Stand Development Monitoring

Harry Kope
Resource Practices Branch

BRITISH COLUMBIA

What SDM is……

- **It's a point-in-time assessment.....**
- **It's a 'mid-rotation' (ages 20 to 40) survey that collects data on pest incidence and stocking.....**

What SDM collects……

- **Polygon size, tree age and BEC information.....**
- **Total live and dead tree by species, by layer.....**
- **Forest Health factors on live and dead trees.....**
- **Height and DBH of layer 1 and layer 2 trees.....**
- **Site index using growth intercept.....**
- **Inventory label.....**

SDM collections so far.....

TSA

- 100 Mile House (29)
- Boundary (29)
- Bulkley (19)
- Cranbrook (29)
- Fort Nelson (6)
- Fraser (17)
- Golden (30)
- Invermere (10)
- Kamloops (49)
- Kingcome (2)
- Lakes (14)
- Mackenzie (30)
- Merritt (22)
- Morice (8)
- Prince George (71)
- Quesnel (35)
- Queen Charlotte Islands (2)
- Revelstoke (7)
- Strathcona (5)
- Sunshine Coast (14)
- Williams Lake (76)

21 TSA's

504 openings

Collected from 2009 to 2013

Where is the SDM data?

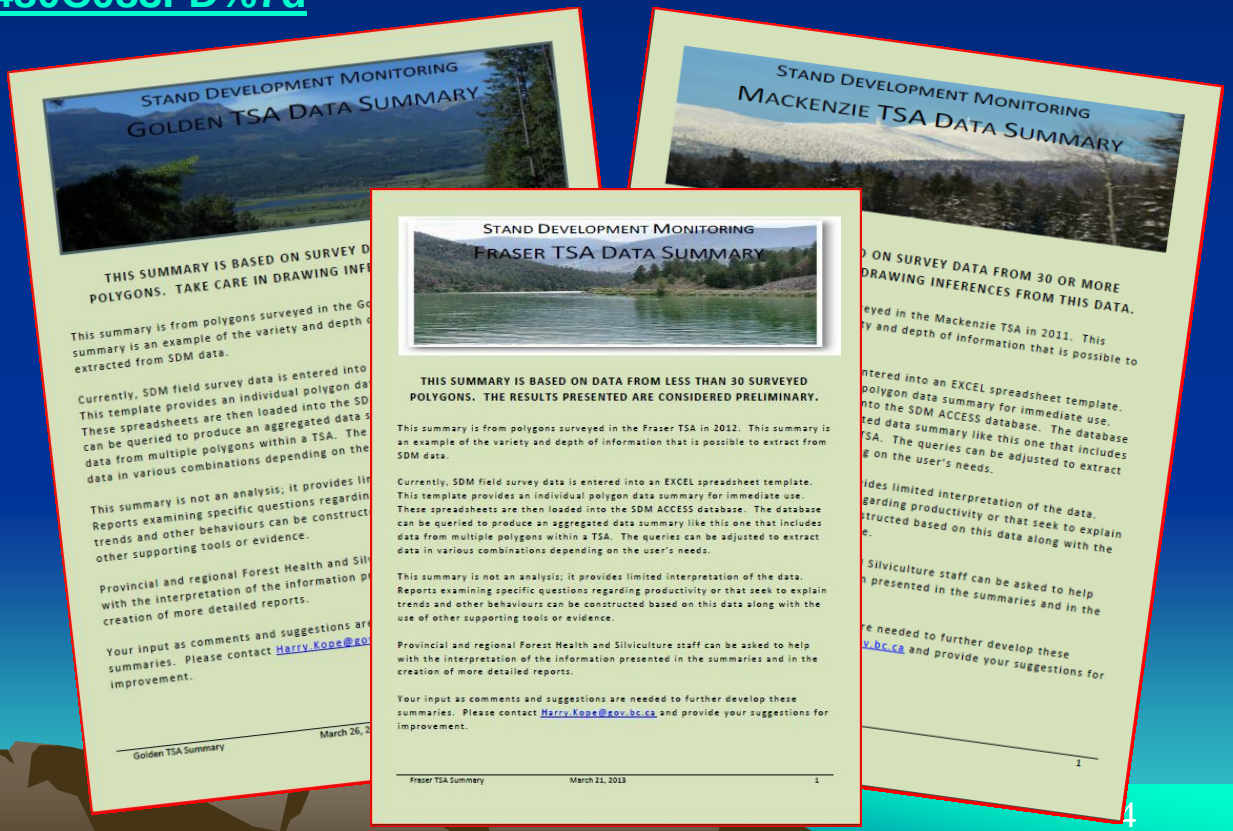
- https://spc-flnr.gov.bc.ca/frep/FREP%20data/Forms/AllItems.aspx?RootFolder=%2Ffrep%2FFREP%20data%2FSDM%2FSDM%20field%20data%20by%20TSA&FolderCTID=0x012000DBA9C8AAFEB3E144A5A407625D5ABE3A&View=%7b0A141741-A7D0-4903-A4B5-504480C083FD%7d

OR

TSA data summaries

Examples

- **Fraser**
- **Golden**
- **Mackenzie**



Sample Summary

STAND DEVELOPMENT MONITORING - MACKENZIE TSA Summary

Purpose and Audience *– Data summaries can help statutory decision makers and operational foresters make informed decisions on stand development, TSR data package inputs, FSP renewals, and FFT activity priorities. They provide information on the growth and health of managed stands. The Forest and Range Evaluation Program (FREP) in conjunction with the provincial forest health program have designed an evaluation protocol (Stand Development Monitoring - SDM) that assesses the condition of post-free-growing managed stands by measuring stand attributes and the impact of biotic and abiotic damaging factors on stand health to help determine whether these free-growing stands are meeting productivity expectations.*

NOTE – This report provides summary information obtained from surveyed polygons. Inferences from this summary should be made cautiously.

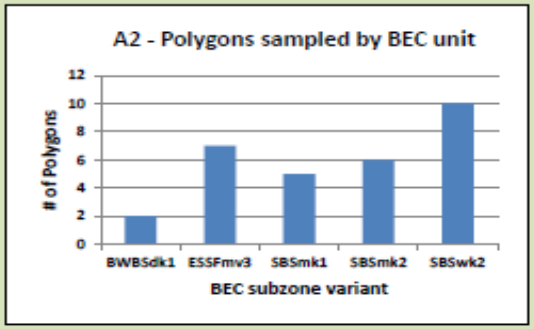
This summary includes data on: SAMPLE SUMMARY FOREST HEALTH STAND DENSITY SPECIES COMPOSITION SITE INDEX

SAMPLE SUMMARY

Polygon and polygon population attributes, and numbers and percentages of sampled live trees.

A1 – NUMBER OF POLYGONS SUMMARIZED

Survey year:	2011
Mackenzie	30



A3 - SAMPLED POLYGON ATTRIBUTES

Attribute	n[a]	Mean	SD[b]	Range
Polygon net area (ha)	30	27.2	18.7	6 – 91
Stand Age (yrs)	30	23.8	6.0	15 – 35
Harvest to Declaration (yrs)	16	14.7	5.0	11 – 32
Planting to Declaration (yrs)	14	13.2	4.6	10 – 28
Declaration to SDM (yrs)	16	5.7	4.3	0 – 17

[a]. Differing 'n' values indicate missing information for some polygons.

[b]. SD - Standard Deviation

A4 - SAMPLE POPULATION COVERAGE

TSA polygon population (n)	Total polygon population area (ha)	Number Polygons ≥5 ha (n)	Population polygon area ≥5 ha (ha)	Number of polygons sampled (n)	Sampling intensity by number of polygons	Area sampled (≥5 ha) (ha)	Sampling intensity by area
1808	37847	1278	36522	30	2.3%	816	2.2%

A5 - NUMBER AND PERCENTAGE OF SAMPLED TOTAL LIVE TREES

Tree species:	Ac	At	Bl	Ep	Pli	Sb	Se	Sw	Sx	Total
Number	224	738	704	437	1819	44	2	67	1785	5820
Percent	4	13	12	8	31	1	0	1	31	100

X1 - TREE SPECIES ABBREVIATIONS

Ac - Poplar
At – Trembling Aspen
Bl – Subalpine Fir
Ep – Common Paper Birch
Pli – Lodgepole Pine (interior)
Sb – Black Spruce
Se – Engelmann Spruce
Sw – White Spruce
Sx – Spruce hybrid

Forest Health

FOREST HEALTH

Forest Health is assessed using the SDM damage criteria for mid-rotation stands (see Appendix 1). The damage criteria establish forest health threshold tolerances identifying unacceptable and damaged trees. In the Mackenzie TSA: the pathogen most recorded was Western Gall Rust (DSG); the insect was Mountain Pine Beetle (IBM); the animal was Moose (AM); and the abiotic damage was Tree Competition (VT).

B1 – MEAN STEMS PER HA BY FOREST HEALTH STATUS

Live Acceptable Trees (sph)	Live Unacceptable Trees (sph)	Dead Unacceptable Trees (sph)	Total Stems[a] (sph)
3002	878	329	4209

[a] For forest health purposes total stems equals all live trees plus all dead trees.

B2 – FOREST HEALTH FACTORS DETECTED

(Number of plots) with a specific forest health factor. Plots = 300

- **Pathogen** → DSG (89) → DSC (25) → DSS (6) → DSA (3)
- **Insect** → IBM (33) → IWS (2) → IWW (2) → ISP (1)
- **Animal** → AM (38) → AB (19); → AP (5) → AD (1)
- **Abiotic** → VT (109) → NY (52); → UF (26) → UBT (13) → USW (1)
- **Unknown** → U (30)

X2 – TREE LAYERS

Layer 1: >12.5 cm dbh

Layer 2: 7.5 to 12.5 cm dbh

Layer 3: >1.3 m in height to 7.49 cm dbh

X3 – FOREST HEALTH ABBREVIATIONS

DSC – Comandra blister rust	IWW – Warren's root collar weevil	
DSG – Western gall rust	ISP – Pitch nodule moth	VT – Tree competition
DSS – Stalactiform blister rust	AB – Beaver	NY – Snow press
DSA – Atropellis canker	AD – Deer	UF – Fork
IBM – Mountain pine beetle	AM – Moose	UBT – Broken top
IWS – White pine weevil	AP – Porcupine	USW – Sweep
	U – Unknown	

B3 – INCIDENCE OF FOREST HEALTH FACTOR BY BEC

BEC	Tree Layer	Total Stems	Acceptable Trees		Unacceptable Trees: Live		Unacceptable Trees: Dead		Percent incidence[c] of Forest Health Factor[d] for each tree layer													
			n	(%[b])	n	(%[b])	n	(%[b])	DSG	DSC	DSS	DSA	IBM	AM	AB	AP	VT	NY	UF	UBT	Other	U
BWBSdk1	1	16	12		4		0		12.5										12.5	6.3		
	2	70	58		12		0		11.4		1.4							1.4		1.4	1.4	
	3	376	248		92		36		5.9	0.3	5.6			0.3			20.7	0.5	0.3		0.5	
	Σ	*462*	*318*	*(68.8)*	*108*	*(23.4)*	*36*	*(7.8)*	*6.9*	*0.2*	*4.8*	*0*	*0*	*0.2*	*0*	*0*	*16.9*	*0.6*	*0.6*	*0.2*	*0.6*	*0*
ESSFmv3	1	54	49		4		1						1.9		5.6					1.9		
	2	144	135		8		1		2.1						0.7		0.7	1.4	0.7		0.7	
	3	573	538		29		6							0.5		0.2	2.4	2.4	0.5			
	Σ	*771*	*722*	*(93.6)*	*41*	*(5.3)*	*8*	*(1.0)*	*0.4*	*0*	*0*	*0*	*0.1*	*0.4*	*0.5*	*0.1*	*1.9*	*2.1*	*0.5*	*0.1*	*0.1*	*0*
SBSmk1	1	109	90		13		6		9.2				6.4					0.9	0.9			
	2	238	207		24		7		5.5				1.3		0.8			2.1	1.7			1.7
	3	1339	883		338		118		9.3	0.2				0.3		0.1	20.5	1.7	0.1	0.2	0.3	1.6
	Σ	*1686*	*1180*	*(70.0)*	*375*	*(22.2)*	*131*	*(7.8)*	*8.7*	*0.2*	*0*	*0*	*0.6*	*0.2*	*0.1*	*0.1*	*16.3*	*1.7*	*0.4*	*0.2*	*0.1*	*1.5*
SBSmk2	1	149	90		28		31		5.4	1.3	1.3		26.2		2.0			1.3	0.7		0.7	0.7
	2	217	165		35		17		6.0	1.8	1.4		7.8	0.9			0.9	0.9	1.8	1.4		0.9
	3	742	533		111		98		5.3	1.5			0.4	2.4			13.1	3.5	0.3	0.3	0.1	1.3
	Σ	*1108*	*788*	*(71.1)*	*174*	*(15.7)*	*146*	*(13.2)*	*5.4*	*1.5*	*0.5*	*0*	*5.3*	*1.8*	*0.3*	*0*	*8.9*	*2.7*	*0.6*	*0.5*	*0.2*	*1.2*
SBSwk2	1	138	106		27		5		2.9	0.7		0.7	5.1	0.7	6.5	0.7		0.7	4.3		0.7	
	2	385	311		65		9		8.3	0.8	0.3	1.3	1.8	0.3	2.3	0.5	0.3	2.1	0.8		0.5	
	3	1763	1078		527		158		3.6	0.5	0.2		0.1	13.8	0.1		14.2	0.9	0.1	0.3		5.2
	Σ	*2286*	*1495*	*(65.4)*	*619*	*(27.1)*	*172*	*(7.5)*	*4.4*	*0.5*	*0.2*	*0.3*	*0.7*	*10.7*	*0.9*	*0.1*	*11.0*	*1.0*	*0.4*	*0.2*	*0.1*	*4.0*

[b] Percent based on total stems (live and dead); [c] Percent incidence of the total stems by layer for each FHF; [d] Only the top FHF are listed, the Other column contains the minor FHF not listed.

Stand Density

STAND DENSITY

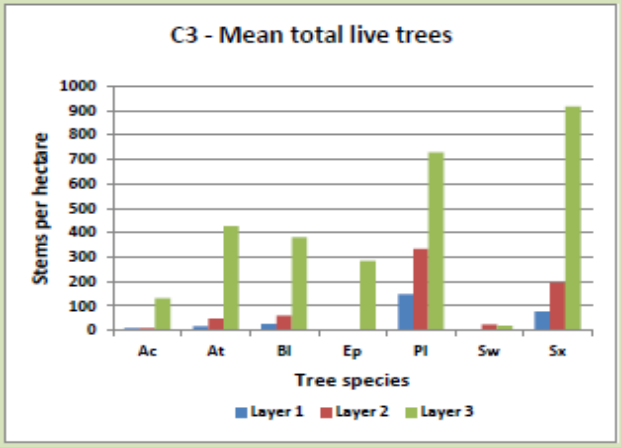
To produce a free-growing crop of trees a stand is managed to the target stocking level of well-spaced, preferred and acceptable species. Over time, changes in stand density may reflect tree competition, mortality due to pests, stand treatments, natural ingress or other influences.

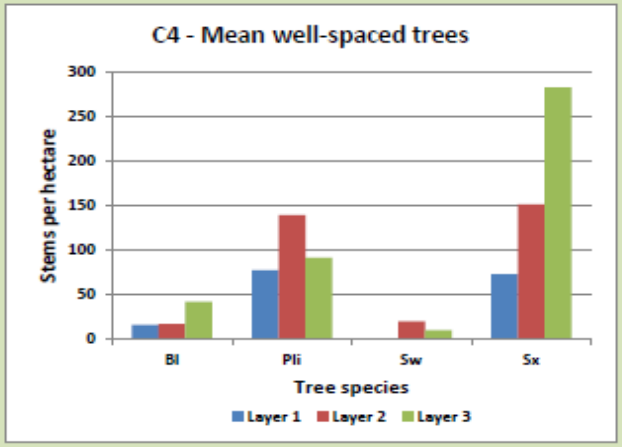
C1 - NUMBER OF POLYGONS WITH CHANGES TO STAND DENSITY

Change in Total Stand Density Total Trees (n= 30)		Change in Stocking Density Well-Spaced Trees (n= 28)	
Decreasing	10	Decreasing	20
Increasing	20	Increasing	6
		Unchanged	2

C2 - STAND DENSITY ATTRIBUTES BY BEC – PRE-SDM AND AT SDM

	BWBSdk1		ESSFmv3		SBSmk1		SBSmk2		SBSwk2		ALL	
	N	Mean (sph)	N	Mean (sph)	N	Mean (sph)	N	Mean (sph)	N	Mean (sph)	N	Mean (sph)
Total Density pre-SDM (sph)	2	3039	7	1879	5	4993	6	6140	10	2643	30	3582
Total Density at SDM (sph)	2	4260	7	2180	5	6220	6	3207	10	4228	30	3880
Change in Total Density (sph)	2	1221	7	301	5	1227	6	-2933	10	1585	30	298
Change in Total Density (%)	*2*	*40*	*7*	*16*	*5*	*25*	*6*	*-48*	*10*	*60*	*30*	*8*
WS density pre-SDM (sph)	2	1142	7	1078	5	994	6	1244	8	1071	28	1101
WS density at SDM (sph)	2	940	7	960	5	1104	6	747	10	884	30	915
Change in WS density (sph)	2	-202	7	-118	5	110	6	-497	8	-203	28	-189
Change in WS density (%)	*2*	*-18*	*7*	*-11*	*5*	*11*	*6*	*-40*	*8*	*-17*	*28*	*-17*
FG density pre-SDM (sph)	2	1047	7	923	5	675	6	1094	8	991	28	944
FG density at SDM (sph)	2	940	7	960	5	1100	6	747	10	884	30	914





Species Composition

SPECIES COMPOSITION

Inventory labels are condensed representations of several stand attributes that describe conditions at the time of assessment. These attributes include leading, secondary and minor tree species by percentage class (usually rounded to the nearest 10%), average age and height of the dominant and co-dominant trees, a site index estimate, an estimate of crown closure, and the total trees per hectare. Inventory labels provide inputs used by the TASS stand model and by timber supply analysts projecting future stand development for timber supply purposes.

D1 - CHANGE IN LEADING SPECIES BETWEEN PRE-SDM AND SDM ASSESSMENTS

	Pre-SDM																			
	BWBSdk1				ESSFmv3				SBSmk1				SBSmk2				SBSwk2				ALL			
At SDM	At	Pli	Sw	Sx	At	Pli	Sw	Sx	At	Pli	Sw	Sx	At	Pli	Sw	Sx	At	Pli	Sw	Sx	At	Pli	Sw	Sx
At	0	-	-	-	0	-	-	-	0	-	-	1	0	-	-	-	0	-	-	1	0	-	-	2
Pli	-	1	-	-	-	1	-	-	-	3	-	-	-	3	-	1	1	4	-	-	1	12	-	1
Sw	-	-	0	-	-	-	0	-	-	-	0	1	-	-	0	-	-	-	1	-	-	-	1	-
Sx	-	-	-	1	-	-	-	6	-	-	-	0	-	-	-	2	-	-	-	3	-	-	-	13
Total	0	1	0	1	0	1	0	6	0	3	0	2	0	3	0	3	1	4	1	4	1	12	1	16

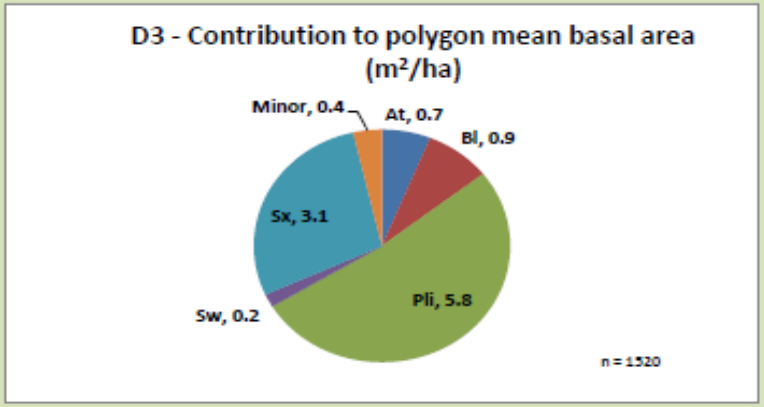
(Shaded values indicate those polygons where the leading species has NOT changed)

(In this TSA, no change in leading species was found in [redacted] 26 (87%) of 30 polygons sampled)

D2 – NUMBER OF TREES, BY SPECIES AND LAYER, CONTRIBUTING TO MEAN BASAL AREA

Tree spp.	Number of Trees					Mean Polygon BA (m^2/ha)				
	Layer 1		Layer 2		All	Layer 1		Layer 2		All
	Live	Dead	Live	Dead		Live	Dead	Live	Dead	
At	26		72	4	102	0.33		0.33	0.02	0.68
Bl	40		91		131	0.50		0.42		0.92
Pli	220	41	506	27	794	2.46	0.54	2.60	0.15	5.75
Sw	2		36		38	0.02		0.18		0.20
Sx	118	2	290	3	413	1.64	0.04	1.43	0.02	3.13
Minor spp.	16		26		42	0.28		0.12		0.40
Total	422	43	1021	34	1520	5.23	0.58	5.08	0.19	11.08
% within layer	27.8	2.8	67.2	2.2		47.2	5.2	0.3	1.7	

(Minor spp. include: Ac, Act, Ep, and Sb).



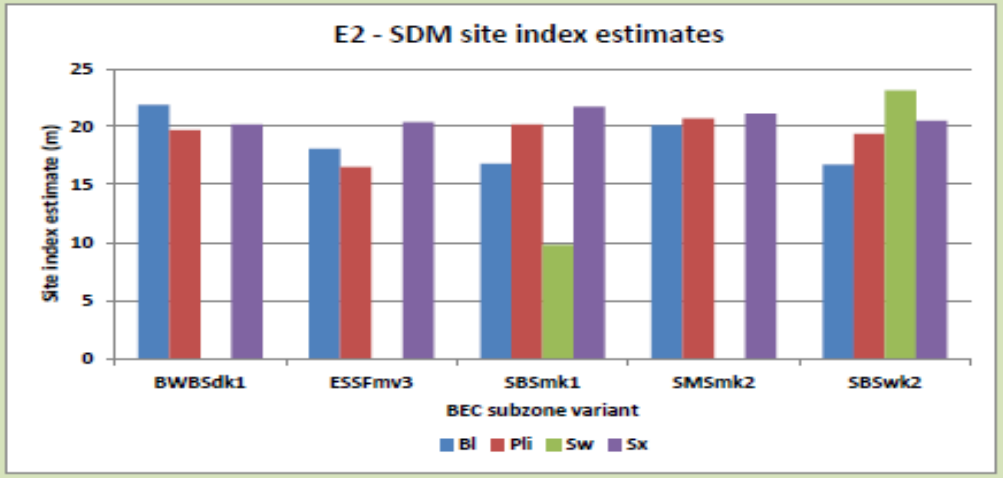
Site Index

SITE INDEX

Site index is estimated using the growth intercept method. These estimates are the mean values of all available trees for that species in a BEC unit. Many stands do not have site index estimates recorded prior to the SDM survey.

E1 - MEAN SITE INDEX ESTIMATE FOR DOMINANT CONIFER SPECIES

	Bl		Pli		Sw		Sx		Total
BEC	N	Mean	N	Mean	N	Mean	N	Mean	N
BWBSdk1	2	21.9	3	19.7	-	-	15	20.2	20
ESSFmv3	8	18.1	12	16.5	-	-	49	20.4	69
SBSmk1	3	16.8	20	20.2	1	9.8	18	21.7	42
SMSmk2	1	20.1	25	20.7	-	-	30	21.1	56
SBSwk2	4	16.7	46	19.4	8	23.1	33	20.5	91
	18	18.1	106	19.5	9	21.6	145	20.7	278



SDM “roll-ups”

TSA’s

- 100 Mile House (29)
- Bulkley (19)
- Lakes (14)
- Mackenzie (30)
- Morice (8)
- Prince George (71)
- Quesnel (35)
- Williams Lake (76)

N= 282

Polygon attributes

- Mean age (yrs) - 25
- Range of ages – 15 to 50
- Net area (ha) - 33
- Range of net area – 6 to 91

Forest Health

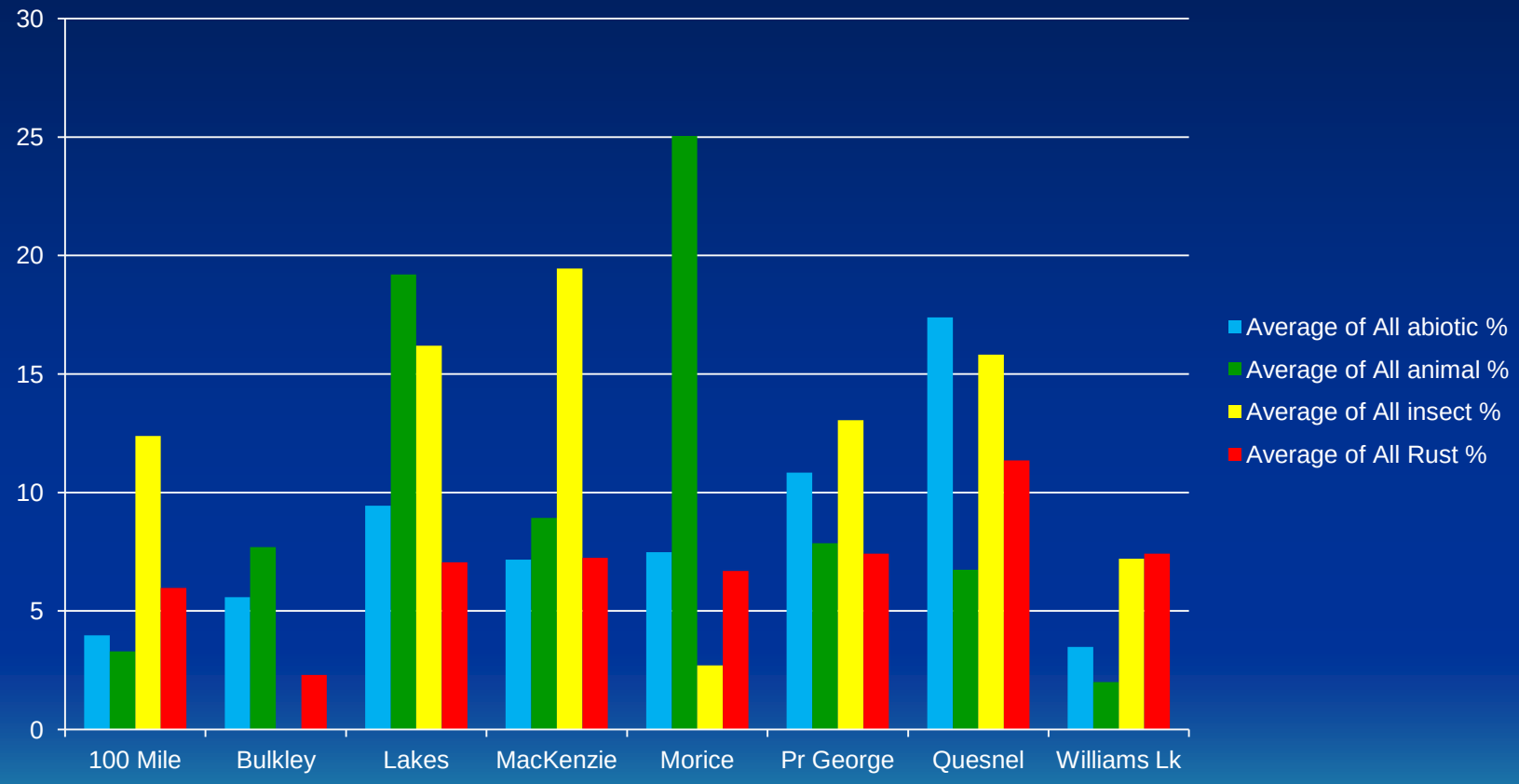
Top 5 Forest Health issues

- Suppression (Veg. competition)
- Western gall rust
- Fork
- Moose
- Snow Press

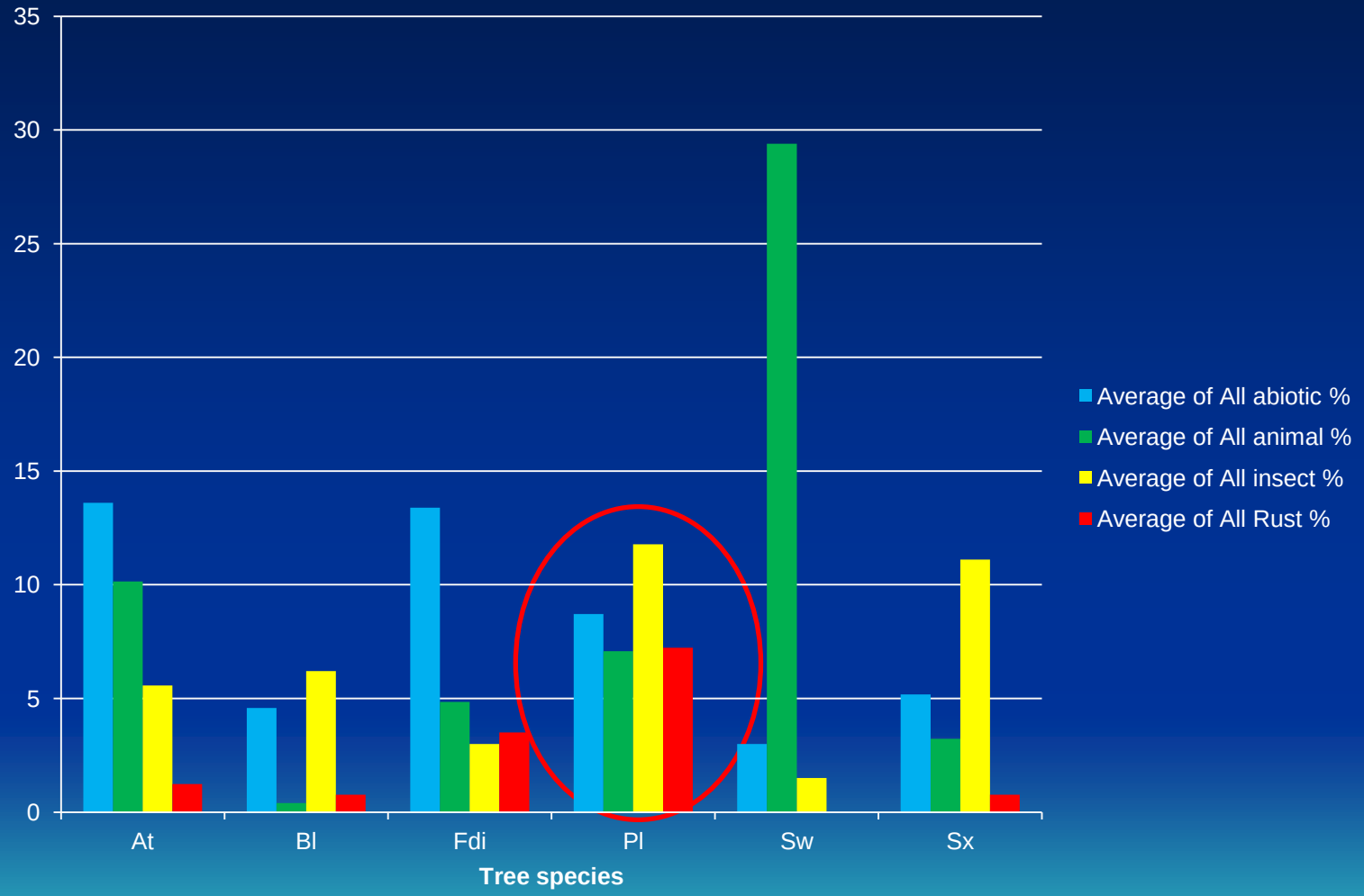
Forest Health issues

- Abiotic
- Animal
- Insect
- Rusts

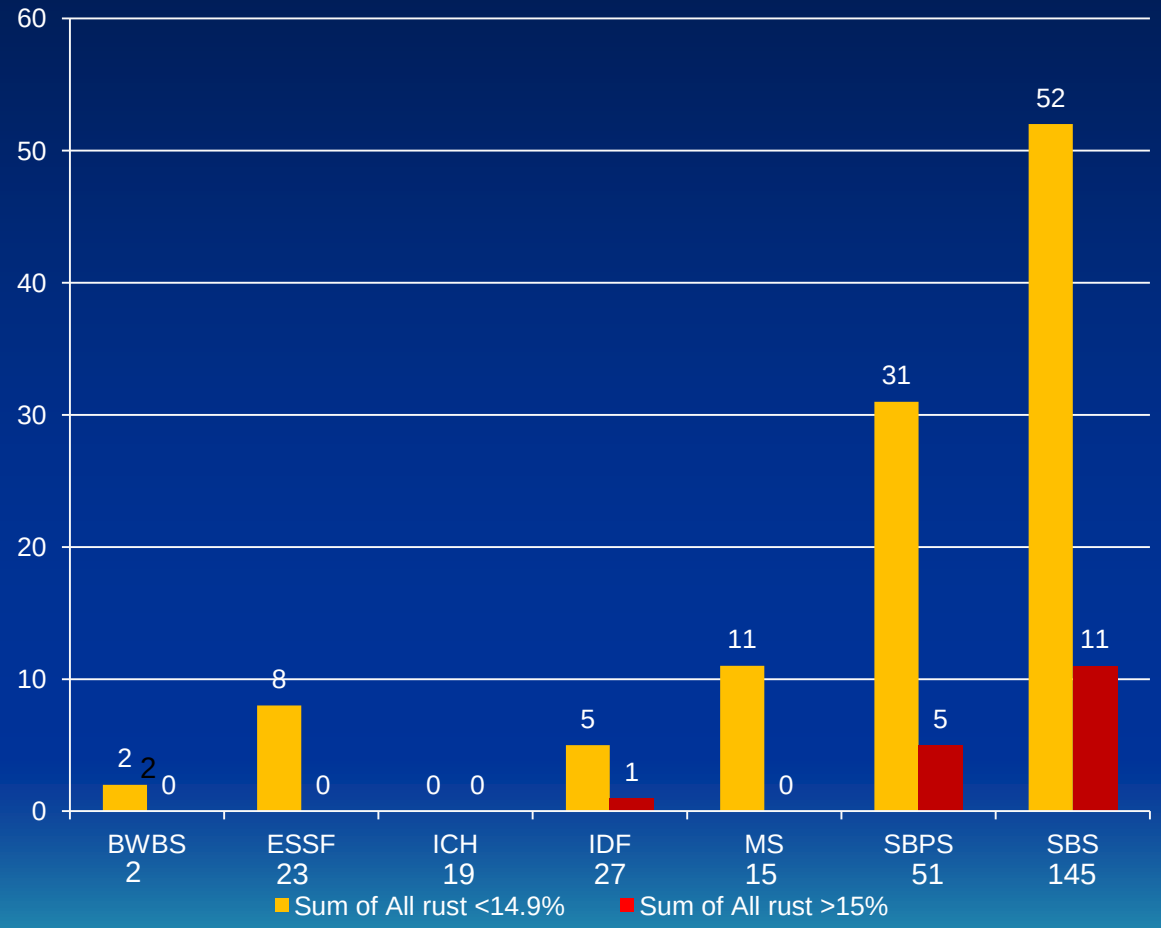
Forest Health – Mean incidence (%) by TSA



Forest Health – Mean incidence (%) by leading species



Forest Health - Pl leading, by BEC (n=282)



Pine Stem Rust Management Guidebook: Table 3 Page 1 of 1

Pine Stem Rust Management Guidebook

Table of Contents

Table 3. Disease incidence and treatment levels by activity

	Pre-free growing (< 15 yrs)		Stand management (15–25 yrs)		
Rust treatment level	Current rust incidence[a]	Post-treatment stocking[b]	Current rust incidence	Post-treatment stocking	Tactics
Minimal	0–10%	TSS[c]	0–15%	TSS	eradicate infected stems
Alternate	10–20%	TSS + (TSS X twice current rust incidence)	15–25%	TSS + (TSS X current rust incidence)	eradicate infected stems and leave extra stems
Intensive	>20%	N/A	>25%	N/A	delay spacing or double entry

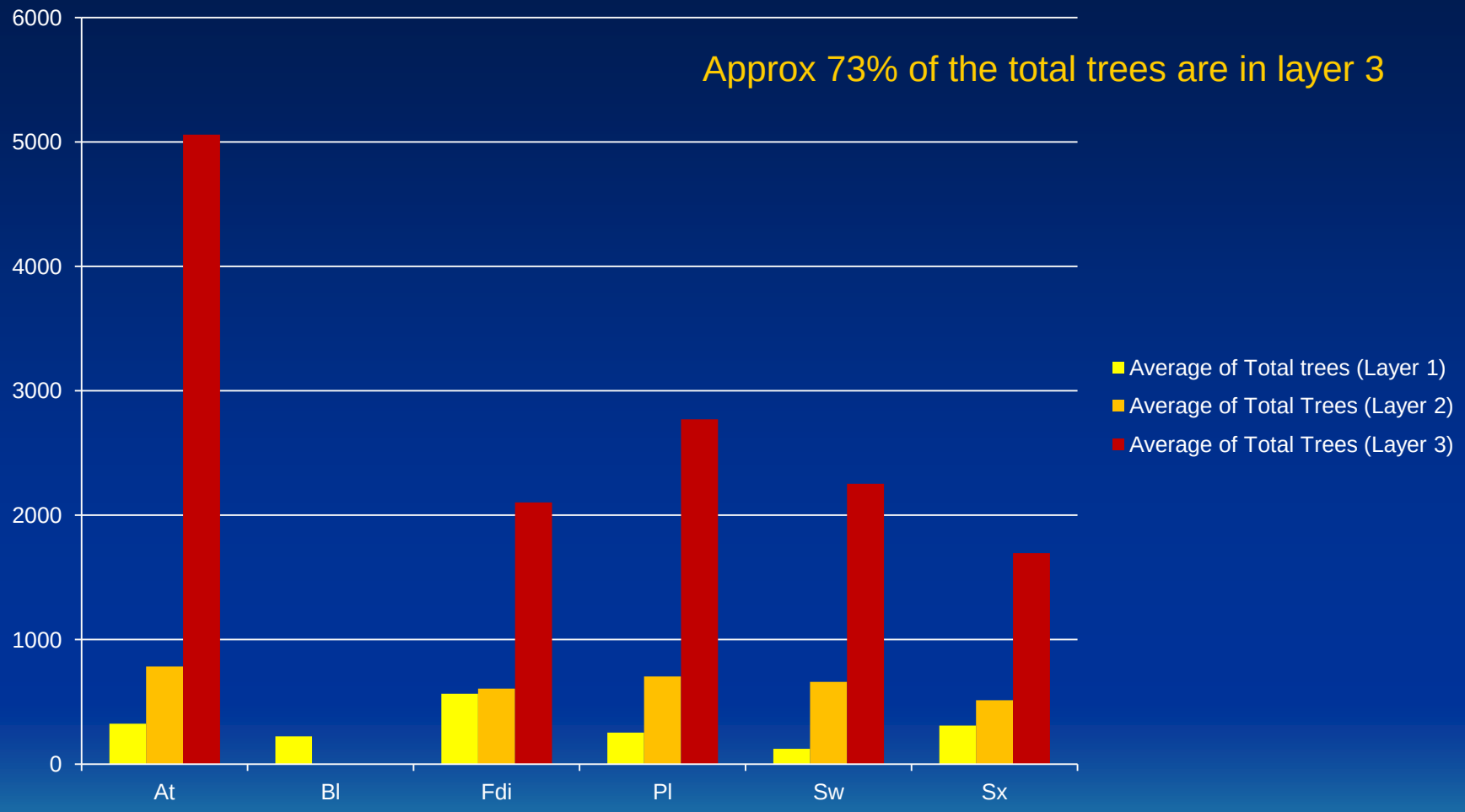
[a] Current rust incidence refers to unacceptable infections as specified in the free growing damage standards (refer to "Free growing damage standards" in this document).

[b] Post-treament stocking = TSS + (TSS x twice current rust incidence as a proportion), assuming TSS = 1200 sph.

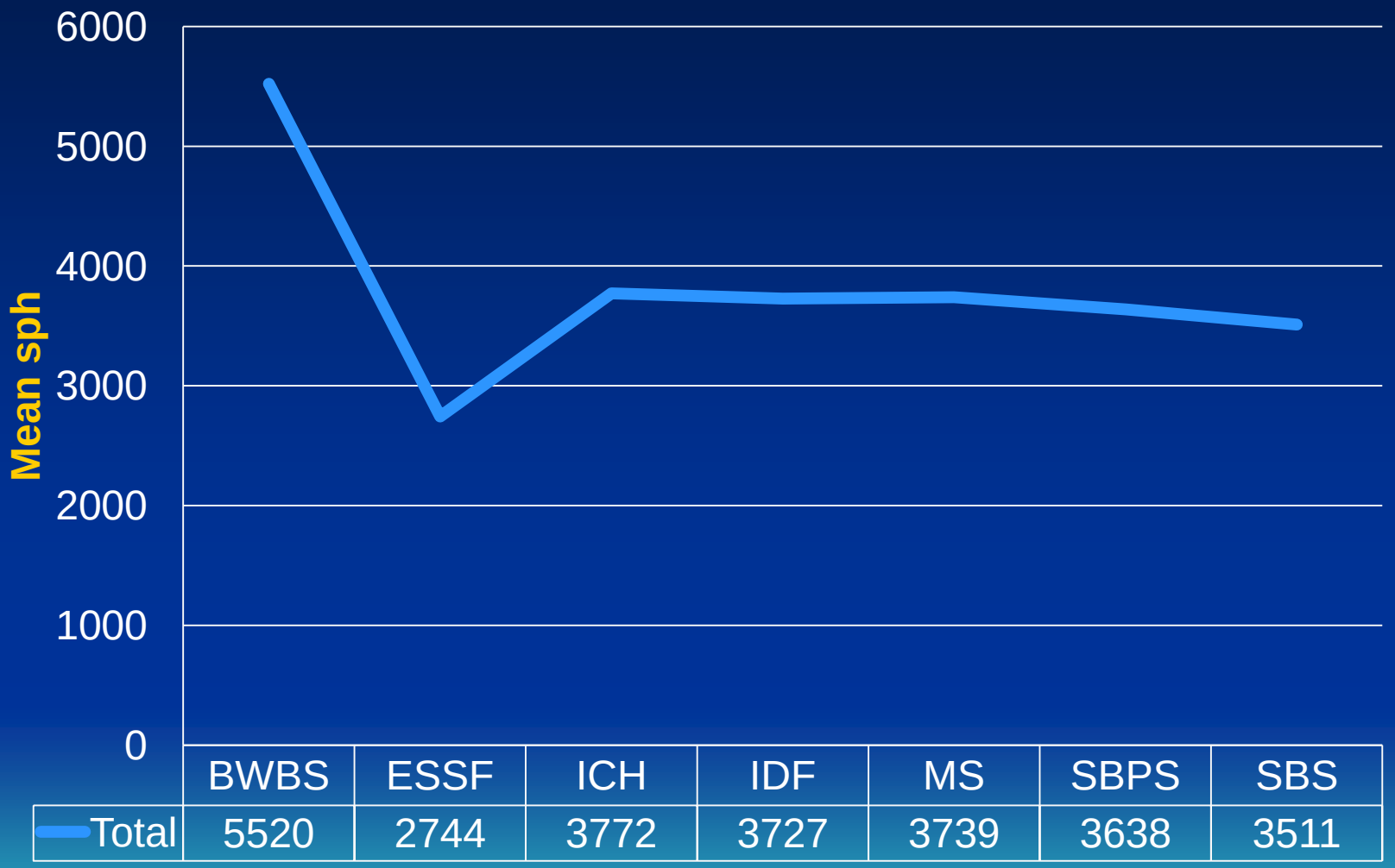
e.g., Post-treatment stocking = 1200 sph + (1200 sph x 2 x 0.15)
= 1200 sph + (1200 sph x 0.30)
= 1200 sph + (360 sph)
= 1560 sph

[c] TSS = target stocking standard.

Stand Composition – Total trees, by layer

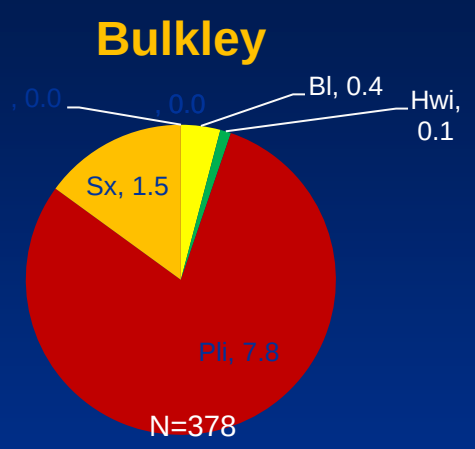


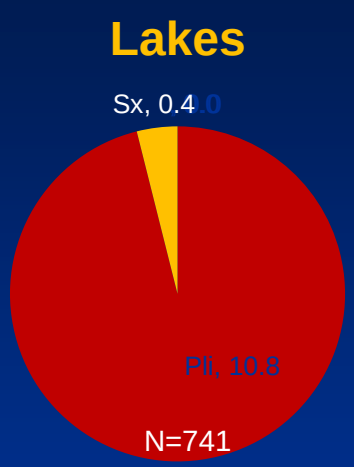
Stand composition – Mean sph by BEC

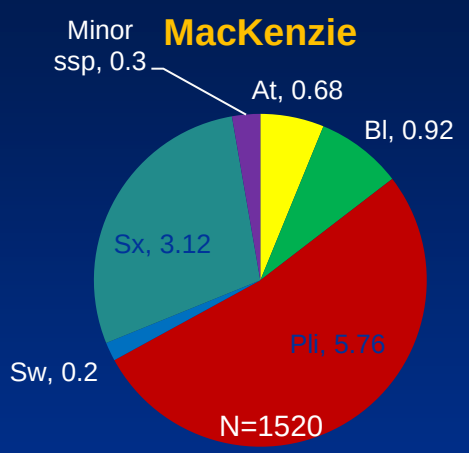


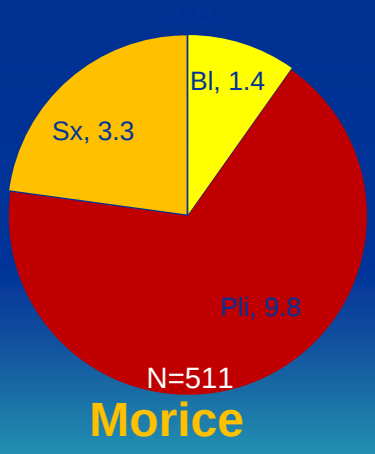
	BWBS	ESSF	ICH	IDF	MS	SBPS	SBS
Total	5520	2744	3772	3727	3739	3638	3511

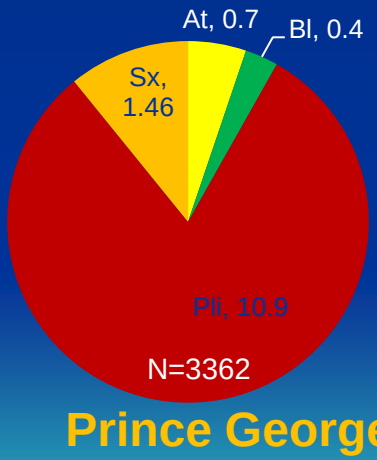
Basal Area – mean polygon basal area (m2/ha)

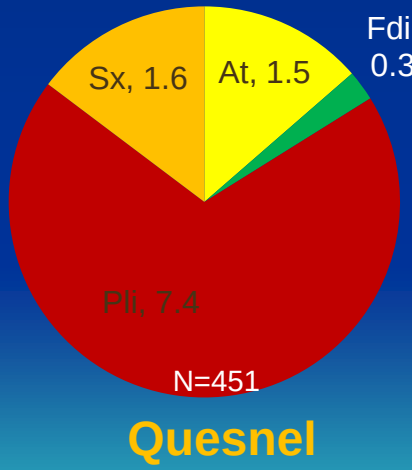












The benefits of a ‘point-in-time’ assessment at mid-rotation

- **Assess forest health.....**
  - **Identify the major and minor forest health factors**
  - **Determine where forest health factors are occurring (BEC)**
  - **Determine on what species of tree forest health factors are occurring**
  - **A count and/or percentage of live and dead trees**
- **Track how stand attributes change in managed forests.....**
  - **Identifying stand composition by layer**
  - **Identify current Basal area**
- **Data supplied to other databases. i.e., RESULTS.....**
  - **Changes to the Inventory label**

SDM data could ultimately be used to support revision of standards associated with current practices.....

FFT and SDM - interactions

- FFT surveyed a stand that was to be surveyed by SDM. However, RESULTS was not updated so the SDM crew didn't know that the polygon boundaries changed.
- This remapping and making changes in RESULTS makes it difficult for SDM to match historical to current stand data

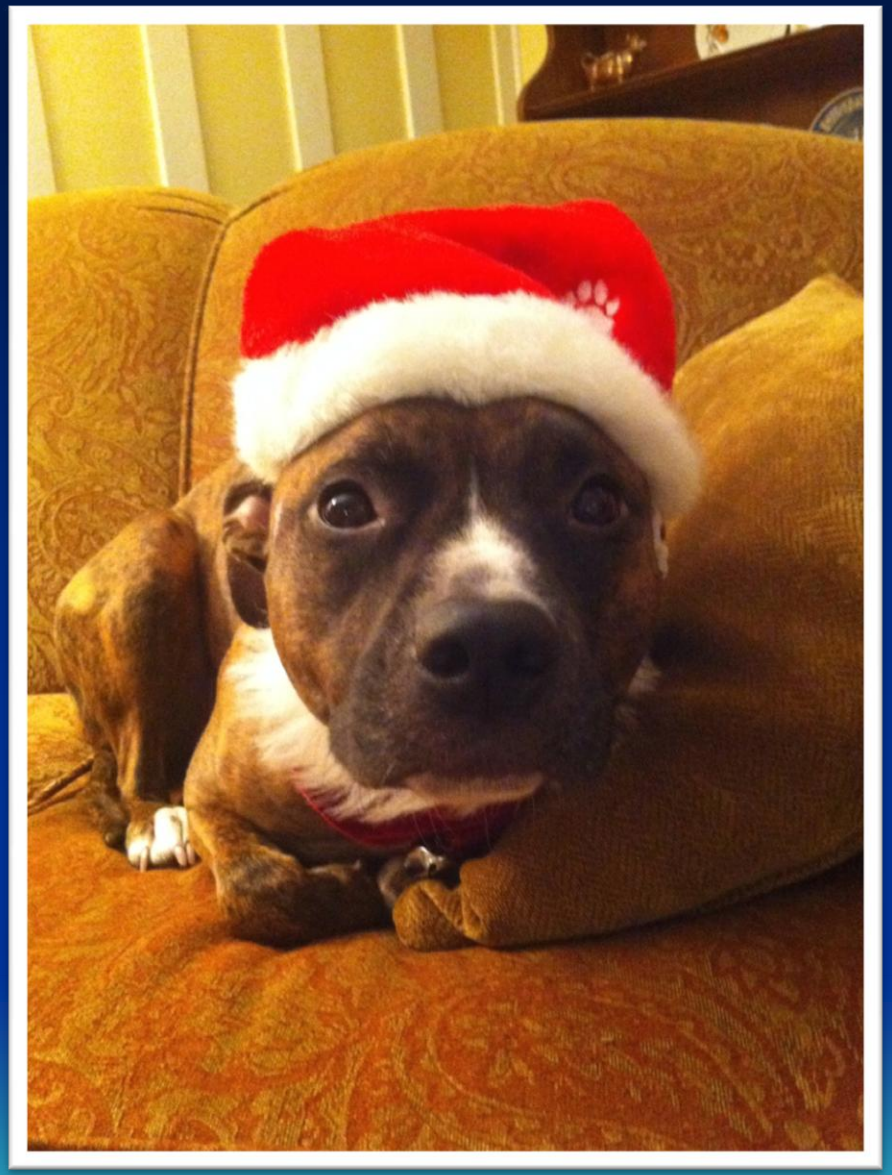
FFT and SDM - opportunities

- FFT and SDM activities should be co-ordinated within districts so that overlapping surveys and competing data do not occur.
- FFT could consider using SDM data of common openings (better than aerial surveys).
- FFT should consider funding SDM surveys where on-the-ground data collection is important and openings are shared.

Questions?

Comments?

Constructive criticism?



SDM team
Kevin Astridge, Frank Barber, Harry Kope, Dave Weaver, Stefan Zeglen (team lead)