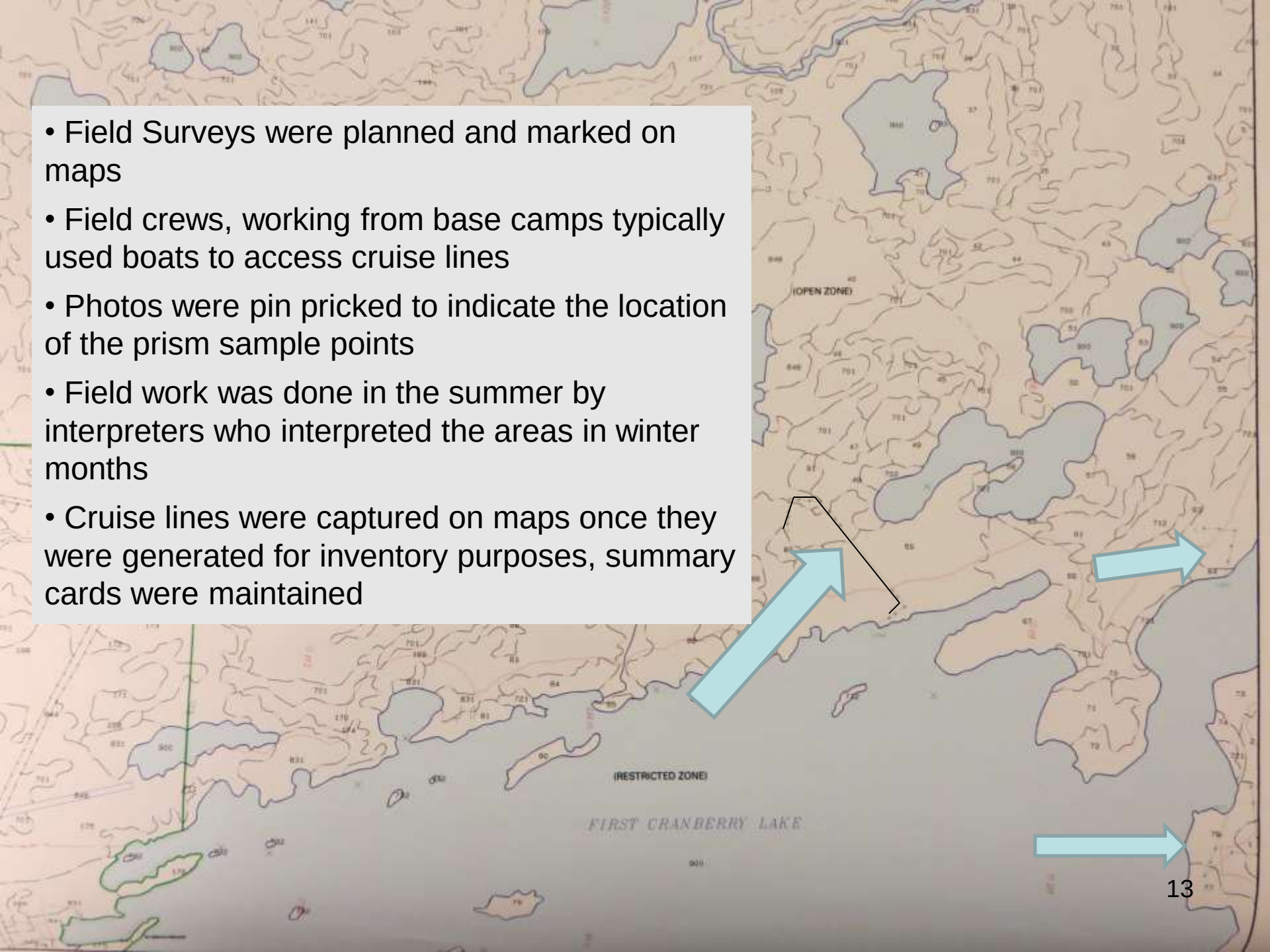


Figure 7-21. Slotted metal arms.



“Adjusting” a Large Photogrammetric Block by Radial Line Method

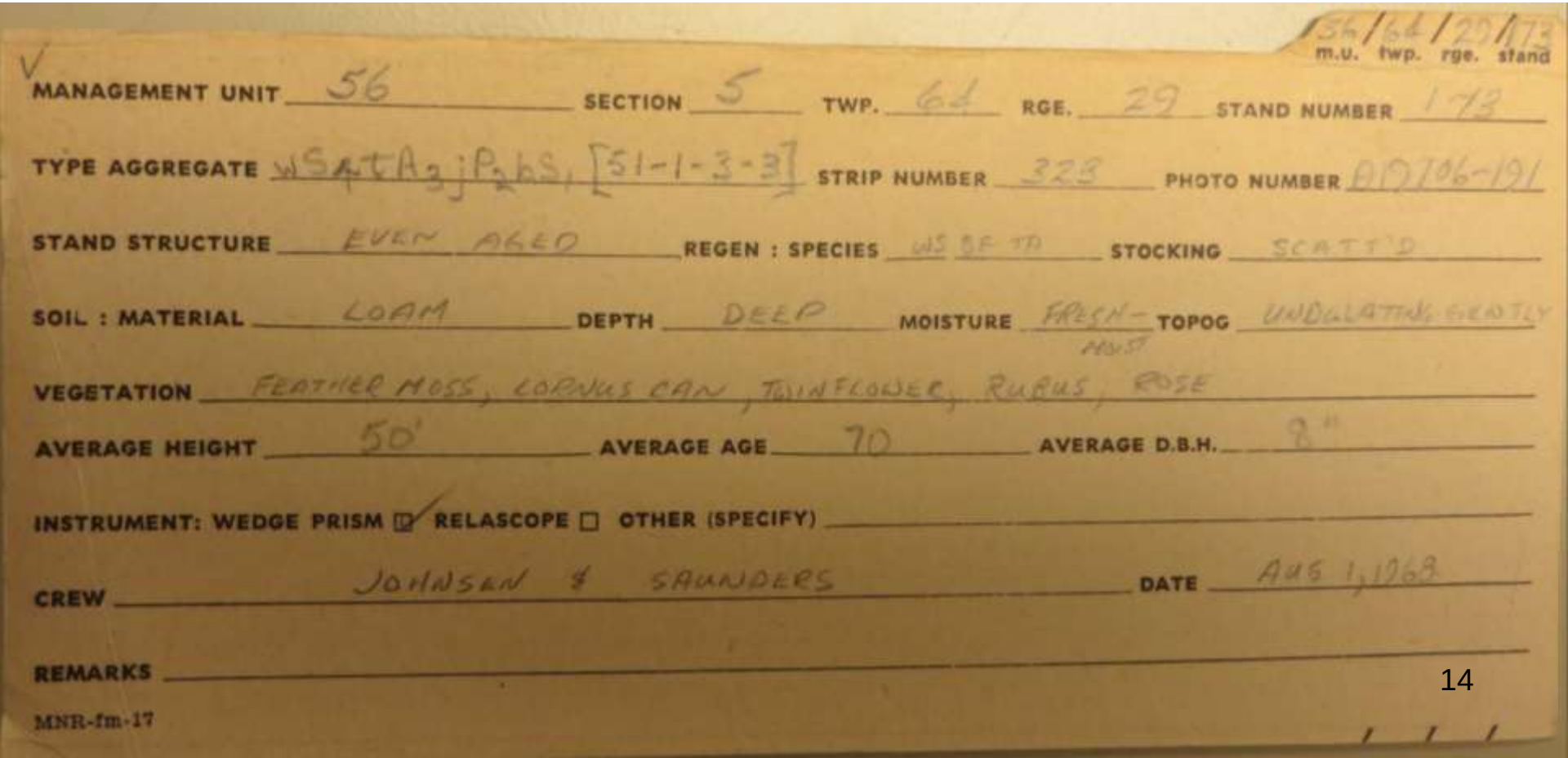
- Time consuming and difficult to replicate
- Required a considerable number of skilled and patient workers
- No ability to compensate for topography



- Field Surveys were planned and marked on maps
- Field crews, working from base camps typically used boats to access cruise lines
- Photos were pin pricked to indicate the location of the prism sample points
- Field work was done in the summer by interpreters who interpreted the areas in winter months
- Cruise lines were captured on maps once they were generated for inventory purposes, summary cards were maintained

Photo Interpretation

- Field survey work was done by those that would do interpretation in the winter


56/64/29/173
m.u. twp. rge. stand

MANAGEMENT UNIT 56 SECTION 5 TWP. 64 RGE. 29 STAND NUMBER 173

TYPE AGGREGATE wSatA3jP2bS1 [51-1-3-3] STRIP NUMBER 323 PHOTO NUMBER AO106-191

STAND STRUCTURE EVEN AGED REGEN : SPECIES WS BF TA STOCKING SCATT'D

SOIL : MATERIAL LOAM DEPTH DEEP MOISTURE FRESH-MOIST TOPOG UNDULATING GENTLY

VEGETATION FEATHER MOSS, CORNUS CAN, TWINFLOWER, RUBUS, ROSE

AVERAGE HEIGHT 50' AVERAGE AGE 70 AVERAGE D.B.H. 8"

INSTRUMENT: WEDGE PRISM ☑ RELASCOPE ☐ OTHER (SPECIFY)

CREW JOHNSON & SAUNDERS DATE AUG 1, 1968

REMARKS

MNR-fm-17

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SUMMARY OF POINT SAMPLE PLOTS LOCATED

PLOT NO.	NUMBER OF TREES																		
	rP	jP	wS	bS	bF	Tl	eC				tA	bA	wB	Oak	Ash	Elm			TOT.
1			6								1								7
2			10								6								16
3			5								15								20
4			5																5
5		10	2								1								13
6		5	5	1									1						12
7				6		1							1						8
8			3									5							8
9																			
10																			
TOT.		15	36	7		1					23	5	2						89

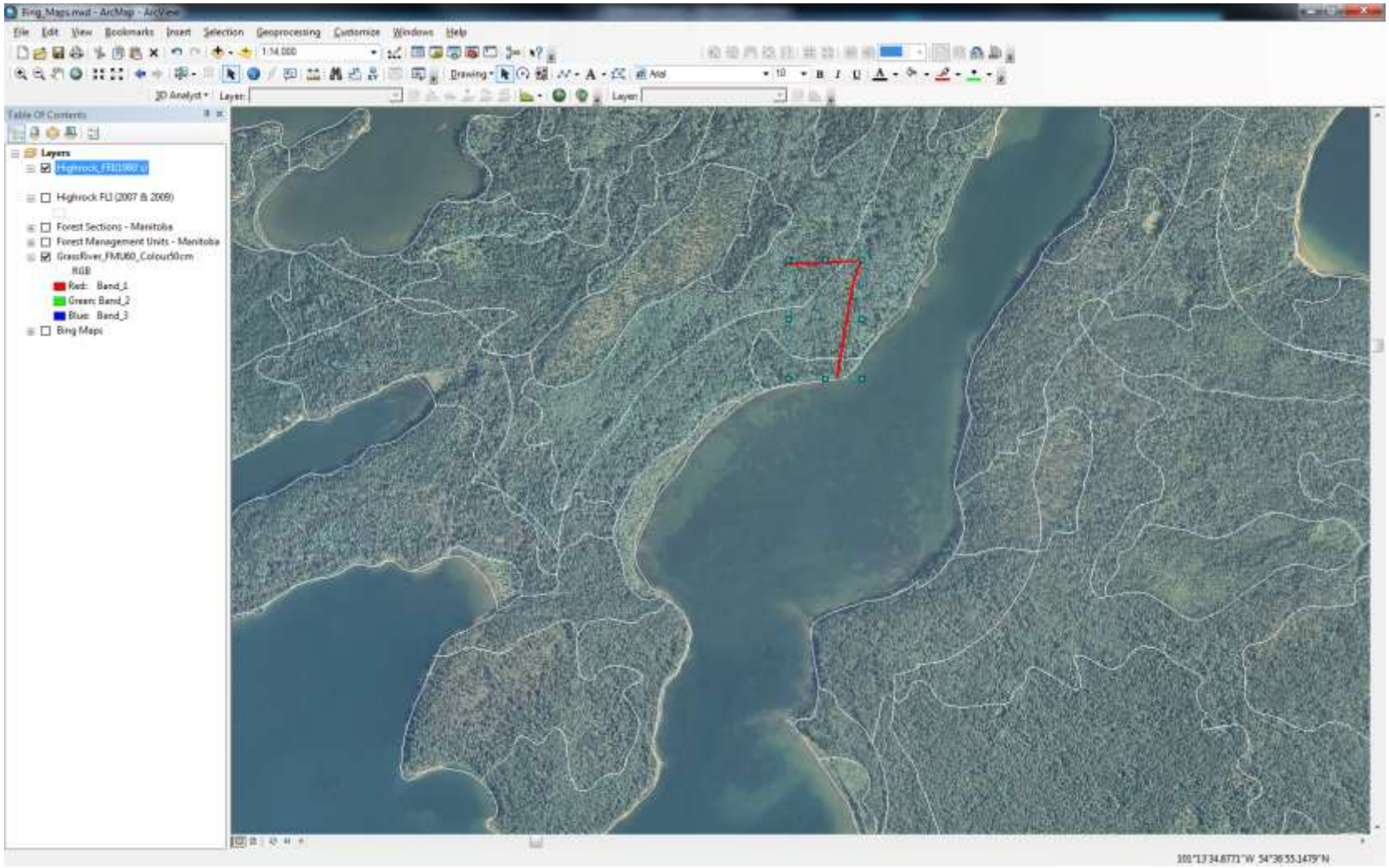
SPECIES COMPOSITION (nearest 10%)

		2	4	1		0					3	0	0						10

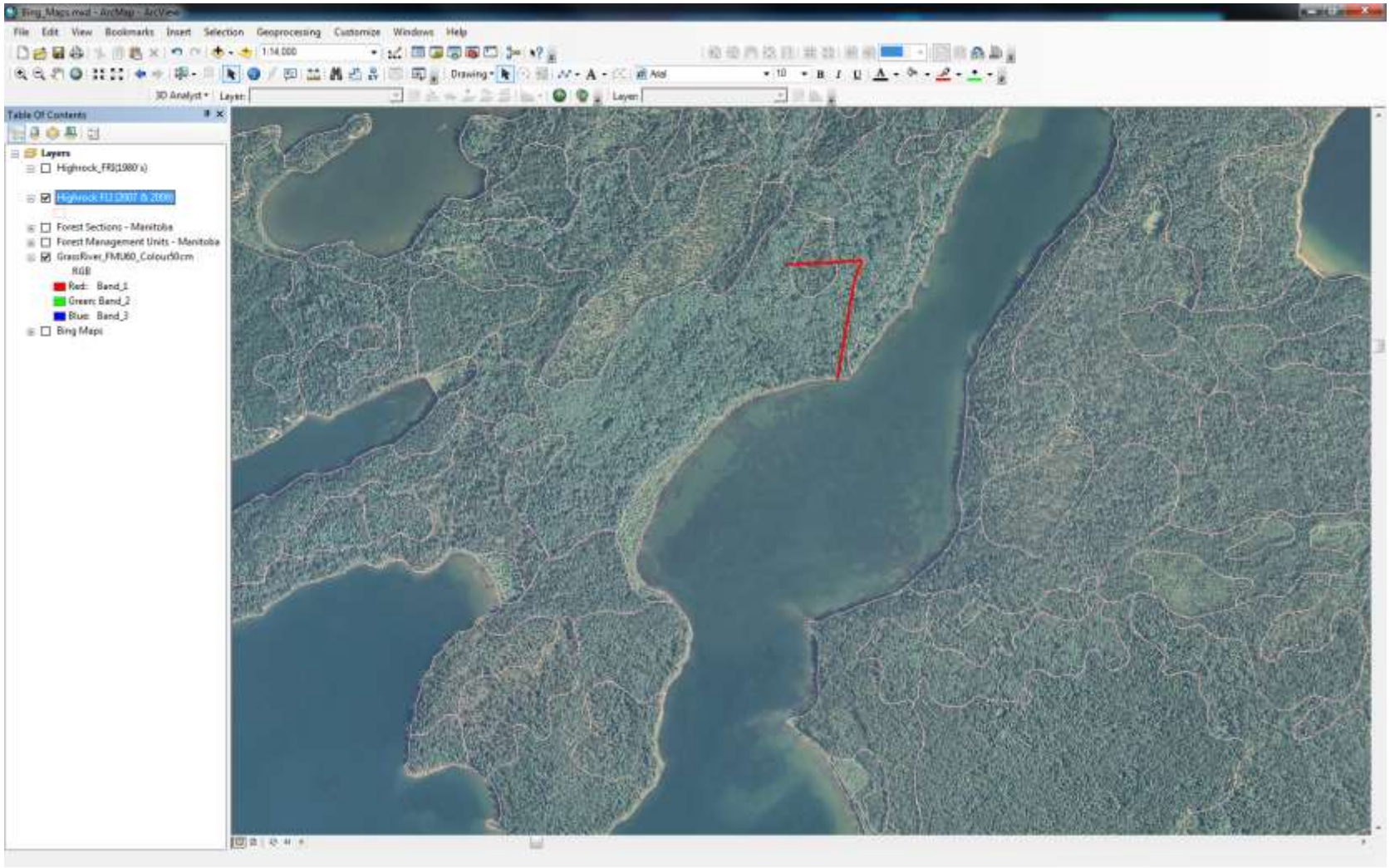
FRI polygons over Orthophoto

- FRI line work fits ok in places, out 50 to 150 meters in other places
- Water levels change, etc.
- Tendency to interpret LARGE polygons

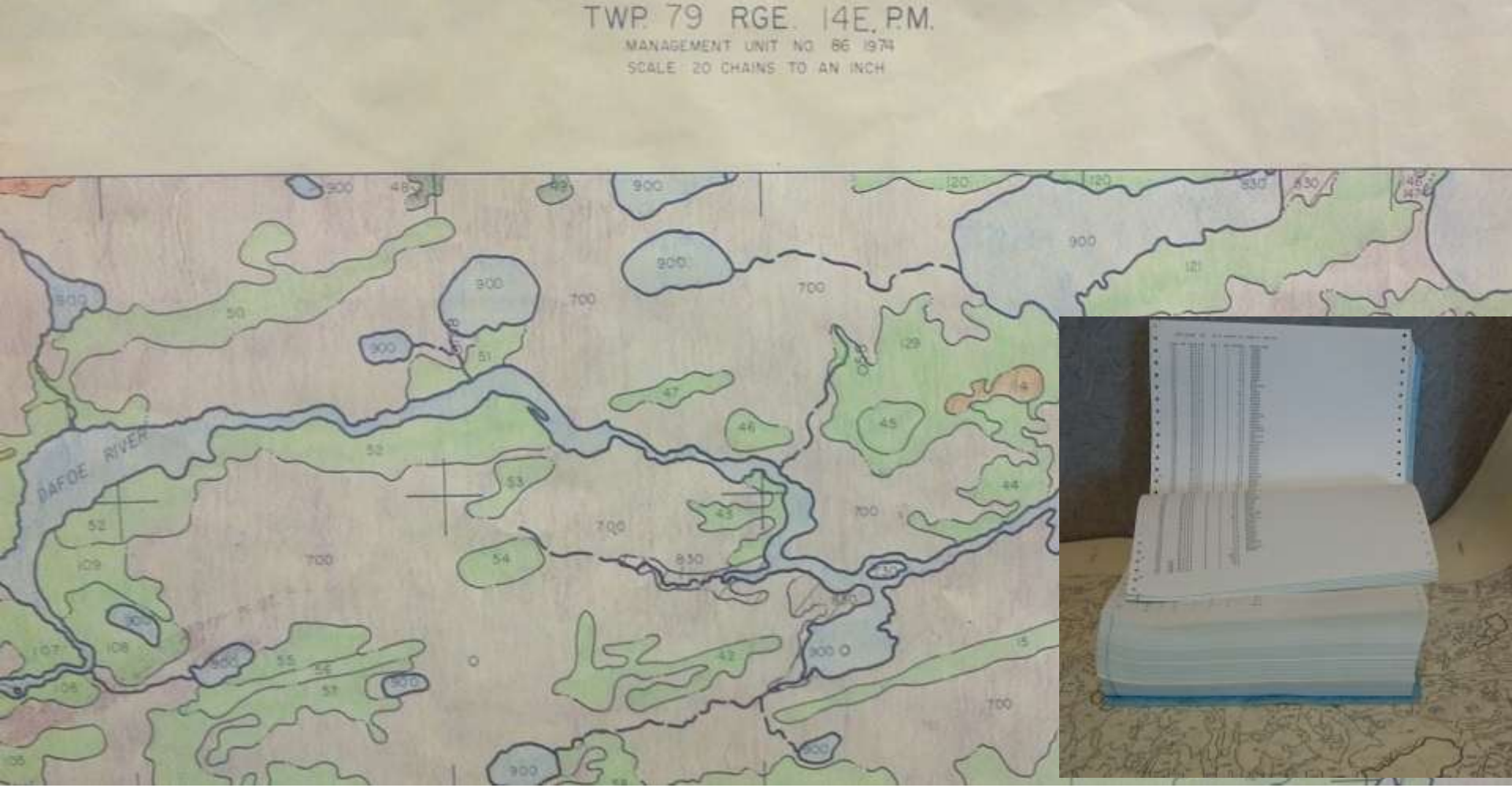
Fitting Cruise Line Data to Orthos



Evaluating how it stacks up to FLI



Analogue



- Inventory maps were created by transfer of delineation from aerial photographs, then coloured by hand, dot counts for area
- Stand numbers in combination with Township and Range provide a unique key to stand list tables
- Older inventories provide a valuable look into the past

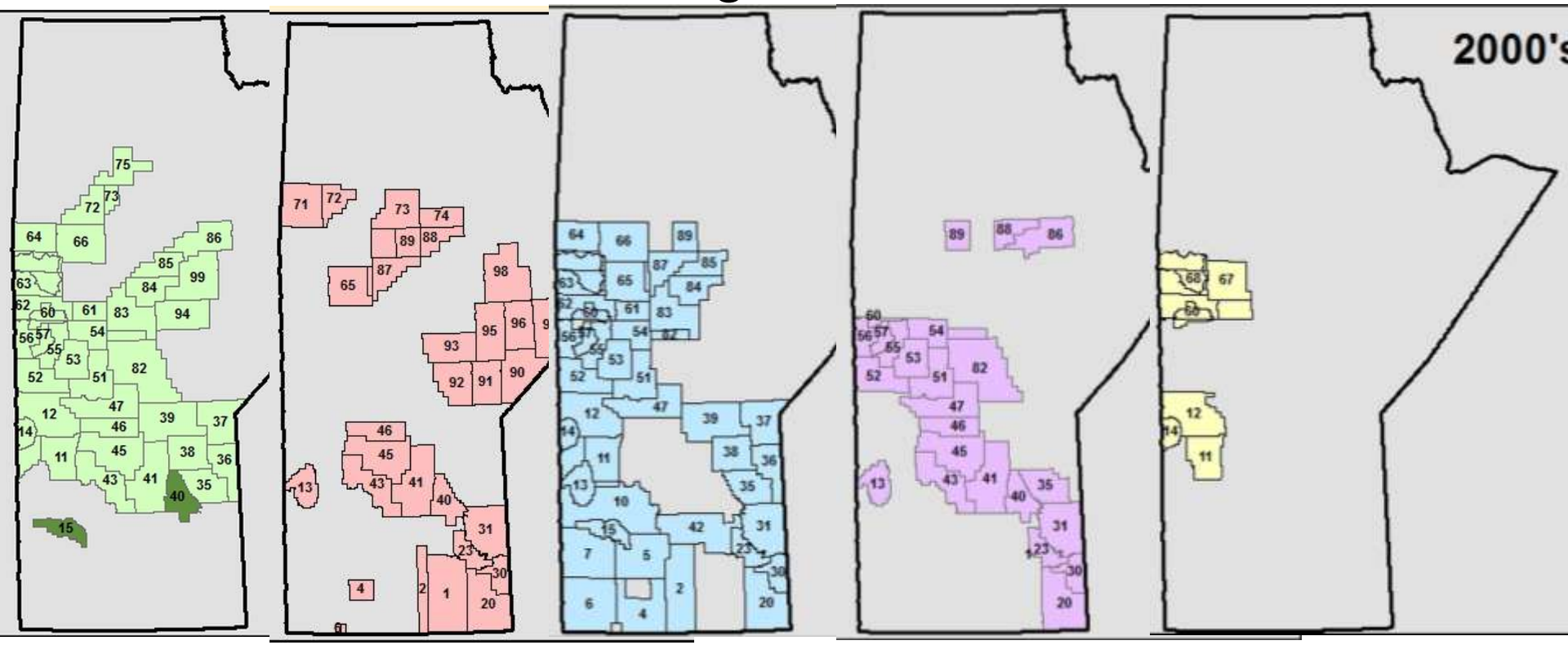
The next BIG step in technology

- The advent of the Stereo plotters brought the ability to create terrain models from stereo pair photographs
- Skilled operators were required
- Manitoba removed it's last one of these in 2011 (it operated until winter)

Wild A7 Triangulation Instrument

Inventory Vintages

- Area acquired has diminished since the 80’s
- Focus has also changed



Inventory Changes

Inventory Cycle (FRI)

- 20 year re-inventory cycle was determined in the 1980's
- Budgets required a focused approach

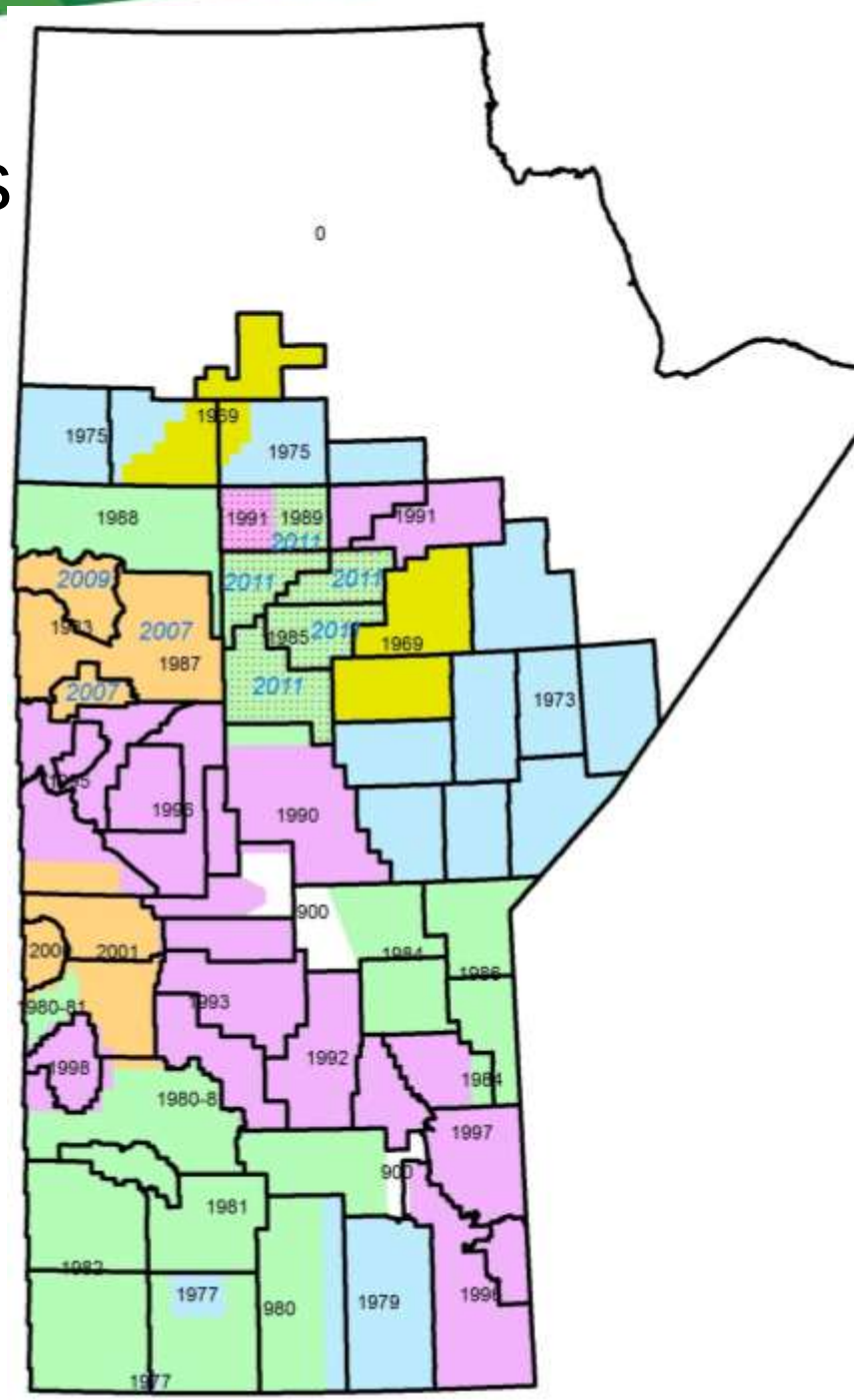
FLI Standard Developed at FLITAC

- FLITAC Established fall of '98
- Draft Standard in April 2000
- Presented to Industry and Government
- Finalized in December 2000

The Forest Lands Inventory (FLI)

- Ecosystem based approach
- More than a source of fibre/lumber
- Considerably more information

Traditional Photography vs. Softcopy



Comparing FRI & FLI Inventories

1950's - 2000
FRI

- Maturity classes
- Single Canopy
- Point in time
- Inconsistent site data
- Non productive land
- Complete Provincial Coverage

2001 - Present
FLI Inventory

- Year of Origin
- Multiple Canopy
- Living Inventory - Updated
- Ecological Component, ecosites, V&S Types
- Landform / soils
- Wetland Classification
- Canopy Heights
- Coverage is growing

Forest Resource Inventory (FRI) Attributes

(1940-1974)

- AREA
- PERIMETER
- UNION_ID
- LND_ID
- OWN_ID
- ST_ID
- MU_ID
- **SPECIES**
- **COVERTYPE**
  - **S,M,N,H**
- CUT CLASS
- CROWN CLOSURE
- HECTARES
- BALHECT
- STDSET
- YEAR_ORG
- TWP
- **COVER_TYPE**
- LAND_TYPE
- **WG**
- **SUBTYPE**
  - **Numeric code**
- OWN_DESC
- MR

COLUMN	ITEM NAME	VIDTH	OUTPUT	TYPE	N.DEC
1	AREA	8	18	F	5
9	PERIMETER	8	18	F	5
17	LANDROB3#	4	5	B	-
21	LANDROB3-ID	4	5	B	-
25	POLYNUM	5	5	I	-
30	MER	1	1	I	-
31	TWP	3	3	I	-
34	RGE	2	2	I	-
36	ID	5	5	N	0
41	MAPSHEET	7	7	N	0
48	SEQ	1	1	N	0
49	SACOV1	1	1	C	-
50	SACLASS1	1	1	N	0
51	SACOV2	1	1	C	-
52	SACLASS2	1	1	N	0
53	COVARR	2	2	C	-
55	CANLAY	1	1	C	-
56	CANRANK	1	1	N	0
57	CANPAT	1	1	N	0
58	COMHT	1	1	N	0
59	SPH	1	1	N	0
60	CC	1	1	C	-
61	HT	2	2	N	0
63	SP1	2	2	C	-
65	SP1PER	2	2	N	0
67	SP2	2	2	C	-
69	SP2PER	1	1	N	0
70	SP3	2	2	C	-
72	SP3PER	1	1	N	0
73	SP4	2	2	C	-
75	SP4PER	1	1	N	0
76	SP5	2	2	C	-
78	SP5PER	1	1	N	0
79	SP6	2	2	C	-
81	SP6PER	1	1	N	0
82	ORIGIN	4	4	N	0
86	LANDMOD	2	2	C	-
88	LMODNO	1	1	C	-
89	SOILTEX	3	3	C	-
92	TOPO	2	2	C	-
94	SLOPEPOS	1	1	C	-
95	SLPER	1	1	N	0
96	ASP	2	2	C	-
98	DRAINPAT	1	1	C	-
99	MR	1	1	C	-
100	NNF_ANTH	3	3	C	-
104	MOD1	2	2	C	-
105	EXT1	1	1	N	0
106	ORIG1	4	4	N	0
110	MOD2	2	2	C	-
112	EXT2	1	1	N	0

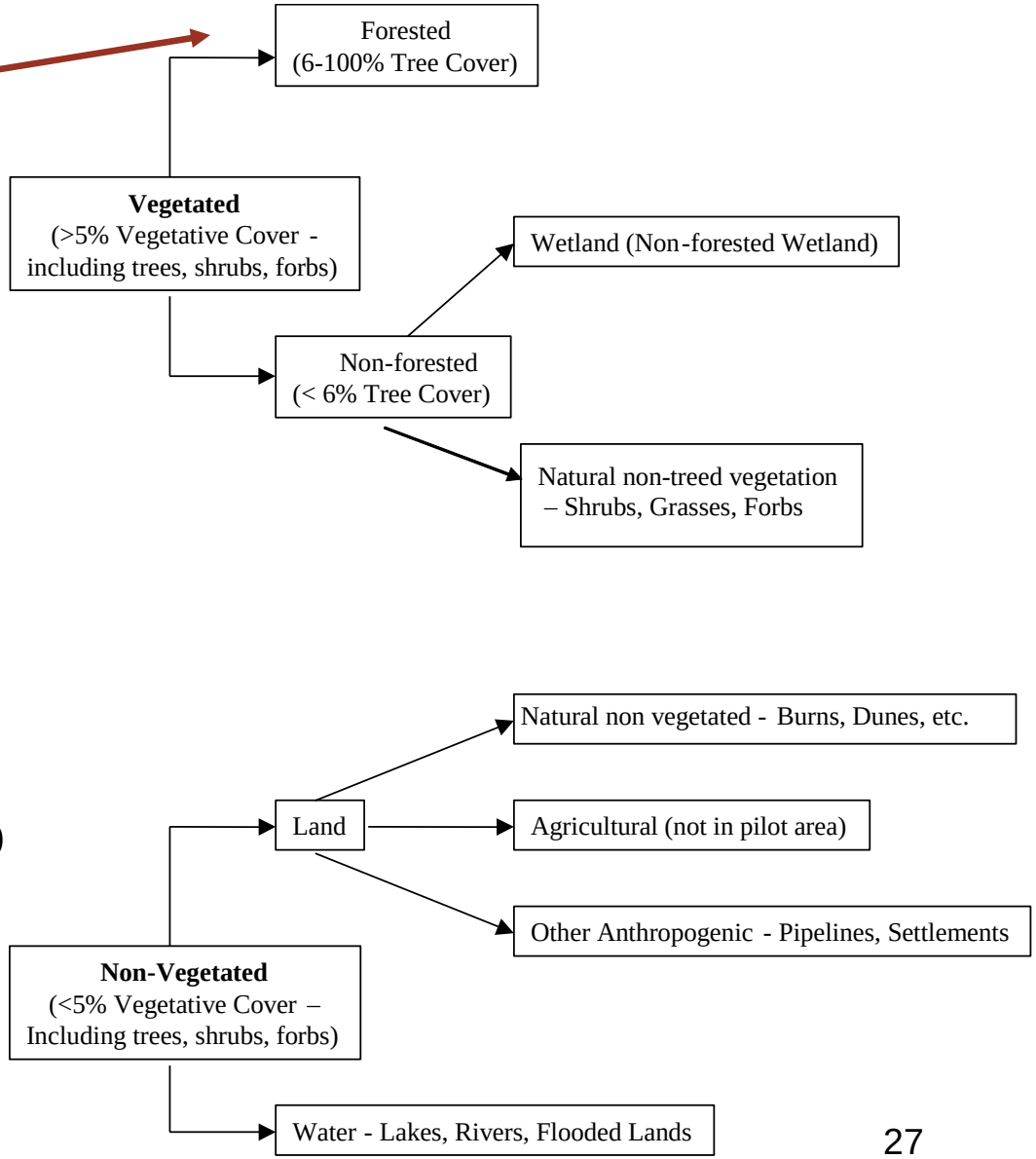
COLUMN	ITEM NAME	VIDTH	OUTPUT	TYPE	N.DEC
113	ORIG2	4	4	N	0
117	TREATMOD	2	2	C	-
119	TREATEXT	1	1	N	0
120	TRORIG	4	4	N	0
124	WETECO1	2	2	N	0
126	WETECO2	2	2	N	0
128	INTER	2	2	C	-
130	DTYPE	1	1	C	-
131	MONTH	2	2	N	0
133	YEAR	4	4	N	0
137	YEARPHOTO	4	4	N	0
141	US2CANLAY	1	1	C	-
142	US2CANRANK	1	1	N	0
143	US2CANPAT	1	1	N	0
144	US2SPH	1	1	N	0
145	US2CC	1	1	C	-
146	US2HT	2	2	N	0
148	US2SP1	2	2	C	-
150	US2SP1PER	2	2	N	0
152	US2SP2	2	2	C	-
154	US2SP2PER	1	1	N	0
155	US2SP3	2	2	C	-
157	US2SP3PER	1	1	N	0
158	US2SP4	2	2	C	-
160	US2SP4PER	1	1	N	0
161	US2SP5	2	2	C	-
163	US2SP5PER	1	1	N	0
164	US2SP6	2	2	C	-
166	US2SP6PER	1	1	N	0
167	US2ORIGIN	4	4	N	0
171	US2NNF_ANTH	3	3	C	-
174	US3CANLAY	1	1	C	-
175	US3CANRANK	1	1	N	0
176	US3CANPAT	1	1	N	0
177	US3SPH	1	1	N	0
178	US3CC	1	1	C	-
179	US3HT	2	2	N	0
181	US3SP1	2	2	C	-
183	US3SP1PER	2	2	N	0
185	US3SP2	2	2	C	-
187	US3SP2PER	1	1	N	0
188	US3SP3	2	2	C	-
190	US3SP3PER	1	1	N	0
191	US3SP4	2	2	C	-
193	US3SP4PER	1	1	N	0
194	US3SP5	2	2	C	-
196	US3SP5PER	1	1	N	0
197	US3SP6	2	2	C	-
199	US3SP6PER	1	1	N	0
200	US3ORIGIN	4	4	N	0
204	US3NNF_ANTH	3	3	C	-

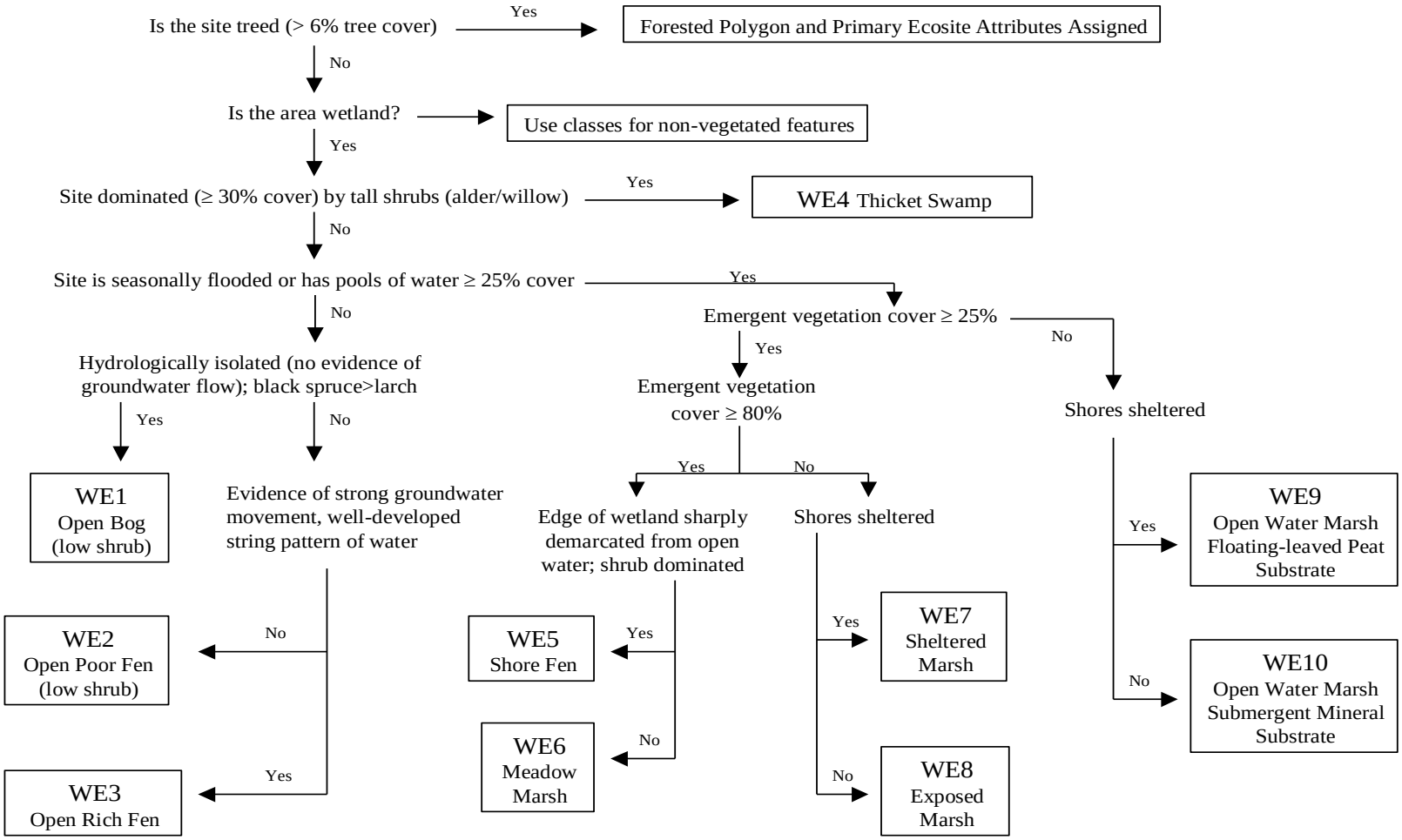
COLUMN	ITEM NAME	VIDTH	OUTPUT	TYPE	N.DEC
207	US4CANLAY	1	1	C	-
208	US4CANRANK	1	1	N	0
209	US4CANPAT	1	1	N	0
210	US4SPH	1	1	N	0
211	US4CC	1	1	C	-
212	US4HT	2	2	N	0
214	US4SP1	2	2	C	-
216	US4SP1PER	2	2	N	0
218	US4SP2	2	2	C	-
220	US4SP2PER	1	1	N	0
221	US4SP3	2	2	C	-
223	US4SP3PER	1	1	N	0
224	US4SP4	2	2	C	-
226	US4SP4PER	1	1	N	0
227	US4SP5	2	2	C	-
229	US4SP5PER	1	1	N	0
230	US4SP6	2	2	C	-
232	US4SP6PER	1	1	N	0
233	US4ORIGIN	4	4	N	0
237	US4NNF_ANTH	3	3	C	-
240	US5CANLAY	1	1	C	-
241	US5CANRANK	1	1	N	0
242	US5CANPAT	1	1	N	0
243	US5SPH	1	1	N	0
244	US5CC	1	1	C	-
245	US5HT	2	2	N	0
247	US5SP1	2	2	C	-
249	US5SP1PER	2	2	N	0
251	US5SP2	2	2	C	-
253	US5SP2PER	1	1	N	0
254	US5SP3	2	2	C	-
256	US5SP3PER	1	1	N	0
257	US5SP4	2	2	C	-
259	US5SP4PER	1	1	N	0
260	US5SP5	2	2	C	-
262	US5SP5PER	1	1	N	0
263	US5SP6	2	2	C	-
265	US5SP6PER	1	1	N	0
266	US5ORIGIN	4	4	N	0
270	US5NNF_ANTH	3	3	C	-
273	OSFIELD1	60	60	C	-
333	OSFIELD2	60	60	C	-
393	OSFIELD3	60	60	C	-
453	OSFIELD4	60	60	C	-
513	US2FIELD	60	60	C	-
573	US3FIELD	60	60	C	-
633	US4FIELD	60	60	C	-
693	US5FIELD	60	60	C	-
753	MSPOLY	12	12	I	-
765	SPECIES	19	19	C	-
784	US2SPECIES	19	19	C	-
803	US3SPECIES	19	19	C	-

The Present

Attributes continue to evolve:

- Added an additional attribute (NP) to the Forest Modifier items MOD1, MOD2 to address non-productives on rock and bogs
- Using previous inventory to assist in ID after the fact
- Currently reviewing island codes …




Is the site treed (> 6% tree cover)
Yes
Forested Polygon and Primary Ecosite Attributes Assigned
No
Is the area wetland?
Use classes for non-vegetated features
Yes
Site dominated (≥ 30% cover) by tall shrubs (alder/willow)
Yes
WE4 Thicket Swamp
No
Site is seasonally flooded or has pools of water ≥ 25% cover
Yes
No
Emergent vegetation cover ≥ 25%
No
Yes
Hydrologically isolated (no evidence of groundwater flow); black spruce>larch
Emergent vegetation cover ≥ 80%
Shores sheltered
Yes
No
Yes
No
WE1 Open Bog (low shrub)
Evidence of strong groundwater movement, well-developed string pattern of water
Edge of wetland sharply demarcated from open water; shrub dominated
Shores sheltered
Yes
WE9 Open Water Marsh Floating-leaved Peat Substrate
No
WE2 Open Poor Fen (low shrub)
WE5 Shore Fen
WE7 Sheltered Marsh
WE10 Open Water Marsh Submergent Mineral Substrate
WE3 Open Rich Fen
WE6 Meadow Marsh
WE8 Exposed Marsh

FLI Attributes

- Pilot on The Duck and Porcupine Mountains
- Regional ecosites developed

Optional Attributes are to be discussed between Forest Industry and Manitoba Conservation as to their requirement to be collected for specific Forest Management Units.

GENERAL		(All Polygons)	Data Field
Mapsheet	Numeric	Corresponding UTM tile (with the last digit dropped – i.e. 6 digit reference number)	MAPSHEET
Polygon number	Numeric	Consecutive per mapsheet	POLYNUM

FORESTED		(Polygons with Forested Covertypes)	Data Field
Canopy Layer. As a rule layers will be 5 meters difference in height. Limit 5 layers.	Character	S – Single 'overstorey' layer (primary tree layer). M – Multi (two) 'overstorey' layers. V – Veteran layer (must be used in conjunction with single or multi 'overstorey' layers; always has a crown closure of '0', representing 0-5%). Can be a layer by itself. C – Complex stand (stands which display a range of heights rather than several distinct height classes; no understoreys allowed). For BS, TL wet stands only. U – Understorey (less then 10 metres; optional on single and multi storey stands but not used with complexes). Both softwood and hardwood identified only if seen on leaf-on aerial photography. Note – Canopy layer is not identified for wetlands or non-vegetated polygons.	CANLAY
Canopy Rank	Numeric	1 to 4 based on order of precedence (see Section3.5.2 for details) Note – overstorey layers (S, M or C) are ranked first (in the case of M, the taller layer is given first ranking); then the Understorey layer (U) and finally, the Veteran layer (V) (lowest priority of the treed layers). If one of the layers (default or M) is non-treed (e.g., shrub), then that layer is given lowest priority. Note – Canopy rank is not identified for wetlands or non-vegetated polygons.	CANRANK
Height Range	Numeric	In complex stands only (i.e., CANLAY = 'C') – number of metres from the midpoint that describes the height of the complex stand (e.g., 12 m ± 5 m, enter 5)	COMHT
Crown Closure	Character	0 – 6 to 10% crown closure (1 to 5% in a Veteran layer). If Veteran layer lease as a dash in crown closure column.	CC
Crown Closure code break down	Character	1 – 11 to 20% crown closure 2 – 21 to 30% crown closure 3 – 31 to 40% crown closure 4 – 41 to 50% crown closure 5 – 51 to 60% crown closure 6 – 61 to 70% crown closure 7 – 71 to 80% crown closure 8 – 81 to 90% crown closure 9 – 91 to 100% crown closure	CC
Height	Numeric	In 1 metre classes	HT
Species 1 - 6	Character	Maximum of 6 species are identified (Table 2)	SP1 SP2 SP3 SP4 SP5 SP6
Origin	Numeric	Actual origin year is coded (using 4 digits), using best available data (i.e., more tolerance in polygons where it is not specifically known (e.g., no specific fire or harvest history)); where disturbance year is known (e.g., fire or harvest) origin is set using the disturbance and an appropriate regeneration interval (e.g., one additional year for hardwood sites, same year if planted, etc.); valid ranges are 1850 to 2001 for WS, 1750 to 2001 for BS/TL and 1880 to 2001 otherwise Note – will require species specific adjustments to convert field sampled breast height age to total age (see Table 2 for list of adjustments); age then converted to origin based on inventory year of 2001 for FMU 13 and 2002 for FMU 14	ORIGIN

Interpreted Attributes - 2

ECOLOGICAL		(all naturally vegetated polygons)		
Soil Texture	Character / numeric	Description	Forestry codes	Notes
	LFS	Loamy fine sand	C0	(C zero)
	LS	Loamy sand	C0	
	S	Sand	C0	
	CS	Course sand	C2	
	FS	Fine sand	C2	
	FSL	Fine sandy loam	C3	
	SL	Sandy loam	C3	
	Na	Bedrock	C7	
	C	Clay	F1	
	SIC	Silty clay	F1	
	C-CL	Clay to clay loam	F2	
	CL	Clay	F2	
	SICL	Silty clay	F2	
	F	Fibric	L12 (L13)	Shallow peats (less than 1m) on forested sites; usually L12 but would be L13 if over fine textured soil (clay, silty clay) Shallow peats (less than 1m) on forested sites; usually L13 but would be L12 if over medium textured soil (silt, loam)
	M	Mesic	L13 (L12)	
	VFSL	Very fine sandy loam	M1	
	L	Loam	M2	
	L-CL	Loam to clay loam	M2	
	SIL	Slit loam	M2	
	ES	Eroded sites	na	
	O	Organic	P1 or P2	These are deep peats (greater than 1m) on non-treed wetlands (P1) or sparsely treed wetlands (P2)
	Comments: Note that if the soil is gravel or cobbly/stoney, the code is "C1". The "L" series of codes in the forestry Corp. data cover the layered soil – this may exist but isn't identifiable from the soil map legend codes.			

ECOLOGICAL		(All Naturally Vegetated Polygons)	Data Field
Drainage Pattern	Numeric	0 – No pattern (for Dry, Fresh or Very Fresh Moisture Regimes); codes 1 to 5 restricted to polygons with Moist and Wet soil moisture regimes. 1 – None – uniform canopy without patterned form 2 – Interspersed – patchy or reticulate (net-like) canopy pattern; few or many irregular canopy openings; sometimes arranged in a regular pattern perpendicular to the direction of water flow 3 – Simple linear – one or a few large linear corridors; generally oriented in the same direction, parallel to the direction of water flow 4 – Complex linear (closed) – Openings accounting for 6-25%, many linear drainage corridors, usually small, distinct or indistinct, generally oriented parallel to the direction of water flow or in complex arrangements 5 - Complex linear (open) – Openings accounting for >25%, many linear drainage corridors, usually small, distinct or indistinct, generally oriented parallel to the direction of water flow or in complex arrangements. Note - see Table 3 for valid combinations of topographic form, slope position, slope percent class, aspect, drainage pattern and soil moisture regime	DRAINPAT
Soil Moisture Regime	Character	D - Dry moisture regime F – Fresh moisture regime V - Very Fresh moisture regime M - Moist moisture regime W - Wet moisture regime Note – see Table 4 and Figure 4 for a full description of the moisture regime classes and a key to their identification; see Table 3 for valid combinations of topographic form, slope position, slope percent class, aspect, drainage pattern and soil moisture regime	MR

Interpreted Attributes - 3

NON-FORESTED		(Natural or Anthropogenic, Vegetated or Non-vegetated)	Date Field
Natural non-forested vegetation	Character		NNF_ANTH
	SO	Open shrub - crown closure less than 50 percent.	
	SC	Closed shrub - crown closure more than 50 percent.	
	HG	Grassland (natural), prairie savannah	
	SP	Sand Prairie, e.g. Spruce Woods area	
	HF	Forb	
	HU	Undifferentiated	
	BR	Bryophyte - mosses	
	CL	Lichen	
	WI	Willow[2] (Salix sp.), may occur in WE1 and WE4	
	AL	Alder[1] (Alnus sp.), may occur in WE4	
	DB	Dwarf Birch[2], may occur in WE1 and WE2	
	CC	Hazel[2] (Corylus cornuta)	
	CS	Dogwood[2] (Cornus stolonifera)	
	AS	Mountain maple[2] (Acer spicatum)	
	VI	Squashberry/high-bush cranberry[2] (Viburnum sp.)	
	RA	Wild rose[2] (Rosa acicularis)	
	DL	Bush honeysuckle[2] (Diervilla lonicera)	
	AU	Bearberry[2] (Arctostaphylos uva-ursi)	
	VA	Blueberry[2] (Vaccinium sp.)	
	CH	Leather leaf[2] (Chamaedaphne calyculata)	
	LG	Labrador tea[2] (Ledum groenlandicum)	
Natural Non-vegetated	Character		NNF_ANTH
	NMB	Recent burn (ecological attributes required)	
	NMC	Watercourse related cut banks, precipitous slopes/fragile sites	
	NMR	Rock barren, bedrock, talus slope, should show up in landform.	
	NMS	Open sand dunes, sand barrens	
	NMG	Gravel, sand beaches, sand bars related to watercourses	
	NWL	Lakes, ponds	
	NWR	Rivers	
	NWW	Lake Winnipeg	
	NWM	Lake Manitoba	
	NWO	Lake Winnipegosis	

Natural Non-vegetated (continued)	Character		NNF_ANTH
	NWE	Red River	
	NWA	Assiniboine River	
	NSL	Small Islands - less then 2 hectares	
	NMF	Mud/Salt Flats	
Agricultural Land	Character		NNF_ANTH
	CP	Crop Perennial	
	CA	Crop Annual	
	CPR	Pasture	
	ASB	Shelter Belts - shown as a polygon	
	AFL	Fence Lines, fire guards (Community Pasture)	
	ADD	Drainage ditches	
Other Anthropogenic	Character		NNF_ANTH
	CIP	Pipelines, transmission lines, tower sites	
	CIW	Well sites, geophysical, oil fields	
	CIU	Land clearing/abandoned land for unknown reasons	
	ASC	Cities, villages, cemeteries, etc.	
	ASR	Rural residential, acreages, cottages	
	ASN	Recreational sites - node development, way side parks	
	AIH	Highway, road right of ways, abandoned roads	
	AIR	Railroad right of way	
	AAR	Abandoned railroads	
	AIG	Gravel pits, borrow pits	
	AII	Industrial sites, mines, dumps	
	AIW	Reservoirs, lagoons, dugouts, waterholes	
	AIA	Air strips	
	AIF	Farmland, agricultural land, farmsteads, abandoned farmland	
		Dikes and Dams- should be base features	
		Beaver floods - call as wetlands	

Interpreted Attributes - 4

FORESTED		Polygons with Forested Covertypes	Data Field
Stand Condition Modifiers 1-2[2]	Character	CC – clearcut or partial cut NP – non productive (e.g. poor/stunted growth) BU – burn or partial burn PP - potential productive WF – windfall CL – clearing DI – disease DM – dwarf mistletoe IK – insect kill IB – budworm kill UK – unknown kill WE – weather (e.g., snow load damage) BF – flooded land – beaver SF – seasonally flooded land (upland occurrence) DT – discoloured or dead tops BT – broken tops SN – snags ST – scattered timber (anthropogenic lands)	MOD 1 MOD 2
Stand Condition Extent 1-2	Numeric	Default - nil 1 – light; 1 to 25 % land area affected or loss of crown closure 2 – moderate; 26 to 50 % land area affected or loss of crown closure 3 – heavy; 51 to 75% of land area affected or loss of crown closure 4 – severe; 76 to 94% of land area affected or loss of crown closure 5 - complete; 95-100% of entire crown or land area is affected	EXT 1 EXT 2
Other Anthropogenic			
Stand Condition Origin 1-2	Numeric	If the year of origin of the condition is known, it is recorded using 4 digits (e.g., BU5-1991)	ORIG1 ORIG 2
Stand Treatment Modifiers	Character	SI – site improved (e.g., fertilized, drained)	TREATMOD

Stand Treatment Modifiers (continued)	Character	SC – seedbed prepared (e.g., scarified, vegetation control) PL – planted or seeded (regardless of success) TH – thinned GR – developed for grazing domestic livestock IR – irrigated WH – modified for wildlife habitat	TREATMOD
Stand Treatment Extent	numeric	Same as **stand condition modifiers**	TREATEXT
Stand Treatment Origin	numeric	Same as **stand condition origin**	TRORIG

VEGETATED		WETLAND (Non-Forested	Data Field
Wetland Ecosite Code 1 - 2	Numeric	1 – open bog – low shrub 2 – open poor fen – low shrub 3 – open rich fen 4 – thicket swamp 5 – shore fen 6 – meadow marsh 7 – sheltered marsh 8 – exposed marsh 9 – open water marsh – floating leaved/peat substrate 10– open water marsh – submergent mineral substrate Note – see Figure 5 for a detailed key to the wetland ecosites; up to two wetland types allowed, ordered by prevalence	WETECO1 WETECO2

REFERENCE		(All Polygons)	Data Field
Interpreter	Character	Interpreter initials	INTER
Data Source	Character	I - interpreted (default) F - ground call P – PSP V – ecosystem volume sampling plot C – cruise data R – regeneration survey A – air call E – ecosite plot (new for LP) H – pre-harvest assessment plot (new for LP)	DTYPE
Reference Month	Numeric	Reference month for data source (e.g., 1-12)	MONTH
Reference Year	Numeric	Reference year for data source (e.g., four digit year)	YEAR
Year Photo	Numeric	Year of aerial photography(e.g., four digit year)	YEARPHOTO

Detail is GOOD… Right?

- Using all the attribute codes in combination can provide a great deal of information… BUT
- How do we use this information without having to spend hours learning (about this exciting topic)
- Summary items have been calculated and added to make the Inventory product easily usable for day-to-day operations

Individual SI values may have been removed to avoid confusion

Table 1. Definition of enhanced attributes calculated/summarized for the FLI of Highrock forest section.

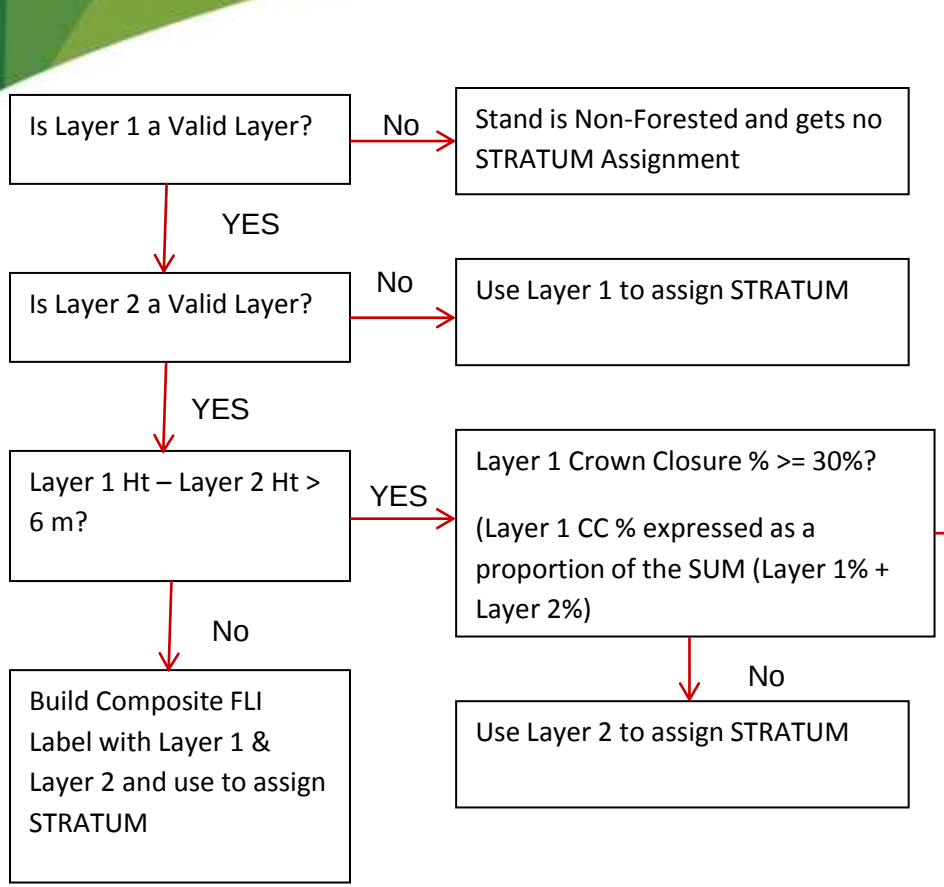
Enhanced attribute	Definition
SIC	Site index class, coded as "H","M" and "L" denoting high, medium and low productivity of site, respectively
SI_JP	Site index estimate for JP (m)
SI_BS	Site index estimate for BS (m)
SI_WS	Site index estimate for WS (m)
SI_TL	Site index estimate for TL (m)
SI_BF	Site index estimate for BF (m)
SI_TA	Site index estimate for TA (m)
SI_BA	Site index estimate for BA (m)
SI_WB	Site index estimate for WB (m)
Sp1_sum	Summarized leading species
Sp1per_sum	Summarized species composition of the leading species
Sp2_sum	Summarized 2nd species
Sp2per_sum	Summarized species composition of the 2nd species
Sp3_sum	Summarized 3rd species
Sp3per_sum	Summarized species composition of the 3rd species
Sp4_sum	Summarized 4th species
Sp4per_sum	Summarized species composition of the 4th species
Sp5_sum	Summarized 5th species
Sp5per_sum	Summarized species composition of the 5th species
Sp6_sum	Summarized 6th species
Sp6per_sum	Summarized species composition of the 6th species
Ht_sum	Summarized height (m)
Cc_sum	Summarized crown closure (0 -100)
Origin_sum	Summarized year of origin
Covertype	Stand cover type, coded as "S","M","N","H", denoting pure softwood, softwood dominated mixed wood, hardwood dominated mixed wood, and pure hardwood, respectively
Strata	Stratum type defined based on the Highrock forest section strata definition
Denagg	Density class aggregate
Agecl_2012	Age class as of 2012
Vol_key	A combination of stratum type, site index class, density class aggregate, and age class; used to link the inventory to the volume tables developed for the Highrock forest section
SI_leading	Site index of the leading species (m)
Age_2012	Age as of 2012

Strata

Table 1. Highrock Forest Section Strata Definitions:

Stratum Code	Stratum	Site Index Class#	Density Class	Crown Closure	Species Composition*
PTA	Pure Trembling Aspen	LMH	123	0-100%	TA≥7.5
MAP	Pure Commercial Hardwood	LMH	123	0-100%	(TA+BA+WB)≥7.5
PJP	Pure Jack Pine	L	123	0-100%	JP≥7.5
PJP		M	123	0-100%	
PJP		H	123	0-100%	
LBS	Lowland Black Spruce	LMH	123	0-100%	BS≥7.5; Moisture Regime='W'
UBS	Upland Black Spruce	L	123	0-100%	BS>=7.5 and Moisture Regime='D','F','M',or 'V'
UBS		MH	1	0-50%	
UBS		MH	2	51-70%	
UBS		MH	3	71-100%	
STL	Black Spruce and Tamarack	LMH	123	0-100%	(BS+TL)≥7.5
SWD	Pure Commercial Softwood	L	123	0-100%	(BS+WS+JP+BF)≥7.5
SWD		M	123	0-100%	
SWD		H	123	0-100%	
MWD	Mixedwood – Softwood Leading	L	123	0-100%	5≤softwood<7.5; 2.5≤hardwood≤5; softwood leading
MWD		MH	123	0-100%	
NWD	Mixedwood – hardwood Leading	LM	123	0-100%	2.5≤softwood<5; 5≤hardwood<7.5; hardwood leading
NWD		H	123	0-100%	
OTHSW**	Other softwood	L	123	0-100%	softwood≥5
OTHSW		MH	123	0-100%	
OTHHW**	Other hardwood	LM	123	0-100%	hardwood≥5
OTHHW		H	123	0-100%	

* strata assignment follows hierarchical order.
**yield curves of MWD and NWD were assigned for OTHSW and OTHHW respectively due to lack of data to fit separate curves for OTHSW and OTHHW.
Site index class was determined based on site index ranges of leading species, which were calculated from mean and standard deviation of the leading species site indices estimated across the entire forested areas of the Highrock forest section. The range of the site index used in determining the site index class for Highrock forest section is shown in the table below:



Use Layer 1 to assign STRATUM

YES

EXAMPLE

Composite Crown Closure (CC)

Comp. CC % - SUM(Layer 1 + Layer 2)

Can be greater than 100% for subsequent calculations but Max. 100% for generating Composite Label

Composite Stand Height

HT_SUM = AVERAGE (Layer 1 Ht + Layer 2 Ht) weighted by CC% of individual layers expressed as a proportion of Composite CC

Species Composite Example

45% TA6 WS4, 23m

75% WS8 BF2, 19m

Composite CC % = 45 + 75 = 120

TA% = (45/120)*60 = 22.5

WS% = (45/120)*60 + (75/120)*80 =

BF% = (75/120)*20 = 12.5

Ht = (45/120)*23 + (75/120)*19 = 20.5

Resultant Label: **100% WS7TA2BF1 20m**

Assigned to Pure White Spruce Species Group; 16-20m Ht Class, High Density Class

Volume Sampling and Permanent Sample Plot`s

Field Measurements

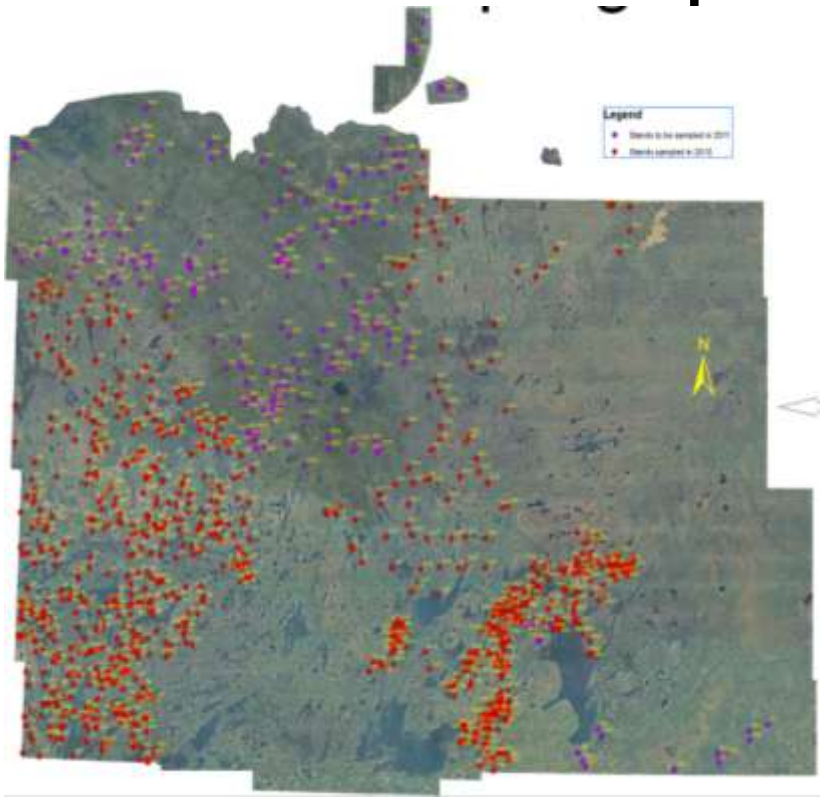
VS

- 3 x 200 m^2 circular plots
- Tree attribute information (DBH, Height, etc.)
- Volume estimation (tree → plot → stand)

PSP

- Site Index curves
- Mortality Curves
- Treatment and Response
- Plant community relationships (new)

Volume Sample data

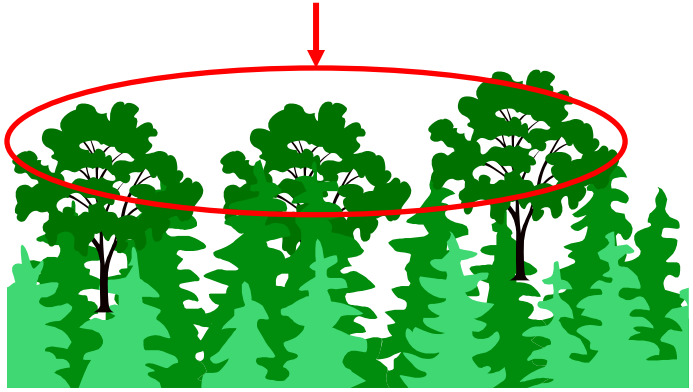


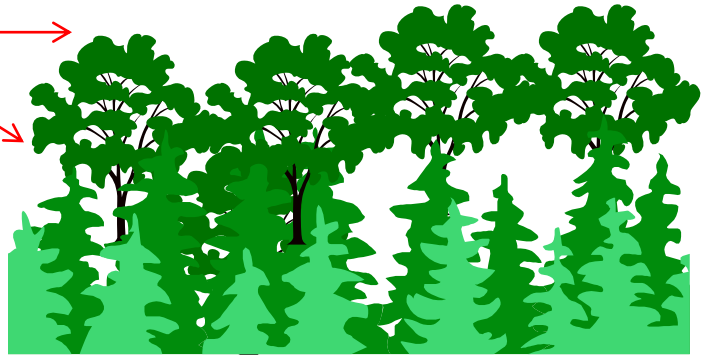
FMU	
TILE	4406070
POLYGON	314
TRANSECT	6000
PLOT	1
FULL_HALF	F
EASTING	445229
NORTHING	6079874
CREW	LK,EM
PLOT RADIUS	7.98
MIN. DBH	7.1
YEAR	2011
MONTH	3
DAY	17
PLOT COMMENTS	On side of steep hill
TP EASTING	445206
TP NORTHING	6079913
MR	F
EVEN/UN	E
SLOPEPOS	U
LAYER	1
CC_1	5
AVG HGT_1	14
SPP1_1	BS
SPP1PER_1	90
SPP2_1	JP
SPP2PER_1	10
SPP3_1	
SPP3PER_1	
SPP3_3	
SPP4_3	
SPP4PER_3	

TREE#	1	2	3	4	5	6	7	8	28	29	30
SPP	BS	BS	BS	BS	BS	DC	BS	BS	BS	BS	BS
DBH(cm)	20.6	18.5	10.6	7.8	18.9	11.9	20.1	19.9	18	13.2	17.1
Total HGT	17.2	16.9	10.5	5.9	16.6	8	17.2	16.4	16.2	15.3	15
M/E	M	M	M	M	M	M	M	M	M	M	M
COND	1	1	1	20	1	10	1	11	1	1	11
CRWNCL	C	C	I	U	C	U	C	C	C	C	C
LAYER	1	1	1	1	1	1	1	1	1	1	1
AGE @ DBH										66	38
COMMENTS						SLIGHT LEAN					STEM DISEASE

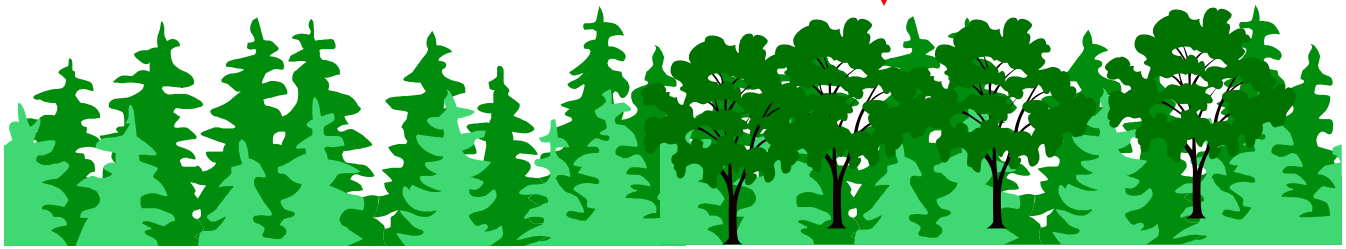
Multi-Storey Stands

Veteran Overstory layer



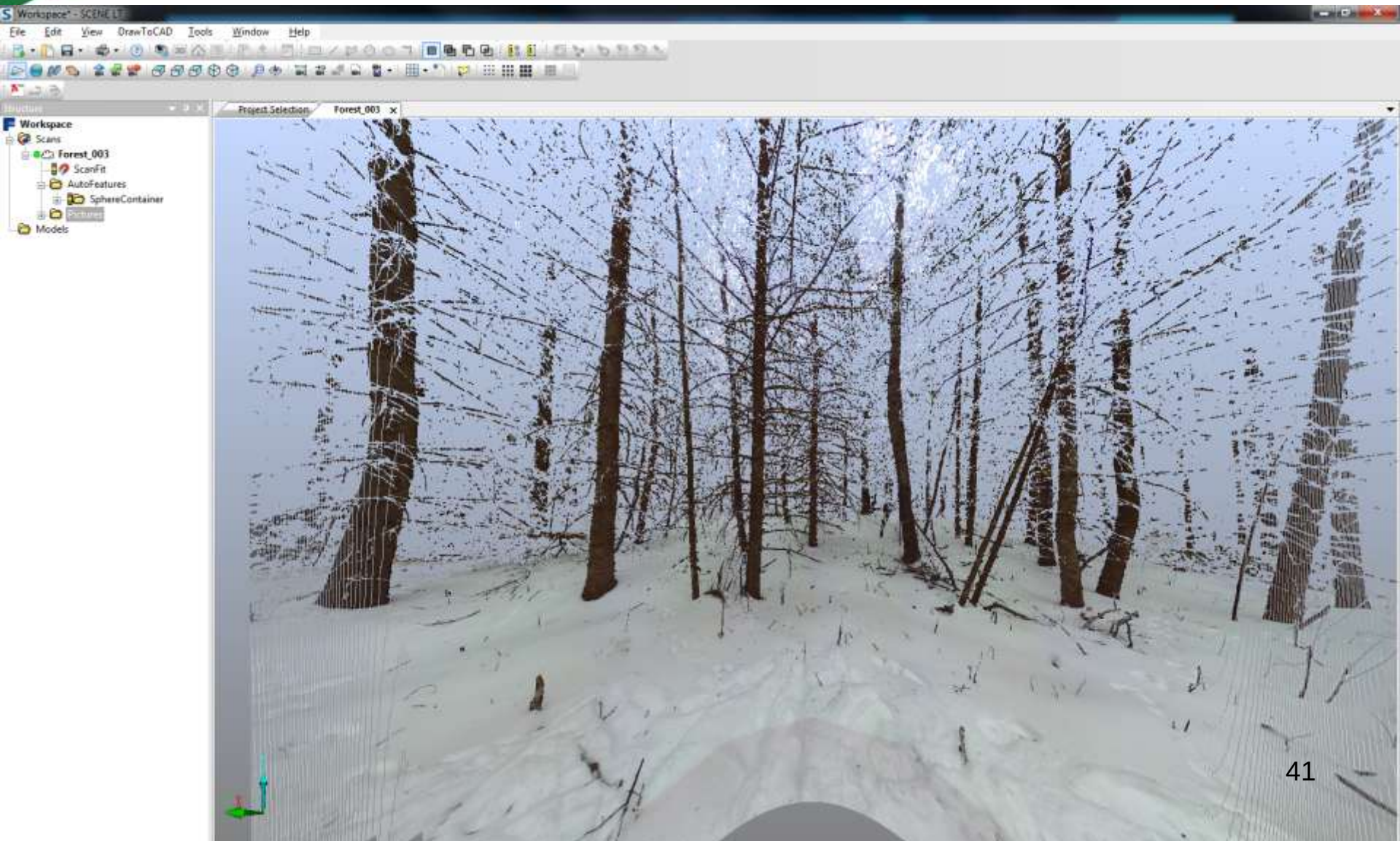


Ground sample may only provide a site specific view of the stand that does not match with average stand attributes



Welcome to the Digital Age (mostly)

Laser Scanner Data



Precise Measurements

- Tree mapping
- Permanent record
- Remeasurements are possible

- Visual representation of site
- Down woody debris
- Biomass, Carbon

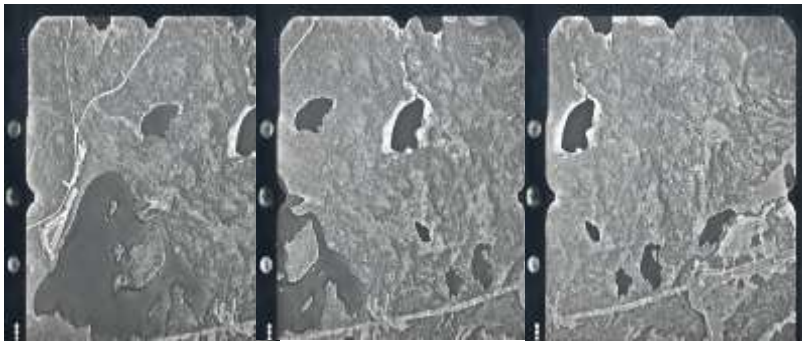
Ground Control

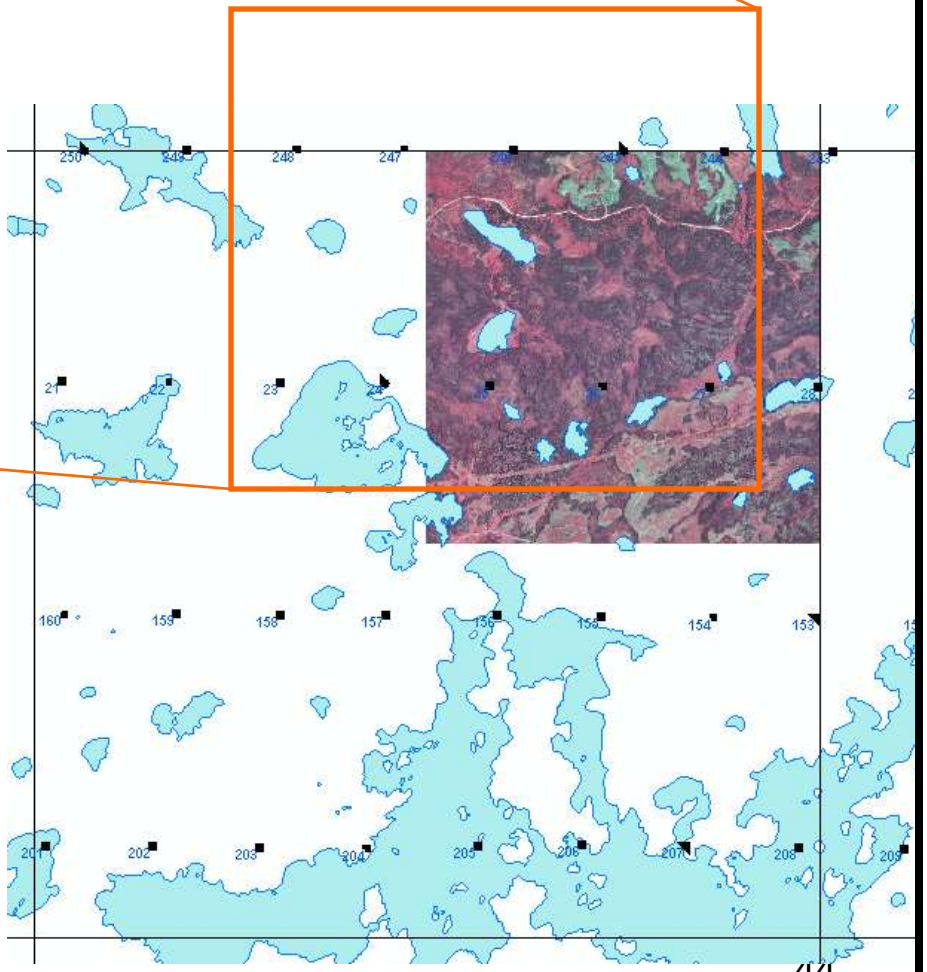
Advent of GPS technology
Compass and Maps?

Imagery needs to be controlled

Targets were established :

- around the project perimeter
- within the central area of the project

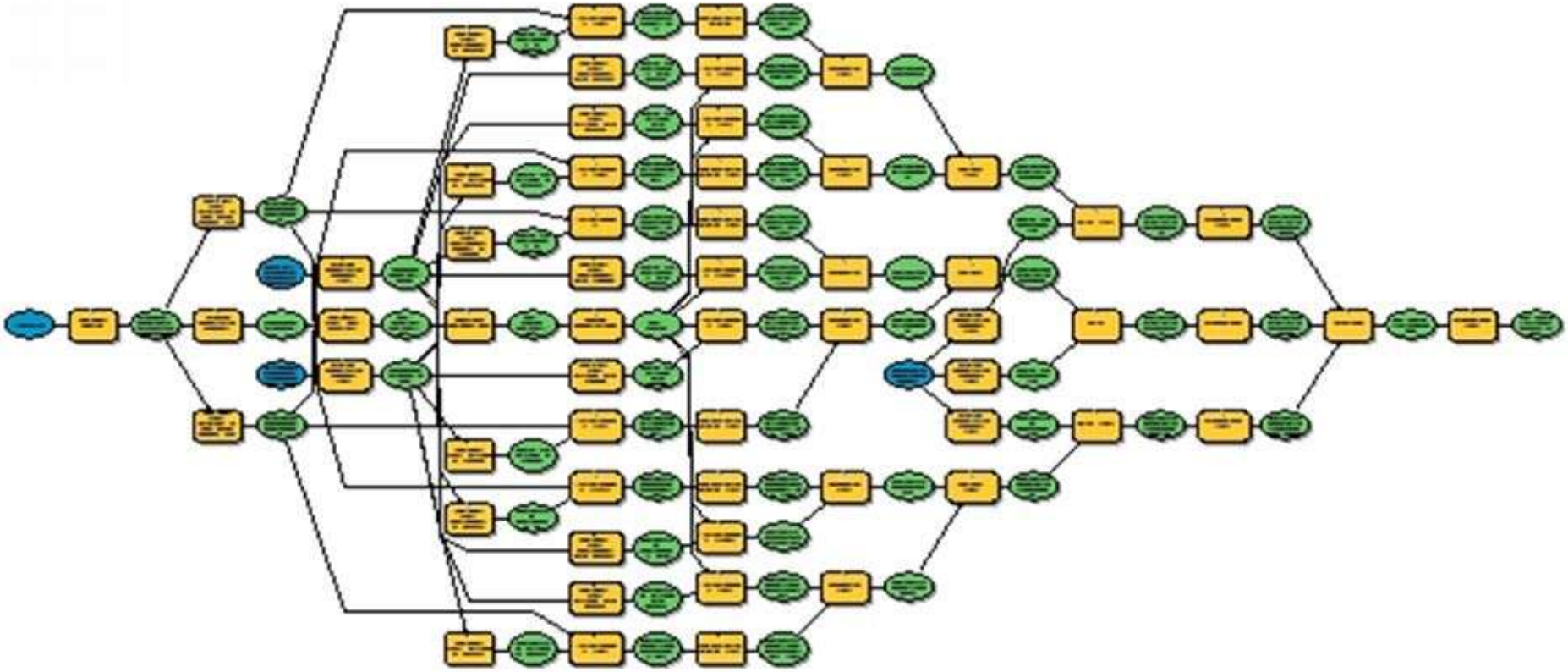




Sequential Aerial photographs above provide the detailed information for interpretation and the Orthophoto information provides a precise base allowing ground based navigation (GPS).

The Future

FRI and FLI Update – A Living Inventory



The Future

Growth Yield

- Treatment and Response pathways for managed areas
- GYPSY model for Natural Stands
- Aerial and Ground Based Lidar

Imagery and Inventory

- Continue to capture (digitize) old paper inventories
- Develop methods for faster, more cost effective ways to gather this information
- Enhanced inventory needed for Carbon Budget models, baseline data for climate change, wetlands, best use of products, management, wood supply, wildlife habitat, etc.


Thank you!
Questions?