Rocky Mountain – Vegetative Structural Stage
Description and Calculations

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I. Geographic Range of Northern Goshawk

The general range of the Northern Goshawk in the Interior West dissects the forested landscapes of National Forest Regions 1 through 4. Refer to Figure 1. Post processing of Rocky Mountain Vegetative Structural Stage using the Forest Vegetation Simulator (FVS) prior to this update was limited to Region 3. In recent years, other Regions have requested this reporting capability.

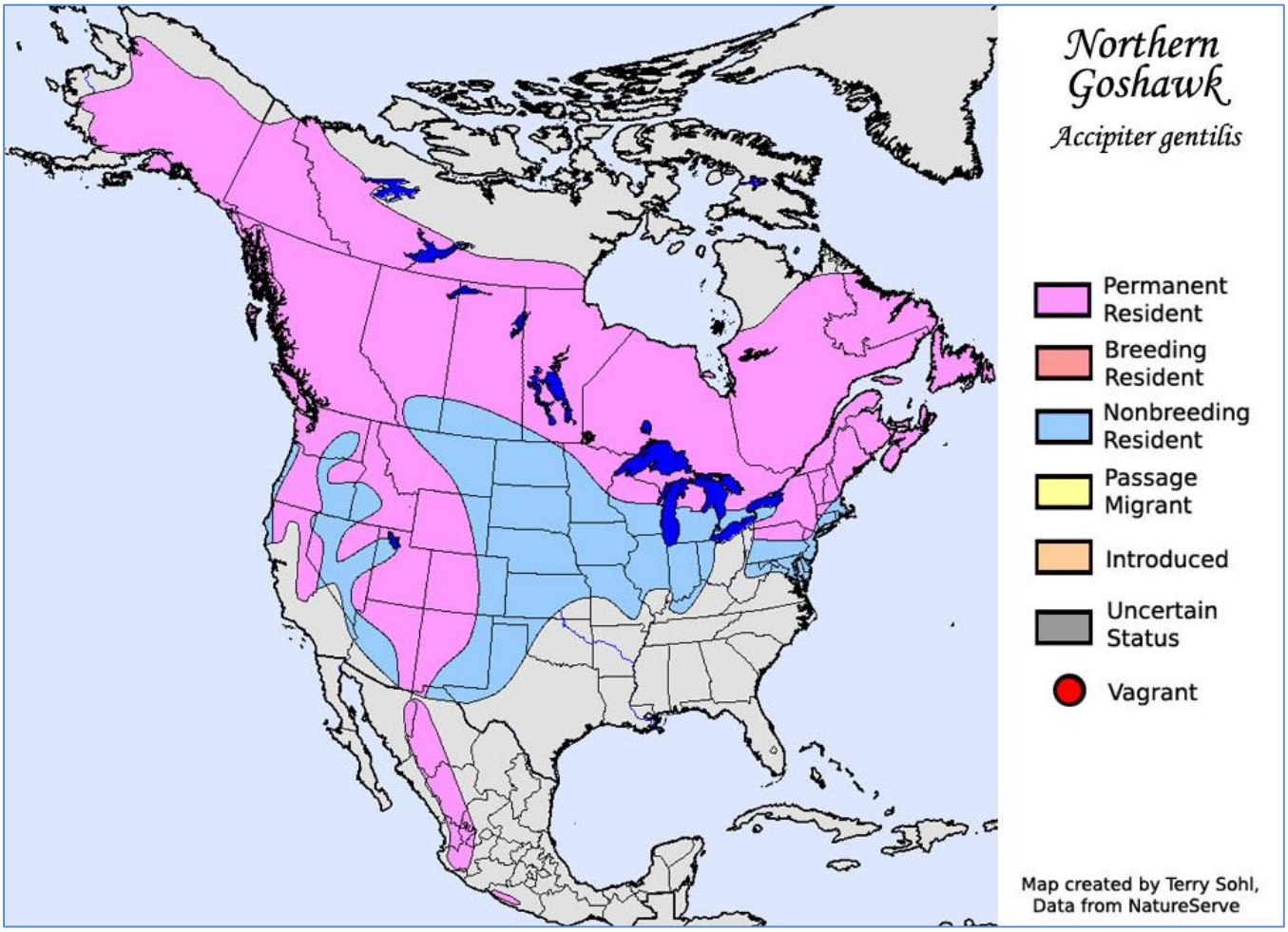


Figure 1 – Northern Goshawk Range in North America.

II. Accounting for NFS Regions and FVS Geographic Variants

Table 1 contains a list of National Forest Regions and associated Forest Vegetation Simulator geographic variants within the Interior West.

Table 1 – NFS Region and FVS Variants in the Interior West.

NFS Regions	FVS Variants
1 - Northern	EM,KT,IE
2 - Rocky Mountain	CR,EM,TT,UT
3 - Southwestern	CR,UT
4 - Intermountain	CI,TT,UT,WS
FVS Variant Abbrv	**FVS Variant Name**
CI	Central Idaho
CR	Central Rockies
EM	Eastern Montana
IE	Inland Empire
KT	Kootenai, Kaniksu, and Tally Lake (KooKanTL)
TT	Tetons
UT	Utah
WS	Western Sierra Nevada

III. Accounting for FVS Tree Species by Geographic Variant for each NFS Region

For each National Forest Region, FVS identified tree species per geographic variant were merge to account for all possible tree species. For example, National Forests located within Region 3 are assigned to use either the Central Rockies or Utah FVS variant. FVS tree species codes for Central Rockies and Utah were combined to eliminate duplicates and to account for all possible tree species. Table 2 provides a complete listing of FVS tree species codes per associated FVS geographic variant by NFS Region. Refer to FVS Variant Overviews for a crosswalk of FVS alpha codes to common names per tree species.

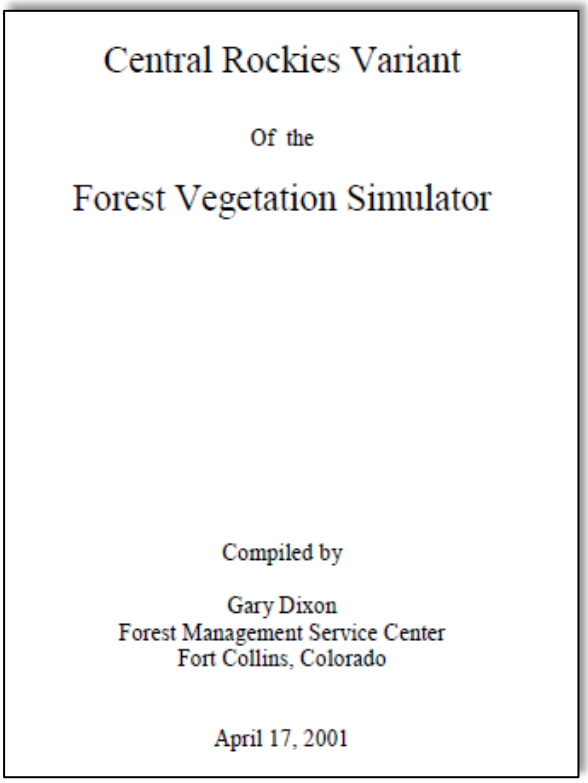
IV. Assigning FVS Tree Species to RMSTAND Forest Types

The basis for tree species assignment for determining the RM-Vegetative Structural Stage is linked to the 2001 version of the FVS Central Rockies Variant. Table 3 provides a listing of the available tree species at that time. Within the associated RM-VSS post processing program, a crosswalk was used to assign tree species to RMSTAND forest types (Jackson 1992, 1993, 2000). Refer to Table 4 for the crosswalk. Refer to Table 5 for the listing of RMSTAND forest types by NFS Region.

Table 2 – FVS Associated Geographic Variant Tree Species Codes by NFS Region.

R1	R2	R3	R4
AF	AF	AF	AF
AS	AJ	AJ	AS
BA	AS	AS	BD
CO	AW	AW	BE
CW	AZ	AZ	BI
DF	BA	BC	BL
ES	BC	BE	BM
GA	BE	BI	BO
GF	BI	BK	BS
LL	BK	BS	CJ
LM	BS	CB	CL
LP	CB	CI	CP
MH	CI	CW	CW
MM	CW	DF	CY
NC	DF	EM	DF
OH	EM	ER	DG
OS	ER	ES	ES
OT	ES	FC	FC
PB	FC	GB	FP
PI	GA	GF	GB
PP	GB	GO	GC
PW	GF	LM	GF
PY	GO	LP	GO
RC	LL	MC	GP
RM	LM	MH	GS
WB	LP	NC	IC
WH	MC	OH	IO
WL	MH	OJ	JP
WP	MM	OS	LM
	NC	PB	LO
	OH	PD	LP
	OJ	PI	MA
	OS	PM	MC
	PB	PP	MH
	PD	PW	MM
	PI	RC	MP
	PM	RM	NC
	PP	SO	OH
	PW	SW	OS
	RC	UJ	PI
	RM	WB	PM
	SO	WF	PP
	SW	WJ	PY
	UJ	WL	RC
	WB	WS	RF
	WF		RM
	WJ		RW
	WL		SF
	WS		SP
			TO
			UJ
			VO
			WB
			WE
			WF
			WH
			WJ
			WL

Table 3 – FVS Central Rockies Variant: Tree Species Codes, circa 2001.



Central Rockies Variant

Of the

Forest Vegetation Simulator

Compiled by

Gary Dixon
Forest Management Service Center
Fort Collins, Colorado

April 17, 2001

FVS Number	Alpha Code	FIA Code	Common Name
01	AF	019	Subalpine fir
02	CB	018	Corkbark fir
03	DF	202	Douglas-fir
04	GF	017	Grand fir
05	WF	015	White fir
06	MH	264	Mountain hemlock
07	RC	242	Western redcedar
08	WL	073	Western larch
09	BC	102	Bristlecone pine
10	LM	113	Limber pine
11	LP	108	Lodgepole pine
12	PI	106	Pinyon pine
13	PP	122	Ponderosa pine
14	WB	101	Whitebark pine
15	WP	114	Southwestern white pine
16	JU	066	Rocky Mountain juniper
17	BS	096	Blue spruce
18	ES	093	Engelmann spruce
19	WS	094	White spruce
20	AS	746	Quaking aspen
21	CO	740	Cottonwoods
22	OA	800	Oaks
23	OS	001	Other softwoods
24	OH	004	Other hardwoods

Table 4 – Crosswalk: CR Tree Species vs. RMSTAND Forest Types.

RMSTAND Forest Types		
R2	R3	R4
2	2	20
2	2	11
4	4	12
1	1	13
4	5	5
1	1	1
1	1	1
1	1	6
9	7	9
10	9	8
7	1	14
6	14	22
3	8	16
8	1	4
1	10	1
6	14	21
4	6	2
2	2	11
2	1	1
12	12	7
13	13	1
14	15	1
11	11	23
15	16	24

Table 5 – RMSTAND Forest Types by NFS Region.

R2		R3		R4	
1	GF,MH,RC,WL,WP	1	GF,MH,RC,WL,LP,WB,WS	1	MH,RC,WP,WS,CO,OA
2	AF,CB,ES,WS	2	AF,CB,ES	2	BS
3	PP	4	DF	4	WB
4	DF,WF,BS	5	WF	5	WF
6	PI,JU	6	BS	6	WL
7	LP	7	BC	7	AS
8	WB	8	PP	8	LM
9	BC	9	LM	9	BC
10	LM	10	WP	11	CB,ES
11	OS	11	OS	12	DF
12	AS	12	AS	13	GF
13	CO	13	CO	14	LP
14	OA	14	JU	16	PP
15	OH	15	OA	20	AF
		16	OH	21	JU
				22	PI
				23	OS
				24	OH

V. Assigning Structural Stage

For example, for Region 3, Ponderosa Pine tree records within the FVS model received the numeric code of 13 (Table 3). Their associated RMSTAND Forest Type code was 8 (Table 4) which translates to Ponderosa Pine (Table 5). Table 6 provides a complete listing of tree species assignment by NFS Region. Region 1 was mapped to Region RMSTAND forest types.

Within the RM-VSS computation, forest cover types are categorized into four subgroups:

- Timberland types
- Riparian Tree types
- Riparian Shrub types
- Woodland types

Within these cover type groups, six diameter size class stages are defined as such:

1. Grass/Forbs/Shrubs
2. Seedlings/Saplings
3. Young Forest
4. Mid-Aged Forest
5. Mature Forest
6. Old Forest

Table 7 displays the diameter size class ranges per vegetative structural stage by forest cover type group. Old Forest declaration is only used for the Timberland cover type group (Jackson 2000).

Table 6 – Assignment of Tree Species to RMSTAND Forest Type by NFS Region.

R1	For_Typ
AF	02
AS	12
BA	13
CO	13
CW	13
DF	04
ES	02
GA	15
GF	01
LL	01
LM	10
LP	07
MH	01
MM	15
NC	13
OH	15
OS	11
OT	15
PB	15
PI	06
PP	03
PW	13
PY	11
RC	01
RM	06
WB	08
WH	01
WL	01
WP	01

R2	For_Typ
AF	02
AJ	06
AS	12
AW	14
AZ	06
BA	13
BC	09
BE	15
BI	15
BK	14
BS	04
CB	02
CI	11
CW	13
DF	04
EM	14
ER	11
ES	02
FC	13
GA	15
GB	09
GF	01
GO	14
LL	01
LM	10
LP	07
MC	15
MH	01
MM	15
NC	13
OH	15
OJ	06
OS	11
PB	15
PD	06
PI	06
PM	06
PP	03
PW	13
RC	01
RM	06
SO	14
SW	01
UJ	06
WB	08
WF	04
WJ	06
WL	01
WS	16

R3	For_Typ
AF	02
AJ	14
AS	12
AW	15
AZ	14
BC	07
BE	16
BI	16
BK	15
BS	06
CB	02
CI	11
DF	04
EM	15
ER	11
ES	02
FC	13
GB	07
GF	01
GO	15
LM	09
LP	01
MC	16
MH	01
NC	13
OH	16
OJ	14
OS	11
PB	16
PD	14
PI	14
PM	14
PP	08
PW	13
RC	01
RM	14
SO	15
SW	10
UJ	14
WB	01
WF	05
WJ	14
WL	01
WS	01

R4	For_Typ
AF	20
AS	07
BD	12
BE	24
BI	24
BL	24
BM	24
BO	24
BS	02
CJ	21
CL	24
CP	23
CW	24
CY	24
DF	12
DG	24
ES	15
FC	24
FP	23
GB	09
GC	24
GF	13
GO	24
GP	23
GS	23
IC	23
IO	24
JP	10
LM	08
LO	24
LP	14
MA	24
MC	24
MH	01
MM	24
MP	23
NC	24
OH	24
OS	23
PI	22
PM	22
PP	16
PY	23
RC	01
RF	03
RM	21
RW	23
SF	20
SP	01
TO	24
UJ	21
VO	24
WB	04
WE	23
WF	05
WH	01
WJ	21
WL	06

Table 7 – Diameter Size Class Range for Vegetative Structural Stage by Cover Type Group.

Cover Type Group	VSS 1	VSS 2	VSS 3	VSS 4	VSS 5	VSS 6*
Timberland	0-1”	1-5”	5-12”	12-18”	18-24	24”+
Riparian - Tree	0-1”	1-5”	5-10”	10-15”	15”+	N/A
Riparian - Shrub	0-1”	1-3”	3-5”	5-7”	7”+	N/A
Woodland	0-1”	1-3”	3-5”	5-11”	11”+	N/A

* Only assigned for the timberland forest cover type group

Note: Diameter size class range is specified at the lower end as “equal to and greater than” and at the upper end as “less than”.

VI. Assigning Canopy Closure

Each forest cover type group, vegetative structural stage (i.e. size class) is further defined to indicate a canopy cover (i.e. density class). The canopy cover code is based on Stand Density Index (SDI) (Reference: Zeide 1987) for the stand as a percent of SDI maximum. In this context, SDI maximum is equivalent to the “Average Maximum Density” for a given forest cover type.

John Shaw, Analyst for the Interior West, Forest Inventory and Analysis (FIA) Unit, Ogden, Utah, has pursued a consistent method for determining Average Maximum Density values for the major tree species of the Western United States (Shaw 2010). Recently, he has extended that work to the East. In an e-mail correspondence to Jim Youtz, Regional Silviculturist, Region 3, John states:

From: Shaw, John D -FS
Sent: Monday, January 23, 2012 3:58 PM
To: Youtz, James A -FS
Subject: RE: SDI max ????

Hi Jim,

We're still working on several SDI-related pubs, but I have some new stuff I can share with you. The first is the revised (and likely final) list of SDI max values for western species. We are reporting the top 50 species, as represented by their abundance in the FIA database. Some of the previous numbers that we've developed were based on forest type (generally, >50% basal area of the target species), but the attached numbers are all species-specific and based on 80+% purity of the target species (green column on sheet1). As a result, you can use these numbers in mixtures and weight the SDImax according to the proportions of different species.

Another bit of progress is that we have 95% confidence intervals on the SDImax values, which I don't think has ever been done before. Even though some species were relatively abundant in the database, it didn't always translate to a lot of plots that were suitable for analysis. Some species are just hard to find in pure patches, even at the scale of an FIA plot. As a result, we get our tried-and-true max of 446 for ponderosa pine, +/- 2 percent, but something noisier for species like alligator juniper (395 +/-14%). That doesn't mean that the max for the noisier species is wrong; it only means that we're not as confident in the number because of things like smaller sample size and wider variety of SDI in the sample.

John

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Refer to Table 8 for a summary of Shaw’s current SDI maximum determinations.

Table 8 – Stand Density Maximum Values for Major Tree Species of the Western U.S.

	A	B	C	D	E	F	G	H	I	J
1	SPCD	Species	N	SDIL	SDImax	SDIR	Ldiff	Rdiff	LPct	RPct
2	11	Pac silver fir	321	739	790	943	51	153	-6%	19%
3	15	white fir	1935	608	634	664	26	30	-4%	5%
4	17	grand fir	1582	531	562	633	31	71	-6%	13%
5	18	corkbark fir	36	405	423		18		-4%	
6	19	subalpine fir	4178	563	602	641	39	39	-6%	6%
7	20	Calif red fir	404	701	768	912	67	144	-9%	19%
8	42	Alaska yellow-cedar	171	523	592	737	69	145	-12%	24%
9	63	alligator juniper	891	340	395	450	55	55	-14%	14%
10	64	western juniper	1725	248	272	299	24	27	-9%	10%
11	65	Utah juniper	11518	484	497	516	13	19	-3%	4%
12	66	Rocky Mt juniper	1730	381	411	456	30	45	-7%	11%
13	69	oneseed juniper	4077	392	408	430	16	22	-4%	5%
14	73	western larch	788	378	423	475	45	52	-11%	12%
15	81	incense-cedar	196	537	576	1026	39	450	-7%	78%
16	93	Engelmann spruce	3893	603	620	649	17	29	-3%	5%
17	94	white spruce	497	317	337	390	20	53	-6%	16%
18	95	black spruce	412	455	500	561	45	61	-9%	12%
19	98	Sitka spruce	1304	633	654	689	21	35	-3%	5%
20	101	whitebark pine	1220	567	621	678	54	57	-9%	9%
21	106	common pinyon	4998	333	348	362	15	14	-4%	4%
22	108	lodepole pine	10509	665	679	695	14	16	-2%	2%
23	113	limber pine	821	375	409	468	34	59	-8%	14%
24	116	Jeffrey pine	702	465	497	551	32	54	-6%	11%
25	117	sugar pine	49	486	561		75		-13%	
26	119	western white pine	142	234	272	348	38	76	-14%	28%
27	122	ponderosa pine	17962	437	446	454	9	8	-2%	2%
28	133	singleleaf pinyon	2509	336	358	386	22	28	-6%	8%
29	202	Douglas-fir	20319	556	570	580	14	10	-2%	2%
30	211	redwood	231	908	1052	1519	144	467	-14%	44%
31	242	western redcedar	513	687	762	789	75	27	-10%	4%
32	263	western hemlock	2647	659	682	712	23	30	-3%	4%
33	264	mountain hemlock	1657	662	687	718	25	31	-4%	5%
34	312	bigleaf maple	141	512	629	842	117	213	-19%	34%
35	321	Rocky Mt maple	113	577	680		103		-15%	
36	322	bigtooth maple	318	509	619	1035	110	416	-18%	67%
37	351	red alder	641	415	441	507	26	66	-6%	15%
38	361	Pacific madrone	87	466	515		49		-10%	
39	375	paper birch	351	375	466	622	91	156	-20%	33%
40	475	curlleaf mountain-mahogany	1118	471	501	536	30	35	-6%	7%
41	544	green ash	1064	362	414	464	52	50	-13%	12%
42	631	tanoak	256	667	785	861	118	76	-15%	10%
43	746	aspen	6010	543	562	574	19	12	-3%	2%
44	747	black cottonwood	341	369	452	484	83	32	-18%	7%
45	803	Arizona white oak gray oak	399	390	403	494	13	91	-3%	23%
46	805	canyon live oak	575	613	667	761	54	94	-8%	14%
47	807	blue oak	791	190	214	247	24	33	-11%	15%
48	810	Emory uak	350	227	284	330	57	46	-20%	16%
49	814	Gambel oak	2881	619	652	685	33	33	-5%	5%
50	815	Oregon white oak	358	359	440	487	81	47	-18%	11%
51	818	California black oak	308	371	406	479	35	73	-9%	18%

As stated in Jackson 2000, the following is a breakdown of the RM-VSS canopy density classes:

A- open	less than 25% of SDI maximum for the designated cover type
B- mod closed	between 25-47% of SDI maximum for the designated cover type
C- closed	greater than 47% of SDI maximum for the designated cover type

SDI maximums are taken from Table 8 derived from Shaw's work.

Refer to table 9 for a listing of associated cover type groups and SDI maximums for each NFS Region by RMSTAND Forest Type.

Table 9 – Cover Type Group and SDI maximums by RMSTAND Forest Type by NFS Region.

R2		ForTyp-Grp	SDI-Max
1	GF,MH,RC,WL,WP	1	600
2	AF,CB,ES,WS	1	620
3	PP	1	450
4	DF,WF,BS	1	570
*5	JP	1	450
6	PI,JU	4	415
7	LP	1	680
8	WB	1	625
9	BC	1	410
10	LM	1	410
11	OS	1	450
12	AS	1	565
13	CO	2	455
14	OA	3	655
15	OH	3	400
16	WS	1	340

R2		ForTyp-Grp	SDI-Max
1	GF,MH,RC,WL,WP	1	600
2	AF,CB,ES,WS	1	620
3	PP	1	450
4	DF,WF,BS	1	570
*5	JP	1	450
6	PI,JU	4	415
7	LP	1	680
8	WB	1	625
9	BC	1	410
10	LM	1	410
11	OS	1	450
12	AS	1	565
13	CO	2	455
14	OA	3	655
15	OH	3	400
16	WS	1	340

R3		ForTyp-Grp	SDI-Max
1	GF,MH,RC,WL,LP,WB,WS	1	600
2	AF,CB,ES	1	620
*3	ES	1	620
4	DF	1	570
5	WF	1	635
6	BS	1	620
7	BC	1	410
8	PP	1	450
9	LM	1	410
10	WP	1	450
11	OS	1	450
12	AS	1	565
13	CO	2	455
14	JU	4	415
15	OA	2	655
16	OH	3	400
*17	AC	2	400
*18	JW	4	415
*19	MQ	3	400
*20	RM	4	415

R4		ForTyp-Grp	SDI-Max
1	MH,RC,WP,WS,CO,OA	1	600
2	BS	1	620
*3	RF	1	635
4	WB	1	625
5	WF	1	635
6	WL	1	425
7	AS	1	565
8	LM	1	410
9	BC	1	410
*10	JP	1	500
11	CB,ES	1	620
12	DF	1	570
13	GF	1	565
14	LP	1	680
*15	ES	1	620
16	PP	1	450
*17	PJ	4	415
*18	XC	1	570
*19	XS	1	690
20	AF	1	605
21	JU	4	415
22	PI	4	350
23	OS	1	450
24	OH	3	400

VII. Assigning Canopy Layers (Stories)

According to Jackson 200, a new VSS rating was developed for identifying even-aged stands. The earlier SDI computation (Jackson 1992) was abandoned. Even-aged stands were determined based on the distribution of the basal area. For a stand to be classified as even-aged, 60% or more of the stand basal area had to be found in an eight-inch diameter class. This eight-inch diameter class is a sliding window; the process calls for calculating the basal area in the 0 - 8" range, then the 1 - 9" range, then the 2 - 10" range, etc., to the final range of 24 - 100". If 60% or more of the stand basal area is found in any diameter class, the stand is called even-aged. If no eight-inch class has at least 60% of the stand basal area (BA), the stand is then called uneven-aged.

To illustrate the sliding window procedure for determining canopy layering, stand table data from projection year 2190 ("before treatment", 6th cutting cycle) for the "Desired Conditions" and "Diameter Limit" treatments is displayed in Figure 2 (Vandendriesche 2012). For the desired conditions treatment, since no sliding window contains at least 60% of the stand basal area, the canopy layering would be considered as multiple storied. In contrast for the diameter limit cutting, since at least one sliding window contains greater than 70% of the stand basal area, its canopy layering would be classified as single storied.

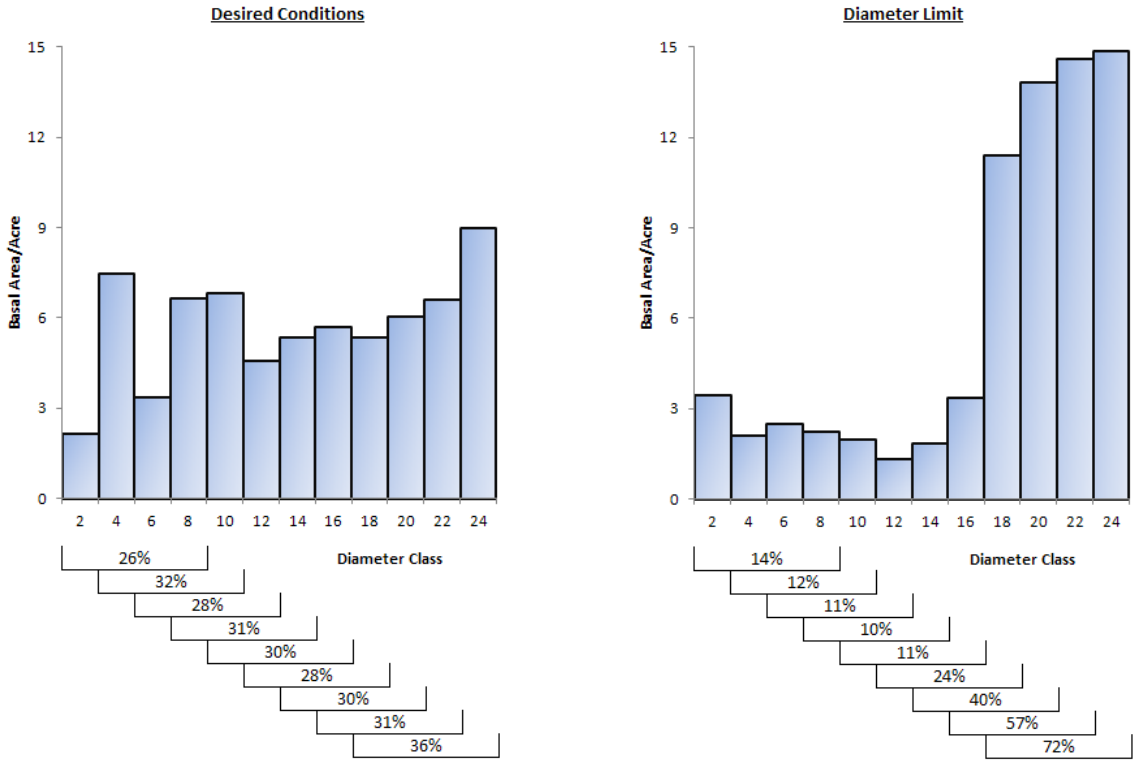

Figure 2. The sliding window approach applied on diameter distributions for Desired Conditions and Diameter Limit treatments to determine canopy layering.

Note: In 2010, while examining the canopy layering algorithm in support of forest plan revision efforts, it was discovered that the 60% BA threshold provided a good benchmark for uneven-aged stands (i.e. *three* or more storied stands). The VDDT models that were constructed for forest planning identified either "single" or "multiple" storied stands. In this case, *multiple storied stands* were defined as *two* or more storied stands. After further investigation of supporting data, it was determined that increasing the threshold from 60% BA to 70% BA enabled isolating single storied from two or more storied stands. Basal area favors larger diameter trees. The lower limit threshold of 60% BA allowed bigger trees to dominant this algorithm and classifies most stands as even-aged. Increasing the basal area threshold tightened the requirement for single storied stands (>=70% BA). Thus, two storied (>=60% BA - <70% BA) can now be distinguished as well as multiple storied stands (<60% BA).

VIII. Putting It All Together

Refer to the template on the following page for the composite attributing of the Rocky Mountain – Vegetative Structural Stage.

ROCKY MOUNTAIN - VEGETATIVE STRUCTURAL STAGE DESCRIPTION

The vegetative structural stage describes the forest successional stage, canopy cover, and stories.

CODE	DESCRIPTION
1	Grass/Forb/Shrub
2A	Seedlings/Saplings, open canopy
2B	Seedlings/Saplings, moderately closed canopy
2C	Seedlings/Saplings, closed canopy
3ASS	Young forest, open canopy, single story
3AMS	Young forest, open canopy, multiple stories
3BSS	Young forest, moderately closed canopy, single story
3BMS	Young forest, moderately closed canopy, multiple stories
3CSS	Young forest, closed canopy, single story
3CMS	Young forest, closed canopy, multiple stories
4ASS	Mid-aged forest, open canopy, single story
4AMS	Mid-aged forest, open canopy, multiple stories
4BSS	Mid-aged forest, moderately closed canopy, single story
4BMS	Mid-aged forest, moderately closed canopy, multiple stories
4CSS	Mid-aged forest, closed canopy, single story
4CMS	Mid-aged forest, closed canopy, multiple stories
SASS	Mature forest, open canopy, single story
5AMS	Mature forest, open canopy, multiple stories
5BSS	Mature forest, moderately closed canopy, single story
5BMS	Mature forest, moderately closed canopy, multiple stories
5CSS	Mature forest, closed canopy, single story
5CMS	Mature forest, closed canopy, multiple stories
6BSS	Old forest, moderately closed canopy, single story
6BMS	Old forest, moderately closed canopy, multiple stories
6CSS	Old forest, closed canopy, single story
6CMS	Old forest, closed canopy, multiple stories

LEGEND

Structural Stage:
- 1 Grass/Forb/Shrub
- 2 Seedlings/Saplings
- 3 Young Forest
- 4 Mid-Aged Forest
- 5 Mature Forest
- 6 Old Forest

Canopy Closure:
- A 0-39 Percent, Open
- B 40-59 Percent, Moderately Closed
- C 60+ Percent, Closed

Stories:
- SS Single Story
- MS Multiple Story

References:

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Documentation Chronology:

1. Jack W. Thomas, 1979, “Wildlife Habitats in Managed Forests, the Blue Mountains of Oregon and Washington”. U.S. Department of Agriculture – Forest Service, Agriculture Handbook 553.

2. Richard T. Reynolds, 1992, “Management Recommendations for the Northern Goshawk in the Southwestern United States”. U.S. Department of Agriculture – Rocky Mountain Forest and Range Experiment Station and Southwestern Region Forest Service, General Technical Report RM-217.

3. Patrick D. Jackson, 1992, “Vegetative Structural Stages, Description and Calculations, Southwestern Region”. U.S. Department of Agriculture – Southwestern Region Forest Service, Internal publication.

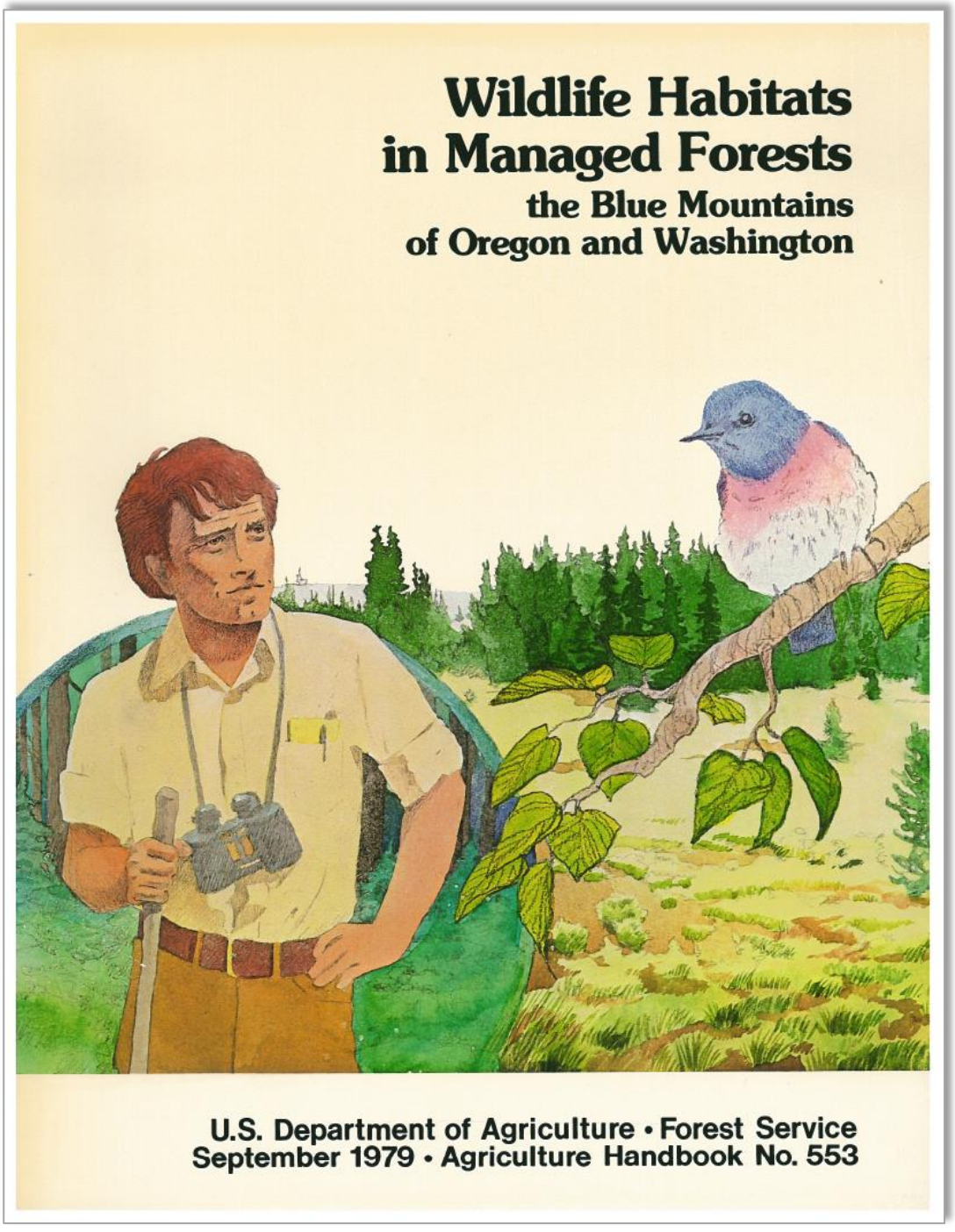
4. Patrick D. Jackson, 1993, “RMSTAND – Chapter 60: Data Processing and Interpretation”. U.S. Department of Agriculture – Southwestern Region Forest Service, Internal publication.

5. Patrick D. Jackson, 2000, “Vegetative Structural Stages Calculations as Calculated by RMSTAND”. U.S. Department of Agriculture – Southwestern Region Forest Service, Internal publication.

6. Stephanie A. Rebain, 2009, “FVS VSS post processor”. U.S. Department of Agriculture – Forest Management Service Center, Forest Vegetation Simulator, E-mail correspondence.

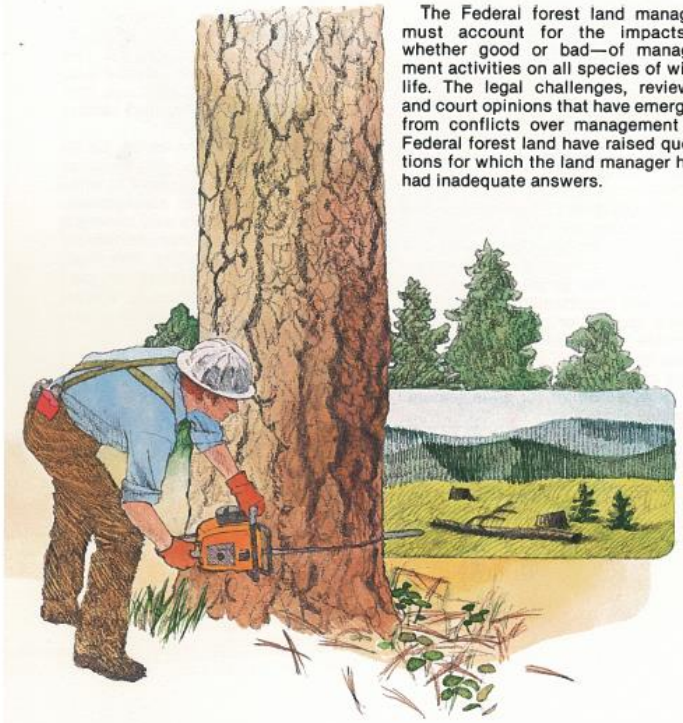
7. Stephanie A. Rebain, 2010, “VSS calculations”. U.S. Department of Agriculture – Forest Management Service Center, Forest Vegetation Simulator, E-mail correspondence.

1. **Jack W. Thomas, 1979, "Wildlife Habitats in Managed Forests, the Blue Mountains of Oregon and Washington". U.S. Department of Agriculture – Forest Service, Agriculture Handbook 553.**



2
Plant Communities and Successional Stages

by
Jack Ward Thomas
Rodney J. Miller
Chris Maser
Ralph G. Anderson
Bernie E. Carter



The Federal forest land manager must account for the impacts—whether good or bad—of management activities on all species of wildlife. The legal challenges, reviews, and court opinions that have emerged from conflicts over management of Federal forest land have raised questions for which the land manager has had inadequate answers.

For example, which species of wildlife will be adversely influenced, which benefited, and which unaffected by forest management activites? What is the degree of impact on those species? How will these influences vary over time? Which negative impacts are irreversible and which can be reduced by appropriate management activity? Which species are especially sensitive to habitat change and how will they respond to habitat alterations? Which species are threatened or endangered and how will they be influenced?

This chapter shows how the forest manager can deal with these problems in forest management planning. The system described is designed to handle a large volume of technical information about wildlife and their habitats in a way that makes sense to the forest manager.

The first task was to assemble all pertinent data for the 378 species of vertebrates in the Blue Mountains. The amount of data varied from extensive for some species to almost nothing for others. This presented two problems—how to "fill in the blanks" when information was inadequate and how to present information on a large number of species without overwhelming the manager with detail.

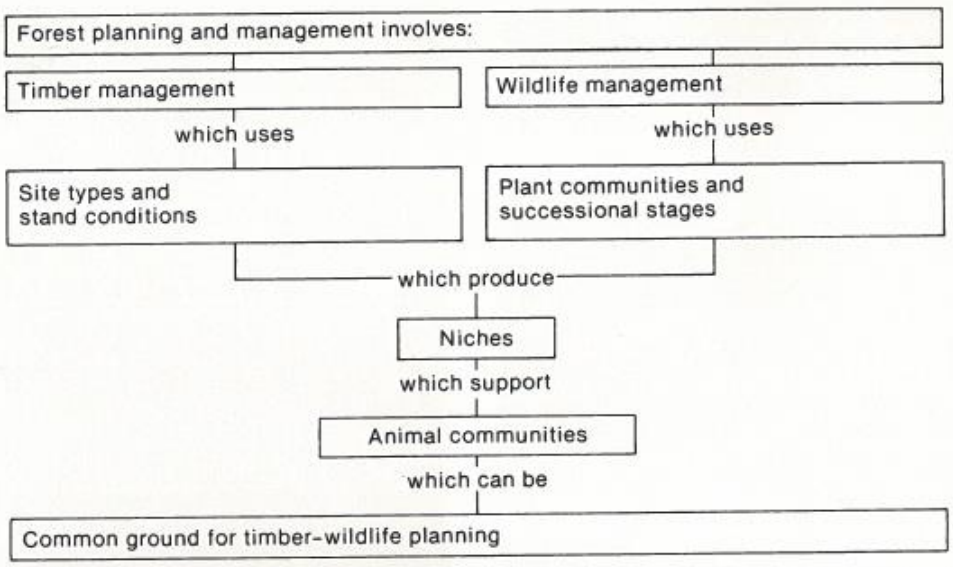
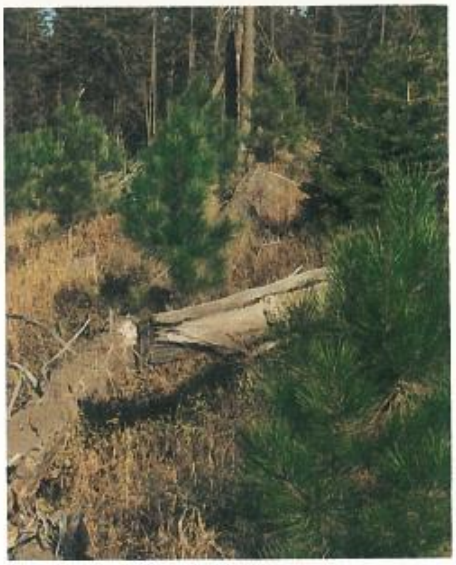


Figure 9. Plant communities and their successional stages can be a common ground for timber-wildlife planning.

Timber harvest activities produce conditions that mimic natural stages of succession. Clearcutting, for example, changes a mature or old-growth forest (left) to the grass-forb stage and then to the shrub-seedling stage (below).

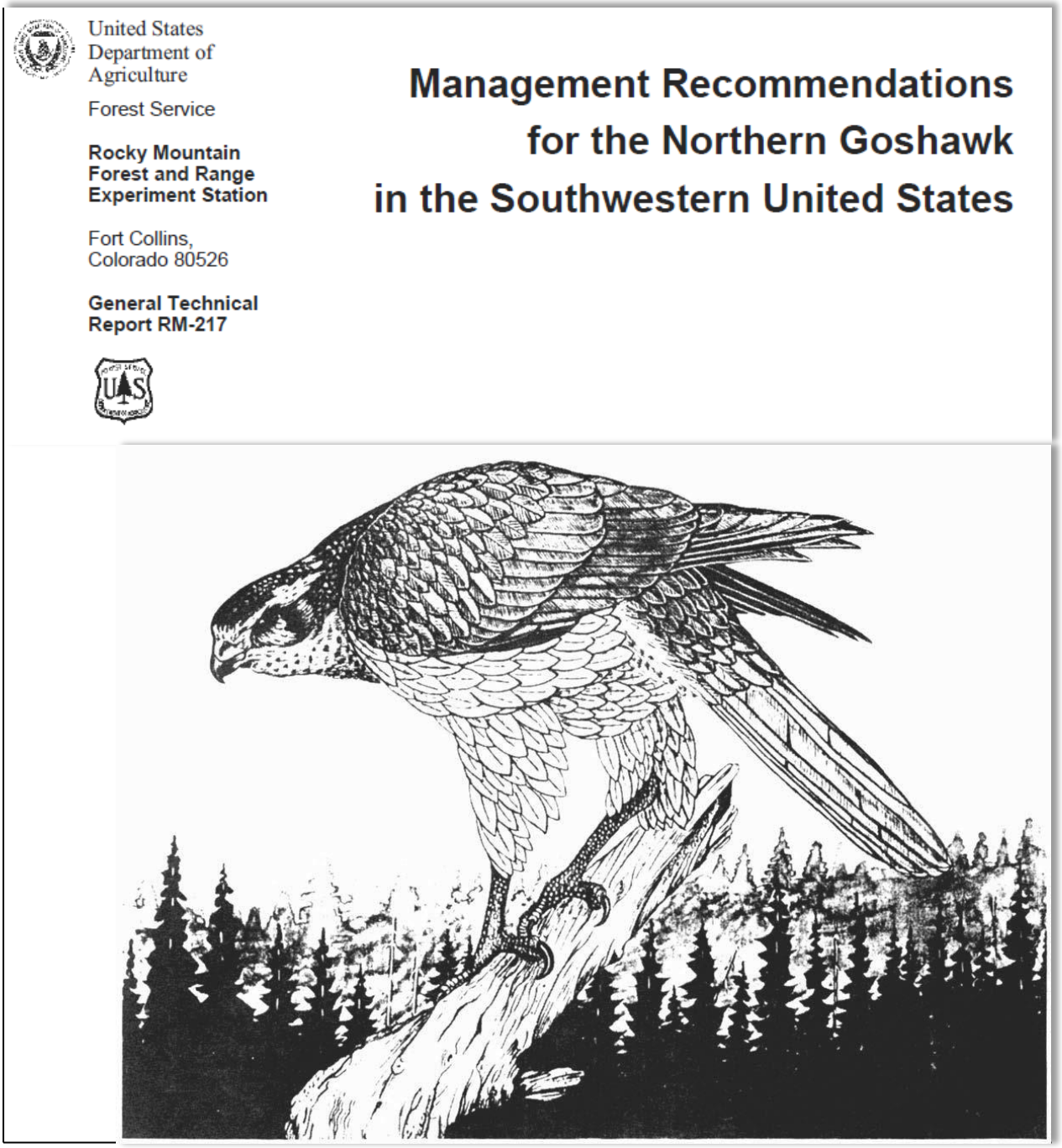


Plant community[1]		Function[1]	Successional stage[1]					
			Grass-forb	Shrub-seedling (0-10 years)	Pole-sapling (11-39 years)	Young (40-79 years)	Mature (80-159 years)	Old growth (160 + years)
			R0 F2	R0 F2	R0 F1	R8 F8	R13 F13	R12 F12
Dry meadow	R 0	R	0	These plant communities do not achieve a habitat form like that characterized by these successional stages.*				
	F 0	F	0					
Moist meadow	R 0	R	0					
	F 0	F	0					
Other grasses	R 0	R	0					
	F 0	F	0					
Sagebrush-bitterbrush	R 0	R	0	0				
	F 0	F	0	0				
Other shrubs	R 0	R	0	0				
	F 0	F	0	0				
Curlleaf mountain-mahogany	R 0	R	0	0	0	0	0	0
	F 0	F	0	0	0	0	0	0
Western juniper	R 1	R	0	0	0	1	1	1
	F 1	F	1	1	1	1	1	1
Quaking aspen	R 3	R	0	0	0	3	3	*as above
	F 4	F	1	1	1	3	4	
Riparian (deciduous)	R 4	R	0	0	0	4	4	
	F 4	F	2	2	1	4	4	
Ponderosa pine	R 8	R	0	0	0	3	8	8
	F 8	F	2	2	1	3	8	8
Mixed conifer	R 9	R	0	0	0	5	9	9
	F 10	F	2	2	1	5	10	10
White fir (grand fir)	R 6	R	0	0	0	4	6	6
	F 6	F	1	1	1	4	6	6
Lodgepole pine	R 4	R	0	0	0	4	*as above	
	F 4	F	0	0	0	4		
Subalpine fir	R 4	R	0	0	0	3	4	4
	F 4	F	0	0	0	3	4	4
Alpine meadow	R 0	R	0	*as above				
	F 0	F	0					

[1]R (reproduction) and F (feeding) refer to total species performing either function in the respective plant communities and successional stages. Vertical scale of each species-total box in life form 13 is equivalent to 10 units.

Table 2. Relative degree of use of plant communities and successional stages by wildlife species in life form 13 (source: appendix 10)

2. **Richard T. Reynolds, 1992, "Management Recommendations for the Northern Goshawk in the Southwestern United States". U.S. Department of Agriculture – Rocky Mountain Forest and Range Experiment Station and Southwestern Region Forest Service, General Technical Report RM-217.**



The following are key concepts fundamental to the GSC recommendations:

- Forests within goshawk nesting home ranges should be an interspersed mosaic of structural stages -- young to old forests -- to increase the diversity of habitat for goshawks and their many prey species. Six vegetation structural stages (VSS) were used to describe regeneration, growth, and development of forests in the Southwest (Fig. 1). The proportions of the VSS and their interspersion in the forest is how the GSC described the forest mosaic.

VEGETATIVE STRUCTURAL STAGES:
Successional stages for a mixed-species forest ecosystem

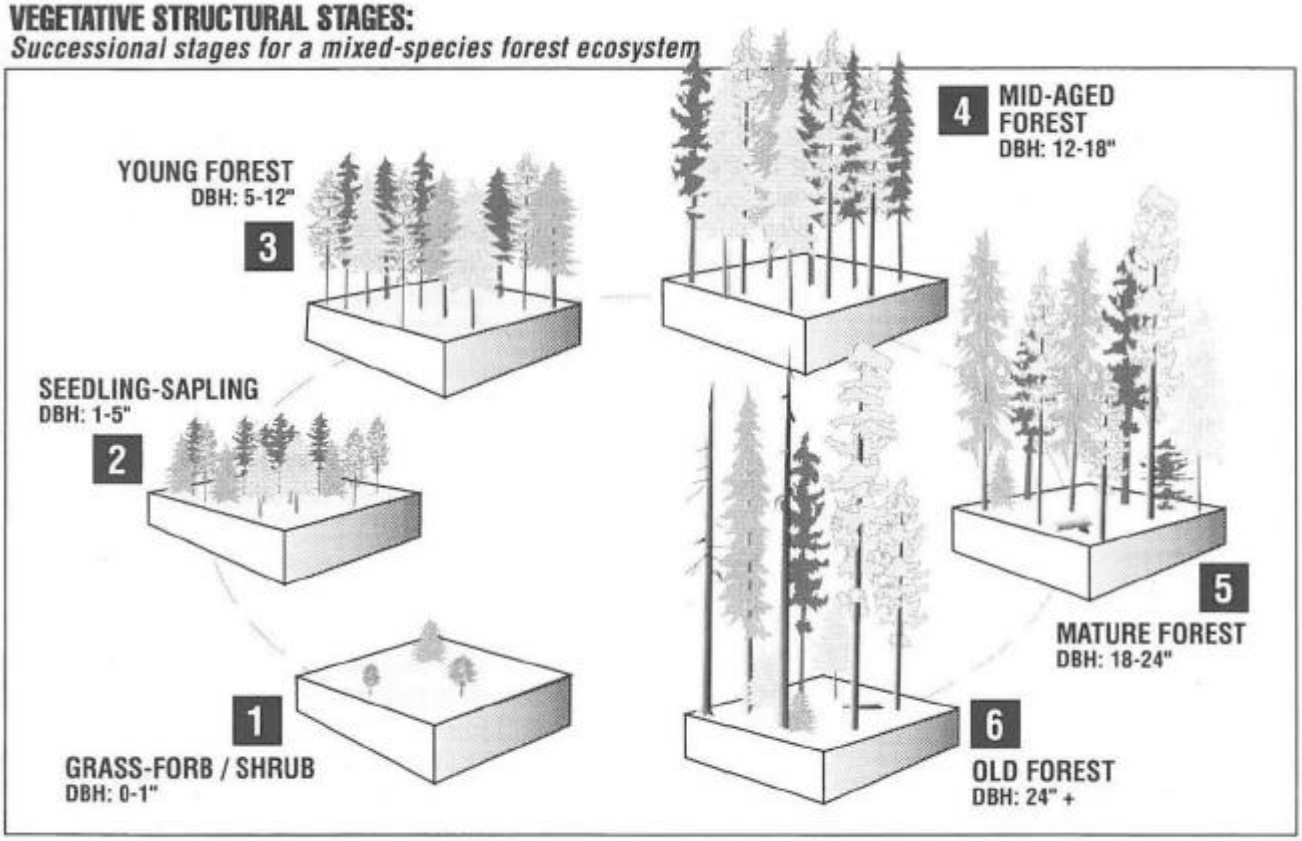


Figure 1. Forest vegetation structural stages and their associated diameter breast height (DBH) ranges.

Table 1. Desired forest conditions in three forest types for sustaining northern goshawks and their principal prey species in the Southwest.

Attribute	Home-Range Components						
	Nest Area[a]	Post Fledging-Family Area			Foraging Area		
		Ponderosa Pine	Mixed-Species	Spruce-fir	Ponderosa Pine	Mixed-Species	Spruce-fir
VSS distribution[b]							
grass/forb/shrub VSS 1 (%)	0[c]	10[c]	10[c]	10[c]	10[c]	10[c]	10[c]
seedling-sapling VSS 2 (%)	0	10	10	10	10	10	10
young forest VSS 3 (%)	0	20	20	20	20	20	20
mid-aged forest VSS 4 (%)	0	20	20	20	20	20	20
mature forest VSS 5 (%)	100	20	20	20	20	20	20
old forest VSS 6 (%)	100	20	20	20	20	20	20
Canopy cover							
mid-aged forest VSS 4[c]	NA[d]	1/3 60+ 2/3 50+	60+	60+	40+	1/3 60+ 2/3 40+	1/3 60+ 2/3 40+
mature forest VSS 5 (%)	50-70+	50+	60+	70+	40+	50+	60+
old forest VSS 6 (%)	50-70+	50+	60+	70+	40+	60+	60+
Years to mid-aged VSS 6	200-300	200-250	200-300	200-300	200-250	200-300	200-300
Opening size							
maximum size (acre)	NA	2	2	1	4	4	1
width--maximum (ft)	NA	200	150	125	200	200	125
Reserve trees[e]							
number of groups/acre	A[f]	1	1	2[h]	1	1	2[h]
number (per group)	NA	3-5	6	6	3-5	6	6
opening threshold[g] (acres)	NA	>1	>1	>0.5	>1	>1	>0.5
Snags (no/acre)	NR[i]	2	3	3	2	3	3
Downed logs (acre)	NR	3	5	5	3	5	5
Woody debris (tons/acre)	NR	5-7	10-15	10-15	5-7	10-15	10-15

[a] *Suitable nest areas only; attribute values may vary by forest type.*

[b] *VSS; Vegetation Structural Stages, a forest description based on the tree diameter distribution within a stand. For example, if the majority of the stems of a stand (based on basal area) were located in the 12-18 inch diameter class, the stand would be classified as a VSS 4. General diameter limits are: VSS 1= 0-1" DBH; VSS 2= 1-5" DBH; VSS 3= 5-12" DBH; VSS 4= 12-18" DBH; VSS 5= 18-24" DBH; VSS 6 = 24"+ DBH. DBH = Diameter at Breast Height (4.5 ft.).*

[c] *Proportion of the area.*

[d] *NA; not applicable.*

[e] *Reserve trees; standing trees left after harvesting that will be allowed to become snags and downed logs.*

[f] *A; applicable, clumpiness, or groups of large trees is also desirable.*

[g] *When threshold size is exceeded, reserve trees are necessary.*

[h] *One group per 0.5 acres.*

[i] *NR; not required, but presence of these features are not detrimental.*

Appendix 5. Vegetation structural stage determination and management options

Vegetation Structural Stage Determination

Vegetation structural stage (VSS) is a method of describing the growth stages of a stand of living trees. It is based on tree size (DBH) and total canopy cover. Overall, the VSS is dependent on the time it takes seedlings to become established and subsequent growth rates. Life expectancy of trees determines how long the oldest VSS can be maintained.

The time required for seedling establishment depends on:

1) cone crop frequencies (Appendix 1, Table 2; page 49),
2) cone development,
3) seed production and distribution,
4) proper conditions for germination,
5) root system establishment, and
6) climatic conditions.

Seedling establishment varies from 10 years in ponderosa pine and mixed-species, to 20 years in spruce-fir after a canopy is opened and a forest floor is disturbed (Pearson 1950, Alexander 1974).

Tree diameter growth rates vary with:

1) initial diameter (starting point),
2) site productivity,
3) climatic conditions, and
4) level of management.

Ponderosa pine and mixed-species forest types have similar diameter growth rates, ranging from 0.2 to 2.5 inches per decade (Edminister et al. 1991) (Tables 1, 2). Spruce-fir forests usually have growth rates of 0.2 to 1.4 inches per decade (Table 3).

Pathological age of trees is the ages (years) when growth slows, significant decay develops, and mortality is high (Boyce 1961). Pathological age ranges from 10 years in Gambel oak to 250-450 years in Engelmann spruce (Table 4). However, individual trees can live much longer. In southwestern tree species, longevity ranges from 80 years in Gambel oak to >2000 years in limber pine (Table 4).

Site productivity and growth rates vary widely among forest types of the Southwest. The following site indices (SI) and basal areas per acre (BA/A) were chosen to typify each forest type (Tables 1, 2, 3):

1) Ponderosa pine: 70 SI, 60 BA/A
2) Mixed-species: 70 SI, 80 BA/A
3) Spruce-fir: 80 SI, 100 BA/A

Management Options for Developing Vegetation Structural Stages

To develop the VSS proportions in goshawk home ranges many options are available. To achieve the desired forest conditions, some form of stand regeneration and tree density control (e.g., fire, insect and disease, understory thinning) is needed. Depending on management intensity (minimal, moderate, and intensive), the desired forest conditions can be obtained at varying rates (Tables 1, 2, 3, 5).

Intensity of forest treatments (thinning) influences the growth rates of trees . For example, because of competition, trees in unthinned ponderosa pine stands will not grow more than 11 inches in diameter over a 220 year period (Table 5). As a result, these unthinned stands will remain in a "young VSS" (DBH) even though they are 200 years old. Table 5, illustrates how trees and forests change (mean diameter, basal are, tree per acre, and VSS) through time under five different management intensities.

3. **Patrick D. Jackson, 1992, "Vegetative Structural Stages, Description and Calculations, Southwestern Region". U.S. Department of Agriculture – Southwestern Region Forest Service, Internal publication.**

VEGETATIVE STRUCTURAL STAGES DESCRIPTION AND CALCULATIONS

U.S.D.A. FOREST SERVICE
SOUTHWESTERN REGION

April 1, 1992

Abstract:

The Southwestern Region uses a six-class vegetation scheme to describe the developmental stages of a forest ecosystem. The purpose of the classification method is to provide a common language between and with the publics and Forest Service employees whereby each can visualize the forest developmental stages. The stages can also be easily inventoried and classified by the Rocky Mountain Stand Program and displayed on a printout for resource managers.

The six stages are grass-forb/shrub (0 - 1" dbh); seedling-sapling (1 - 5" dbh); young forest (5 - 12" dbh); mid-age forest (12 - 18" dbh); mature forest (18" dbh and larger); and old-growth (meets Regional minimum dbh, age, and number of tree required standards). Stand density index (SDI) is calculated for each forest stage and the stage with the highest density is selected for the classification. SDI is also used to determine the canopy closure class (open; moderately closed; or closed) and whether a stand is single or multiple storied. The classification system is most useful for even-aged stands with single or multiple stories, but looses its utility when applied to either a uniform or groupy uneven-aged (all-aged) stand.

VEGETATIVE STRUCTURAL STAGE TABLE

The following tables illustrate the stem diameter for each structural stage by forest cover type.

Ponderosa Pine, Southwestern White Pine, Miscellaneous Soft Woods

	GRASS FORB/SHURB (1) SINGLE STORY	SEEDLING/ SAPLINGS (2) SINGLE STORY			YOUNG FOREST (3) SINGLE & MULTIPLE			MID-AGED FOREST (4) SINGLE & MULTIPLE			MATURE FOREST (5) SINGLE & MULTIPLE			OLD-GROWTH (6) SINGLE & MULTIPLE	
CANOPY		A	B	c	A	B	C	A	B	c	A	B	c	B	c
DBH	0- 0.9"	1.0"-4.9"			5.0"-11.9"			12"-17.9"			18"+			Low	High
														14"	18"
														20	20

A = 0 - 39% B = 40 - 59% C = 60%+

Blue Spruce, Douglas-fir, White Fir, Limber Pine, Bristlecone Pine.

	GRASS FORB/SHURB (1) SINGLE STORY	SEEDLING/ SAPLINGS (2) SINGLE STORY			YOUNG FOREST (3) SINGLE & MULTIPLE			MID-AGED FOREST (4) SINGLE & MULTIPLE			MATURE FOREST (5) SINGLE & MULTIPLE			OLD-GROWTH (6) SINGLE & MULTIPLE	
CANOPY		A	B	C	A	B	C	A	B	C	A	B	C	B	C
DBH	0 - 0.9"	1.0"-4.9"			5.0"-11.9"			12"-17.9"			18"+			Low	High
														18"	20"
														12	16

A = 0 - 39% B = 40 - 59% C = 60%+

Engelmann Spruce-Subalpine Fir, Engelmann spruce.

	GRASS FORB/SHURB (1) SINGLE STORY	SEEDLING/ SAPLINGS (2) SINGLE STORY			YOUNG FOREST (3) SINGLE & MULTIPLE			MID-AGED FOREST (4) SINGLE & MULTIPLE			MATURE FOREST (5) SINGLE & MULTIPLE			OLD-GROWTH (6) SINGLE & MULTIPLE	
CANOPY		A	B	c	A	B	C	A	B	c	A	B	c	B	c
DBH	0- 0.9"	1.0"-4.9"			5.0"-11.9"			12"-17.9"			18"+			Low	High
														10"	14"
														20	30

A = 0 - 39% B = 40 - 59% c = 60%+

Aspen*, Cottonwood*, Willow**, Miscellaneous Hardwoods**.

	GRASS FORB/SHURB (1) SINGLE STORY	SEEDLING/ SAPLINGS (2) SINGLE STORY		YOUNG FOREST (3) SINGLE & MULTIPLE		MID-AGED FOREST (4) SINGLE & MULTIPLE		MATURE FOREST (5) SINGLE & MULTIPLE			OLD-GROWTH (6) SINGLE & MULTIPLE	
CANOPY		A	B	A	B	C	A	B	C	A	B	C	B	C
DBH* DRC**	0- 0.9"	1.0"-2.9"		3.0"-7.9"		8"-11.9"		12"+			Low	High	NOT DEFINED	
								DBH Trees/ac.						

A = 0 - 39% B = 40 - 59% C = 60%+

Pinyon-juniper, Juniper, Rocky Mountain Juniper, Arizona Cypress.

	GRASS FORB/SHURB (1) SINGLE STORY	SEEDLING/ SAPLINGS (2) SINGLE STORY		YOUNG FOREST (3) SINGLE & MULTIPLE		MID-AGED FOREST (4) SINGLE & MULTIPLE		MATURE FOREST (5) SINGLE & MULTIPLE			OLD-GROWTH (6) SINGLE & MULTIPLE	
CANOPY		A	B	A	B	C	A	B	C	A	B	C	B	C
DRC	0- 0.19"	0.2"-2.9"		3.0"-5.9"		6"-8.9"		9"+			Low	High		
								DBH Trees/ac.			9″ 12	12″ 30		

A = 0 - 39% B = 40 - 59% C = 60%+

Gambel Oak, Mesquite.

	GRASS FORB/SHURB (1) SINGLE STORY	SEEDLING/ SAPLINGS (2) SINGLE STORY		YOUNG FOREST (3) SINGLE & MULTIPLE		MID-AGED FOREST (4) SINGLE & MULTIPLE		MATURE FOREST (5) SINGLE & MULTIPLE			OLD-GROWTH (6) SINGLE & MULTIPLE	
CANOPY		A	B	A	B	C	A	B	C	A	B	C	B	C
DRC	0- 0.19"	0.20"-2.9"		3.0"-4.9"		5"-6.9"		7"+			Low	High	NOT DEFINED	
								DBH Trees/ac.						

A = 0 - 39% B = 40 - 59% C = 60%+

VEGETATIVE STRUCTURAL STAGE DESCRIPTION

The vegetative structural stage describes the forest successional stage, canopy cover, and stories.

CODE	DESCRIPTION
1	Grass-forb/shrub
2A	Seedling/sapling, open canopy
2B	Seedling/sapling, moderately closed canopy
2C	Seedling/sapling, closed canopy
3ASS	Young forest, open canopy, single story
3AMS	Young forest, open canopy, multiple story
3BSS	Young forest, moderately closed canopy, single story
3BMS	Young forest, moderately closed canopy, multiple story
3CSS	Young forest, closed canopy, single story
3CMS	Young forest, closed canopy, multiple story
4ASS	Mid-aged forest, open canopy, single story
4AMS	Mid-aged forest, open canopy, multiple story
4BSS	Mid-aged forest, moderately closed canopy, single story
4BMS	Mid-aged forest, moderately closed canopy, multiple story
4CSS	Mid-aged forest, closed canopy, single story
4CMS	Mid-aged forest, closed canopy, multiple story
SASS	Mature forest, open canopy, single story
5AMS	Mature forest, open canopy, multiple story
5BSS	Mature forest, moderately closed canopy, single story
5BMS	Mature forest, moderately closed canopy, multiple story closed
5CSS	Mature forest, canopy, single story
5CMS	Mature forest, closed canopy, multiple story
6BSS	Old-growth, moderately closed canopy, single story
6BMS	Old-growth, moderately closed canopy, multiple story
6CSS	Old-growth, closed canopy, single story
6CMS	Old-growth, closed canopy, multiple story

DESCRIPTION

LEGEND

Structural Stage:
- 1 Grass-Forb/Shrub
- 2 Seedling/Sapling
- 3 Young Forest
- 4 Mid-aged Forest
- 5 Mature Forest
- 6 Old-growth

Canopy Closure:
- A 0-39 Percent, Open
- B 40-59 Percent, Moderately Closed
- C 60+ Percent, Closed

Stories:
- SS Single Story
- MS Multiple Story

VEGETATIVE STRUCTURAL STAGE CALCULATIONS

STRUCTURAL STAGES

VSS 1 is determined:

when $\frac{\text{Total Stand SDI}}{\text{Maximum SDI for Forest Type}} \times 100 = -$ <10% or Basal Area is < 20. (Forest type is not set if BA is less than 20)

VSS 6 is determined:

when The number of trees and stem diameter are equal to or greater than the stated number for the forest type. The stated stem size and number of trees are the Regional old-growth minimums.

VSSs 2, 3, 4, and 5 are determined:

when $\frac{\text{Total Stand SDI}}{\text{Maximum SDI for Forest Type}} \times 100$ is $\geq 10\%$

and VSS 6 number of tree and stem diameters are < the numbers stated; the class with the highest calculated square foot basal area is the assigned structural stage. The calculated basal area for each VSS includes all tree species.

CANOPY COVER

Canopy cover is determined:

when $\frac{\text{Total Stand SDI}}{\text{Maximum SDI for Forest Type}} \times 100 =$ 10 to ≤30% then A is assigned meaning Open, 0 to 39% canopy cover

when $\frac{\text{Total Stand SDI}}{\text{Maximum SDI for Forest Type}} \times 100 =$ >30 to ≤47% then B is assigned meaning Moderately Closed, 40 to 59 % cover

when $\frac{\text{Total Stand SDI}}{\text{Maximum SDI for Forest Type}} \times 100 =$ >47% then C is assigned meaning Closed, 60+% canopy cover

STORIES

Stories is determined:

when $\frac{\text{SDI for Selected VSS}}{\text{Total Stand SDI}} \times 100 =$ ≥60% then SS is assigned meaning Single Story

when $\frac{\text{SDI for Selected VSS}}{\text{Total Stand SDI}} \times 100 =$ < 60% then MS is as singed meaning Multiple Story

AN EXAMPLE OF THE STAND EXAMINATION PRINT OUT - PAGE 6

********** VEGETATIVE STRUCTURAL STAGE **********

FOREST COVER TYPE = DF
STAND SITE INDEX = 63

MAX SDI FOR TYPE = 595.0
STAND SDI = 113.5
SDI OF MAX SDI = 19.08

********** STRUCTURAL CLASSES **********

	(1) GRASS FORB	SEED/ SAPS	YOUNG FOREST	MID-AGE FOREST	MATURE FOREST	OLD-GROWTH
BEGIN CLASS DBH	.0	1.0	5.0	12.0	18.0	20.0
REQUIRED TREES						16.0
# TREES IN CLASS		895.1	86.2	9.8	1.2	
BA FOR CLASS		11.2	23.3	10.0	3.3	
QMD OF CLASS		1.5	7.0	13.7	22.4	
SDI IN CLASS		43.7	49.2	16.2	4.4	
% SDI IN CLASS		38.51	43.35	14.24	3.90	

STRUCTURE STAGE = 3AMS

MAXIMUM SDI FOR VARIOUS FOREST COVER TYPES

Spruce-fir	670
Engelmann Spruce	670
Douglas-fir	595
White fir	830
Blue Spruce	670
Bristle Cone pine	700
Ponderosa pine	450
Limber pine	700
Southwestern White pine	450
Miscell Softwoods	450
Aspen	600
Cottonwood	420
Pinyon-juniper	465
Oak Woodland	460
Miscell Hardwoods	400
Arizona Cypress	400
Juniper Woodland	344
Mesquite	344
Rocky Mountain Juniper	344

FORMULAS USEFUL FOR STAND DENSITY

$$SDI = N \left[\frac{\bar{D}}{10} \right]^{1.6}$$

$$N = \frac{SDI}{\left[\frac{\bar{D}}{10} \right]^{1.6}}$$

$$\bar{D} = 10 \left[SDI / N \right]^{.625}$$

$$SDI = \left[\frac{BA}{\bar{D}^{\,0.395}} \right] 4.55282$$

LEGEND

SDI = Reineke's Stand Density Index

N = Number of Trees Per Acre

$\bar{D}$ = Quadratic Mean Diameter Breast Height in Inches

BA = Square Feet Basal Area at Diameter Breast Height in Inches

3/25/2004

R3 Forest Cover Types
And Associated Max SDI

RMRIS

Cover Type	Despcription	Max SDI
TSF	Spruce-Fir	670
TES	Engelmann Spruce	670
TDF	Douglas-Fir	595
TWF	White Fir	830
TBS	Blue Spruce	670
TBC	Bristlecone Pine	700
TPP	Ponderosa Pine	450
TLI	Limber Pine	700
TWP	Southwestern White Pine	450
TOS	Miscellaneous Softwoods	450
TAA	Aspen	600
TCW	Cottonwood	420
TPJ	Pinon-Juniper	465
TOW	Oak Woodland	460
TOH	Miscellaneous Hardwoods	400
TAZ	Arizona Cypress	400
TJW	Juniper Woodland	344
TMQ	Mesquite	344
TRJ	Rocky Mountain Juniper	344

4. **Patrick D. Jackson, 1993, "RMSTAND – Chapter 60: Data Processing and Interpretation". U.S. Department of Agriculture – Southwestern Region Forest Service, Internal publication.**

CHAPTER 60
DATA PROCESSING AND INTERPRETATION

TABLE OF CONTENTS

DATA PRESENTATION AND INTERPRETATION

Because stand exam information is integrated into the RMRIS ORACLE system, most needed summaries could be a simple oracle query. However, there are still some instances when stand printouts are useful, and they may be looked at as additional reports available to the RMRIS user. This section will explain the various page types and information on the standard RMSTAND printout.

Explanation of Stand Exam Printouts (RMSTAND)

RMSTAND will produce a standard printout up to six pages long for each stand. The printout is designed to print on 80 columns or 8 1/2" x 11" paper. The information is summary data compiled by the RMSTAND program from individual tree data tallied in the field. The summary data is segregated into page types according to type of data and what it will be used for the RMSTAND Default options allow the user to select ONLY the desired page types for printout.

RMSTAND converts all sample trees to a per acre basis by one of two methods. If they were tallied on the fixed-plot, the number of trees represented per acre equals the reciprocal of the fixed-plot size divided by the number of sample points. For example, if the fixed-plot size is 1/300-acre and 10 points were sampled in the stand, the fixed-plot tree blowup would be 300/10 or 30.

If tallied on the variable plot, the blowup factor for each tally tree equals the basal area factor divided by the number of sample points divided by the actual basal area of the tree. Volumes and other measurements can be determined for tally trees and expanded to per acre values using the calculated blowup factors.

Explanation of PAGE TYPE 1

Refer to Exhibit 1 displaying Page Type 1. This page type displays information on productivity, mortality, and damages.

Standard Header Line

The top line on the page is a header line, which is repeated on all Page Types.

1. LOC - SITE

This is the 10-digit Location/Site number. This number must be unique within a Forest. It is a locater used to locate the stand in the data base, the tree data support file, and the stand map.

2. REG This is the Region Code.

3. DISTRICT

This four-digit code is the administrative Forest and Ranger District Code. This is the same as the districts RMRIS database code.

4. SURVEY DATE

Survey date is the year and month the field data was collected.

EXHIBIT 1

Loc·Site 001021-0007 Reg 4 District 1301 Survey Date 9209 Acres 26 PAGE 1
****

S I T E I N D E X & P R O D U C T I V I T y

Species	DBH AGE	HGT	Product-ivity	SITE INDEX BASE 100	BASE 80	BASE SO	Reference
PICO	87	32	13	32	0	21	INT-75
PICO	93	49	23	47	0	31	INT-75
PICO	98	3"1	12	29	0	19	INT-75
PICO - LODGEPOLE				16	36	0	24	Average	3 TREES)

* Site Productivity is Based on Brickell, INT-7S
Total Age is Estimated by adding 4 years for
Hardwoods, 15 for Softwoods & 30 for Spruce

F O R E S T T Y P E	S T A N D S I Z E	V E G S I Z E
LODGEPOLE PINE	SAWTIMBER	LARGE

Forest type based on BASAL AREA size class S.O"+ <- R4 specific message.

A N N U A L M O R T A L I T Y X C A U S E

MEASURE	INSECT	DISEASE	FIRE	ANIMAL	WEATHER	SUPPRESSED	OTHER
Stems(1-4.9)	.00	.00	.00	.00	.00	.00	.00
Stems(SIN+)	.00	.00	.00	.00	.00	.00	.00
Cubic(SIN+)	.00	.00	.00	.00	.08	.00	.00
Scrib(7IN+)	.00	.00	.00	.00	.00	.00	.00

L I V E T R E E S P E R A C R E X D A M A G E

DAMAGE		0-4.9IN	5-8.9IN	9IN+
1-	NONE	2100:0	64.6	76.0
72-	FORK TQP	.0	19.1	.0

NET Cubic Volume of Growing Stock 1563. (Min. DBH 5.0 Min. DIB 4.0)
NET Scrib Volume of Growing Stock 6007. (Min. DBH 7.0 Min. DIB 6.0)

% Nonstocked .0 % Nonstockable = .0

MET C SAM 3 LIN 27 BA20 FP300 LFP 0 SFP 0 GP 0 DBA 0 DFP 0 BDBSO BDR30

END OF PAGE - INDIVIDUAL STAND RUN 6- 4-1993 Rev# 5.00.01

Region 2

Step 1--Determine Forest Cover Type

a. If the total basal area of all live trees 5 inches d.b.h. and larger is at least 20 sq. feet (average minimum stocking for all types), determine cover type based on plurality of all live tree basal area by the species groups displayed below.

b. If the total basal area of all live trees 5 inches d.b.h. and larger *is* less than 20 sq. feet, determine cover type based on plurality of all live tree numbers per acre by the species groups displayed below.

c. If the-re are .not enough trees to calculate a cover type (i.e.·· nonstocked), the type will be set to UNCLASSIFIED. A forest type should be determined and entered into the Data Base by photointerpretation or on-the-ground inspection. Note that if the forest cover type is set to UNCLASSIFIED, the Stand Age is set to zero years old.

Forest Type	Included Tree Species
Spruce/fir	PIEN, ABLA, ABAR
White spruce	PIGL
Ponderosa pine	PIPO
Douglas-fir/WF	PSME, PIPU, ABCO
Jack pine.	PIBA
Pinyon/Juniper	PIED, JUSC plus others
Lodgepole pine	PICO
Whitebark pine	PIAL
Bristlecone pine	PIAR
Limber pine	PIFL
Other Softwoods	
Aspen ·	POTR
Cottonwood	POFR
Oak	QUGA or QUMA
Other Hardwoods	

Region 3

Step 1--Determine Forest Cover Type

a. If the total basal area of all live trees 5 inches d.b.h. and larger is at least 20 sq. feet (average minimum stocking for .all types), determine cover type based on plurality of all live tree basal area by the species groups displayed below.

b. If the total basal area of all live trees 5 inches d.b.h. and larger is less than 20 sq. feet, determine cover type based on plurality of all live tree numbers per acre by the species groups displayed below.

c. If there are not enough trees to calculate a cover type (i.e. nonstocked), the type will be set to UNCLASSIFIED. A forest type should be determined and entered into the Data Base by photointerpretation or on-the-ground inspection. Note that if the forest cover type is set to UNCLASSIFIED, the Stand Age is set to zero years old.

Forest Type	Included Tree Species
Spruce/fir	PIEN,ABLA
Engelmann spruce	PIEN
Douglas fir	PSME
White fir Blue	ABCO
spruce	PIPU
Bristlecone pine	PIAR
Ponderosa pine	PIPO
Limber pine	PIFL
SW white pine	PIST
Other softwoods	
Aspen	POTR POFR
Cottonwood	PIED,JUOS,JUMO
Pinyon-Juniper	QUGA,QUAR,QUEM
Oak woodlands	
Other Hardwoods	CUAR
Arizona cypress	JUOS,JUMO,JUSC
Juniper	PRGL
Mesquite	JUSC
Rocky Mt juniper	

Region 4

Step 1--Determine Forest Cover Type

a. If the total basal area of all live trees 5 inches d.b.h. and larger is at least 20 sq. feet (average minimum stocking for all types), determine cover type based on plurality of all live tree basal area by the species groups displayed below.

b. If the total basal area of all live trees 5 inches d.b.h. and larger is less than 20 sq. feet, determine cover type based on plurality of all live tree numbers per acre by the species groups displayed below.

c. If there are not enough trees to calculate a cover type (i.e. nonstocked), the type will be set to UNCLASSIFIED. A forest type should be determined and entered into the Data Base by photo interpretation or on-the-ground inspection. Note that if the forest cover type is set to UNCLASSIFIED, the Stand Age is set to zero years old.

Forest Type	Included Tree Species
Blue Spruce	PIPU
Red Fir	ABMA
Whitebark Pine	PIAL
White fir	ABCO
Western Larch	LAOC,LALY
Aspen	POTRS
Limber Pine	PIFL2
Bristlecone	PILO,.PIAR
Jeffrey Pine	PIJE
E.Spruce/S.A.Fir	PIEN,ABLA
Douglas Fir	PSME
Grand Fir	ABGR
Lodgepole Pine	PICO
E.Spruce	PIEN
Ponderosa Pine	PIPO
Pinyon/Juniper	PIED,PIMO,JUOC,JUOS,JUSC2
Ca.MX S.Alpine	PSME,LIDE,PILA
Sierra Mx Conf	TSME, ABLA
Subalpine Fir	ABLA
Juniper	JUOC,JUOS,JUSC2
Pinyon Pine	PIED,PIMO
Other Softwoods	
Other Hardwoods	

Step 2--Determine Stand-Size Class

Region 2

a. Qualified Trees here = Growing Stock Trees (Current Status = "L") for Timber Types and All Live Trees for Woodland Types (Current Status "W"). Minimum height for softwood seedlings is 3-inches: Minimum height for hardwood seedlings is 12-inches.

b. Does the stand have 10of Basal Area Average Maximum Density (BA AMD) from the Gingrich Stocking Curves (actually from the equations used to build the tables) in Qualified Trees 5.0-inches and larger?

If so, then the stand is SAWTIMBER, POLETIMBER, or WOODLAND

If the Forest Type is a woodland type, then WOODLAND stand-size is assigned.

If the Basal Area of Qualified Trees 9.0-inches and larger is greater than the Basal Area of Trees 5.0 to 8.9-inches, then the stand is MATURE.

If the Basal Area of Qualified Trees 5.0 to 8.9-inches is greater than the Basal Area of Trees 9.0-inches and larger, then the stand is POLES.

If the stand DOES NOT have 10 of the BA AMD for the calculated Forest Type, then it is either SEEDLING/SAPLING or NONSTOCKED. Calculations are based on STOCKABLE points (Not Status X) only.

Does the stand have 120 softwood trees per acre or 300 hardwood trees per acre? If so, then the stand-size class is SEEDLING/SAPLING.

If minimum stocking standards are not meet, then the site is NONSTOCKED.

If 30of the of the Stockable portion of the stand is noristocked (STATUS N), the stand is considered nonstocked.

Region 3

Calculate the basal area of all live trees = 5.0" DBH and larger for timber species (spruce,fir,pine, and aspen) or = 3.0" and larger DRC for woodland species. The basal area must meet or exceed minimum stocking levels by productivity classes for the forest cover type.

If the minimum basal area standards are met or exceeded, the following classes are assigned.

If the Forest Cover Type is spruce, fir, pine, or aspen and the Basal Area of Trees 9.0-inches and larger is greater than the Basal Area of Trees 5.0 to 8.9-inches, then the stand is MP URE

If the Forest Cover Type is spruce, fir, pine, or aspen and the Basal Area of Trees 5.0 to 8.9-inches is greater than the Basal Area of Trees 9.0-inches and larger, then the stand is IMMATURE

If the Forest Coyer Type is woodland and the Basal Area of Trees 9.0-inches and larger is greater than the Basal Area of Trees 3.0 to 8.9-inches, then the stand is WDLD 9"+ DRC.

If the Forest Cover Type is woodland and the Basal Area of Trees 3.0 to 8.9-inches is greater than the Basal Area of Trees 9.0-inches and larger, then the stand is WDLD 3-8" DRC.

If minimum basal area standards are not met for the calculated Forest Type, then it is either SEED/SAPS or NONSTOCKED. Calculations are based on STOCKABLE points (Not Status X) only.

Does the stand meet minimum stocking levels (trees per acre) by productivity classes for the forest cover type (F H)? If so, then the stand-size class is SEED/SAPS or WDLD SEED/SAPS depending on forest cover type.

If minimum stocking standards are not meet, then the site is NONSTOCKED.

If 30of the of the Stockable portion of the stand is nonstocked (STATUS N), the stand is considered nonstocked.

Region 4

Calculate the basal area of all live trees = 5.0" DBH and larger. The basal area must meet or exceed minimum stocking levels by productivity classes for the forest cover type.

.If the minimum basal area standards are met or exceeded, the following classes are assigned.

If the Forest Cover Type is spruce, fir, pine, or aspen and the Basal Area of Trees 9.0-inches and larger is greater than the Basal Area of Trees 5.0 to 8.9-inches, then the stand is SAWTIMBER

If the Forest Cover Type is spruce, fir, pine, or aspen and the Basal Area of Trees 5.0 to 8.9-inches is greater than the Basal Area of Trees 9.0-inches and larger, then the stand is POLETIMBER

If the Forest Cover Type is woodland and the Basal Area of Trees 9.0-inches and larger is greater than the Basal Area of Trees 3.0 to 8.9-inches, then the stand is WDLD 9"+ DRC.

If the Forest Cover Type is woodland and the Basal Area of Trees 3.0 to 8.9-inches is greater than the Basal Area of Trees 9.0-inches and larger, then the stand is WDLD 3-8" DRC

If minimum basal area standards are not met for the calculated Forest Type, then it is either SEED/SAPS or NONSTOCKED. Calculations are based on STOCKABLE points (Not Status X) only.

Does the stand meet minimum stocking levels (trees per acre) by productivity classes for the forest cover type (FSH)? If so, then the stand-size class is SEED/SAPS qr WDLD SEED/SAPS depending on forest cover type.

If minimum stocking standards are not meet, then the site is NONSTOCKED.

If 30% of the of the Stockable portion of the stand is nonstocked (STATUS N), the stand is considered nonstocked.

The confidence limits are for the average basal area as follows:

x + t (SE)

SO + 1.25 (3.87)

SO + 4.84 sq. ft

So it is 70 percent probable that the true mean of the stand lies between 45.16 and 54.84 square feet of basal area. This assumes that all measurements made at the point are 100 percent accurate.

Explanation of Page Type 5

Page Type 5 consists of summary data about the stand. The data on this page is what will be input to the District RMRIS data base (Refer to FSH 6609.21). This page type has two functions: first, to show what data will be entered into the data base, and second to provide one place to locate all the data needed to write a diagnosis. Refer to Exhibit 5 for data elements to be described on this page of the stand printout.

This page type should be reviewed. Any illogical or unsatisfactory data should be changed by updating the District RMRIS data base.

It is possible, as an option in the RMSTAND data entry program on the Data General computer system, to order copies of this Page Type 5 alone without all the rest of the printout.

A diagnosis for the stand should be written on this page at the bottom of the printout. This page then should be inserted into the proper location or site folder.

1. TIM PRODUCTIVITY

The potential cubic foot volume growth per year at culmination of mean annual increment for a fully-stocked, natural stand. See Site Productivity, Item 9 on Page Type 1 for a more involved explanation.

2. SITE INDEX

The average Site Index and Site Index Species is repeated from Page Type 1, Item 12.

3. TREE SURVEY TYPE

This code refers to the method or intensity of the stand examination. In older surveys and in RMRIS, this code is either Level 3 or Level 4. In later versions this code will be a "C" or "I" for Compressed and Intensive surveys.

4. TREE SURVEY DATE The year and month the data was collected.

EXHIBIT 11

Loc-Site 001021-0007 Reg 4 District 1301 Survey Date 9209 Acres 26 PAGE 5
****

R M R I S D A T A

TIM PRODUCTIVITY:	16		SITE INDEX PICO	24
TREE SURVEY METHOD:	C		BF SW:	6007
TREE SURVEY DATE:	9209		CUBIC SAW SW:	1021
DOMINANT SPECIES:	LP		CUBIC SAW HW:	0
VEG SIZE CLASS:	L		CUBIC POLE SW:	542
PCT NON STOCKED:	0		CUBIC POLE HW:	0
ORIGIN DATE:	1810		CUBIC CULL/WOODLAND:	0
QMD X 10:	52	92-5+)	CUBIC SOUND DEAD:	345
STAND HEIGHT:	SO		PCT DOWN SOUND DEAD:	0
BASAL AREA 1"+	82	73-5+)	HARD (SOUND) SNAGS:	12
TOTAL TREES 0"+:	2260	560-1+)	SOFT (ROTTEN) SNAGS:	0
LARGE TREES 5"+:	160		GROSS CUBIC GROWTH:	30
CONE SEROTINY:	0		CUBIC MORTALITY:	0
FREQUENT DAMAGE:	0	(NONE		
MISTLETOE (DMR):	.0		BEETLE RISK:	0

L I V E T R E E B A S A L & T R E E S X S P E C I E S & D B H

	FIR	SPR	PP	OP	LP	DF	AS	OH	OS	FIR	SPR	PP	OP	LP	DF	AS	OH	OS
DBH	BAA									TREES								
0	0	0	0	0	0	0	0	0	0	300	0	0	600	500	0	0	0	300
1-4	0	0	0	7	2	0	0	0	0	0	0	0	300	100	0	0	0	0
5-8	0	0	0	0	27	0	0	0	0	0	0	0	0	84	0	0	0	0
9-15	0	0	0	13	27	0	0	0	0	0	0	0	24	49	0	0	0	0
16-20	0	0	0	0	7	0	0	0	0	0	0	0	0	3	0	0	0	0
21+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1+	0	0	0	20	62	0	0	0	0	0	0	0	324	236	0	0	0	0

SDI	AGE	MAI	PAI	AMD	100%	40%	60%	%AMD	STRUCTURE STAGE	ELK
196	182	9	30	254		101	152	32%	4A Mature	MB

W R I T E I N D I A G N O S I S - Stand Condition

Habitat Type: Growth Comment: Density:

Structure: Composition: Condition:

Arrangment: Fuel Loading: Other:

NET Cubic Volume of Growing Stock 1563. (Min. DBH 5.0 Min. DIB 4.0)
NET Scrib Volume of Growing Stock 6007. (Min. DBH 7.0 Min. DIB 6.0)

% Nonstocked .0 % Nonstockable = .0

MET C SAM 3 LIN 27 BA20 FP300 LFP 0 SFP 0 GP 0 DBA 0 DFP 0 BDB50 BDR30

END OF PAGE - INDIVIDUAL STAND RUN 6- 4-1993 Rev# 5.00.01

34. SDI

Stand Density Index (Reinecke's) of all live trees over 1.0 inch d.b:h. Stand Density Index is calculated as follows:

$$SDI \quad TREES(1+) \times (QMD / 10)^{1.6}$$

35. AGE Average age of the stand based on Origin Age, Item 8 above.

36. MAI

Mean Annual Increment here is based on the NET CUBIC volume of the stand divided by the stand AGE. It is a measure of the average annual cubic foot growth that this particular stand has achieved through its life. The cubic foot volume standards used to determine MAI do vary (5.0 inches and larger here), so be aware. The NET CUBIC foot volume is displayed below in the Standard Footer lines along with the minimum size specifications. Thus:

MAI = NET CUBIC / AGE

37. PAI

Periodic Annual Increment is the yearly cubic foot growth rate the stand is now experiencing based on Radial Growth measurements. It is a net value here. PAI here can be calculated by subtracting Cubic Mortality, Item 28 from Gross Cubic Growth, Item 27. The calculation is also repeated from Item 21 in Page Type 2. The calculation is based on trees over 5.0-inches in d.b.h. in the example of Exhibit 5 as this is the minimum d.b.h. standard listed in the footer line.

In order to smooth out year-to-year variations in growth due to climatic conditions; Periodic Annual Increment is usually calculated as the average over a short period of time, usual).y 10 years. Thus:

PAI = (Cubic Feet, Year 10 - Cubic Feet, Year 0) / 10 Years

In general, if PAI is greater than MAI, then the stand has not reached culmination of mean annual increment (CMAI) and is thus immature. Regeneration harvests should not be planned until a stand has passed CMAI.

If PAI is a negative number, then it is an indication that mortality is truly rampant in the stand. This type of stand should be a primary candidate for some sort of management treatment.

When the present growth rate of the stand equals the mean annual increment of the stand, then it will have reached CMAI.

Timber Productivity (Item 1 above) is different than the growth shown in the Gross-Growth (Item 19, Page Type 2), MAI, and PAI calculations. Growth here is calculated from the growth trees measured in the stand. This growth represents what THIS STAND IS DOING. Timber Productivity is calculated from Site Tree data and therefore represents what the SITE has the POTENTIAL OF GROWING. Be aware of the difference.

38. AMD 100%

This is the Average Maximum Density projected for this stand based on the Regional *Gingrich* Stocking Curves. The figure is the average maximum density reported in square feet of Basal Area per Acre.

39. 40%

This is the Basal Area at 40 of Average Maximum Density from above. This 40 JI.MD is typically considered to be the "Lower Limit of Management Zone", or LLMZ, for a fully-stocked site. If stand basal area *is* below this LLMZ, then site occupancy by the stand *is* lost and regeneration will occur or invasion by competing vegetation will result. In reality, the specific site conditions (aspect, elevation, species, etc.) control what level of stocking is the LLMZ.

40. 60%

This is the Basal Area at 60of Average Maximum Density from above. This 60% AMD is typically considered to be the "Upper Limit of Management Zone", or ULMZ, for a fully-stocked site. If stand basal area is above this ULMZ, the stand is overstocked. Overstocking results in increased mortality and suppression. In reality, the specific site conditions (aspect, elevation, species, ect.) control what level of stocking is the ULMZ.

41. %AMD

This is the current stands percentage of Average Maximum Density. It's simply the Basal Area 1"+ from Item 11 divided by the AMD 100% basal area listed in Item 38.. The percent tells the user relatively how dense the stand is.

Ideally, the manager should be controlling the stocking of his stands through commercial or precommercial thinnings. The site should have enough trees or basal area to fully occupy the site. Too many trees results in excessive competition. Stocking ideally should be maintained between 40% and 60of AMD.

This concept is also used in Stand Density Index (SDI, Item 34). The theory is based on Langsaeter's Curves of tree population interactions. Both SDI and Gingrich Curves are intended to measure the RELATIVE DENSITY of the stand.

42. STRUCTURE STAGE

Wildlife Structural Stage partly describes the vegetation which makes up the wildlife habitat. The code assigned is a two-digit alphanumeric such as "2" or "3a". This value is input to the RMRIS database. Structural stage is usually defined by the stand-size class, stand age, crown cover percent, and old growth score.

Region 2 Calculations

In order to calculate the structural stage class automatically, RMSTAND uses Stand-Size Class (Item 6) and Percent of Average Maximum Density (Item 41) to assign a code. If the Stand-Size class is sawtimber, then a "4 Mature" is assigned. If the stand is poletimber sized, then a "3 Sapling/Pole" is assigned. If the stand-size class is seedling/sapling and more than 200 saplings per acre are found, then the class "3 Sapling/Pole" is assigned. If 200 saplings per acre are not present, then RMSTAND assigns "2 Seed1ing/Shrub". Finally, if the stand-size class is nonstocked, a "1 Grass/Forb" class is assigned.

Classes 3-Sapling/Pole and 4-Mature are each broken down into three crown closure classes denoted by letters "a", "b", and "c". Percent of AMD is used as a substitute for crown closure percent. Thus:

% AMD	Stage Letter
0 to 39%-	A
40 to 59%-	B
60%- +	C

A "5-0ld Growth" structural stage is not calculated by RMSTAND at the time of writing. Further research is ongoing into the definition of Old Growth in Region 2. To assign the old growth classification, use an Old Growth Scorecard and input to code into RMRIS as part of the Header Sheet, R2-2410-7a.

The structure stage code determined on the Header Sheet, R2-2410-7a, will override the automatic calculation if necessary for accuracy. The user should refer to Page 21 of the "Standard Specifications For Stand Exam" and to the publication "Managing Forested Land For Wildlife" for further and detailed information concerning wildlife structural stages.

Region 3 Calculations

See Appendix A

The final portion of the Page Type 5 printout is a workspace for preparing a stand diagnosis. The headings will provide for a somewhat consistent format for the diagnosis.

Explanation of Page Type 6

Page Type 6 presents another view of stand conditions. See Exhibit 6 for an example. Stand data is grouped by the following age classes; SEED/SAPS, YOUNG FOREST, MID-AGE FOREST, MATURE FOREST, AND OLD GROWTH. This page introduces MAX SDI FOR TYPE. Appendix — further explains both MAX SDI FOR TYPE and Page Type 6.

EXHIBIT 6

Lac-Site 001021-0007 Reg 4 District 1300 Survey Date 9209 Acres 26 PAGE 6
****

********** VEGETATIVE STRUCTURAL STAGE **********
Note: SDI for STRUCTURE STAGE is a summation of SDI by 1" diameter classes
SDI shown on PAGE 5 is based on tree of avg diameter (QMD) for stand
SDI is based on all live trees 1"+ dbh in all calculations
****

FOREST COVER TYPE LP MAX SDI FOR TYPE 700.0
STAND SITE INDEX= 24. STAND SDI 167.2
% SDI OF MAX SDI 23.88

	********** STRUCTUCLASSES **********					
	(1) GRASS FORBS	(2) SEED/ SAPS	(3) YOUNG FOREST	(4) MID-AGE FOREST	(5) MATURE FOREST	(6) OLD GROWTH
BEGIN CLASS DBH	.0	1.0	5.0	12.0	18.0	10.0
REQUIRED TREES						20.0
# TREES IN CLASS		400.0	156.6	.0	3.1	48.9
BA FOR CLASS		8.7	66.7	.0	6.7	
QMD OF CLASS		2.0	8.8	.0	19.7	
SDI IN CLASS		30.5	127.4	.0	9.3	
% SDI IN CLASS		18.22	76.20	.00	5.58	

STRUCTURE STAGE 3ASS

STAND DENSITY INDEX RATING

* POINTS	DIAMETER GROUPS 1- 4.9	5-11.9	12-17.9	18-23.9	24+ *
# TREES	400.0	156.6	.0	3.1	.0
BA	8.7	66.7	.0	6.7	.0
QMD	2.0	8.8	.0	19.7	.0
SDI	30.5	127.4	.0	9.3	.0
%SDI	18.2	76.2	.0	5.6	.0
TOTJI 3					
LT 15%-SDI 0					

SDI RATING 00.28010.24

GROSS Cubic Volume of Growing Stock 0. (Min. DBH: .0 Min. DIB .0)
GROSS Scrib Volume of Growing Stock 0. (Min. DBH .0 Min. DIB .0)

% Ncinstocked .0 % Nonstockable .0

MET C SAM 3 LIN 26 BA20 FP300 LFP 0 SFP 0 GP 0 DBA 0 DFP 0 BDBSO BDR30

END OF PAGE - INDIVIDUAL STAND RUN 6-16-1993 Rev# 5.00.01

5. **Patrick D. Jackson, 2000, "Vegetative Structural Stages Calculations as Calculated by RMSTAND". U.S. Department of Agriculture – Southwestern Region Forest Service, Internal publication.**

Vegetative Structural Stage Calculations
As Calculated by RMSTAND
March 2000 (updated 8/10/2005)

The Vegetative Structural Stage (VSS) rating system for Region 3 was developed in 1991. The basis for the VSS class was the research by Jack Ward Thomas in Oregon. As described by Thomas, VSS was applicable to evenaged stands only.

In the original version, forest cover types were grouped into 6 categories of similar growth conditions. Each category could have different diameter breaks for each of the 6 classes of vss. VSS class 6 (Old Growth) was a subset of class 5 and was only assigned if the proper number of trees of the correct diameter range was found; the condition being based on the site index of the site.

Table 1
Vegetative Structural Stages Classes by Forest Cover Types
Original Diameter and Cover Type Groupings

Cover Types	1 Grass/Forbs/ Shrubs	2 Seedlings/ Saplings	3 Young Forest	4 Mid-Aged Forest	5 Mature Forest	6 Old-Growth
1. Ponderosa Pine, Southwestern White Pine, Misc Softwoods	0 – 0.9"	1.0 – 4.9"	5.0 – 11.9"	12.0 – 17.9"	18.0"+	High – 20 trees 18"+ Low – 20 trees 14"+
2. Blue Spruce, Douglas Fir, White Fir, Limber Pine, Bristlecone Pine	0 – 0.9"	1.0 – 4.9 "	5.0 – 11.9"	12.0 – 17.9"	18.0"+	High – 16 trees 20"+ Low – 12 trees 18"+
3. Engelmann Spruce-Subalpine Fir, Engelmann Spruce	0 – 0.9"	1.0 – 4.9"	5.0 – 11.9"	12.0 – 17.9"	18"+	High – 30 trees 14"+ Low – 20 trees 10"+
4. Aspen, Cottonwood, Willow, Misc Hardwoods	0 – 0.9"	1.0 – 2.9"	3.0 – 7.9"	8.0 – 11.9"	12"+	Not defined
5. Pinyon-Juniper, Juniper, Rocky Mtn Juniper	0 – 0.19"	0.2 – 2.9"	3.0 – 5.9"	6.0 – 8.9"	9"+	High – 30 trees 12"+ Low – 12 trees 9"+
6. Gambel Oak, Mesquite	0 – 0.19"	0.2 – 2.9"	3.0 – 4.9"	5.0 – 6.9"	7"+	Not defined

In 1998, changes were made to VSS that did away with the Old Growth determinations. VSS class 6 was re-defined to Old Forest and was set for trees that were 24 inches or greater in diameter. VSS class 5 diameter range was changed to 18 – 23.9". All cover types were evaluated on the same diameter breaks.

The biggest change was that a new VSS rating was added for uneven-aged stands, called ***unev***. Even-aged stands were determined based on the distribution of the basal area. For a stand to be called even-aged, sixty percent or more of the stand basal area had to be found in an eight inch diameter class. This 8 inch diameter class is a moving range; the program calculates the basal area in the 0-7.9 inch range, then the 1.0-8.9 range, then the 2.0-9.9 range, etc., to the final range of 24-99.9 inches. If 60% or more of the stand basal area is found in any diameter class, the stand is called even-aged. If no 8 inch class has at least 60% of the stand basal area, the stand is then called Uneven-aged and the VSS rating is set to UNEV.

Table 2
Vegetative Structural Stages Classes by Forest Cover Types
Diameter and Cover Type Groupings as Modified in 1998

Cover Types	1 Grass/Forbs/ Shrubs/ Seedlings	2 Saplings	3 Young Forest	4 Mid-Aged Forest	5 Mature Forest	6 Old- Forest
1. Ponderosa Pine, Southwestern White Pine, Misc Softwoods	0 – 0.9”	1.0 – 4.9”	5.0 – 11.9”	12.0 – 17.9”	18.0 – 23.9”	24”+
2. Blue Spruce, Douglas Fir, White Fir, Limber Pine, Bristlecone Pine	0 – 0.9”	1.0 – 4.9 “	5.0 – 11.9”	12.0 – 17.9”	18.0 – 23.9”	24”+
3. Engelmann Spruce-Subalpine Fir, Engelmann Spruce	0 – 0.9”	1.0 – 4.9”	5.0 – 11.9”	12.0 – 17.9”	18.0 – 23.9”	24”+
4. Aspen, Cottonwood, Willow, Misc Hardwoods	0 – 0.9”	1.0 – 4.9”	5.0 – 11.9”	12.0 – 17.9”	18.0 – 23.9”	24”+
5. Pinyon-Juniper, Juniper, Rocky Mtn Juniper	0 – 0. 9”	1.0 – 4.9”	5.0 – 11.9”	12.0 – 17.9”	18.0 – 23.9”	24”+
6. Gambel Oak, Mesquite	0 – 0.9”	1.0 – 4.9”	5.0 – 11.9”	12.0 – 17.9”	18.0 – 23.9”	24”+

This change inadvertently resulted in some cover types never being able to be rated as old-forest (VSS 6) and, in some cases, even mature forest (VSS 5).

On February 3, 2000, Bryce Rickel and Keith Fletcher, R3 Wildlife Staff, and John Shafer and Pat Jackson, R3 Forestry Staff, met to discuss changes to the VSS rating system. It was agreed that changes were necessary in order for some of the cover types to be rated properly.

It was also agreed that the original grouping of cover types could be modified into different groupings that shared similar in characteristics. The original 6 cover type groups were re-arranged into 4 groups. It was agreed at this meeting that VSS numbers should still be applied to even-aged stands only with uneven aged stands receiving a VSS of UNEV. ***It was also agreed that all references to age should be deleted from the system since it is based on diameters, not age. Different species and different site productivity will result in trees reaching a given diameter class at various ages and stages of maturity, so references to maturity are removed. It is important to note that VSS 6 does not equate to old growth since it does not account for all the required elements of old growth, like snags, down logs, decadent trees or patch dynamics***.

Results of this meeting are shown in Table 3.

Table 3
Vegetative Structural Stages Classes by Forest Cover Types
Diameter and Cover Type Groupings as Modified 3/2000

Cover Types	1	2	3	4	5***	6
1. Ponderosa Pine, Southwestern White Pine, Misc Softwoods, Douglas Fir, White Fir, Limber Pine, Engelmann Spruce-Subalpine Fir, Engelmann Spruce, Blue Spruce, Bristlecone Pine, Corkbark Fir, Aspen	0 – 0.9"	1.0 – 4.9"	5.0 – 11.9"	12.0 – 17.9"	18.0 – 23.9"	24"+
2. Cottonwood, Arizona Cypress, Gambel Oak (tree form*)	0 – 0.9"	1.0 – 4.9"	5.0 – 9.9"	10.0 – 14.9"	15"+	N/A
3. Willow, Misc Hardwoods, Gambel Oak (shrub form**)	0 – 0.9"	1.0 – 2.9"	3.0 – 4.9"	5.0 – 6.9"	7"+	N/A
4. Pinyon-Juniper, Juniper, Rocky Mtn Juniper	0 – 0. 9"	1.0 – 2.9"	3.0 – 4.9"	5.0 – 10.9"	11"+	N/A

* Gambel Oak tree form exists on the following Forests in R3:	** Gambel Oak shrub form exists on the following Forest in R3:	*** For Forest Cover Type groups 2, 3 and 4, VSS There are only 5 VSS classes.
- Apache-Sitgreaves - Cibola (Magdalena & Mt. Taylor districts only) - Coconino - Coronado - Gila - Kaibab (south districts) - Lincoln - Prescott - Tonto	- Carson - Cibola (except the Magdalena and Mt. Taylor districts) - Kaibab (North Kaibab district) - Santa Fe	

Each VSS class is accompanied by the letter A, B, or C, to indicate **canopy density category**. The canopy density category is based on ***stand density index*** value for the stand and the percent of maximum SDI the stand contains. The following is a breakdown of that canopy density category:

A- open	less than 25% of maximum SDI for the designated covertype (see table below)
B- mod closed	between 25-47% of maximum SDI for the designated covertype (see table)
C- closed	greater than 47% of maximum SDI for the designated covertype (see table)

Species	SDI_{max}
White fir	830
Douglas-fir	595
Ponderosa pine	450
Oak woodland	460
Pinon-Juniper	465
Misc. Softwoods	450
Misc. Hardwoods	400
Juniper Woodland	344

An SDI_{max} of 450 for stands classified as ponderosa pine means that a maximum of 450 10-inch trees can exist on a site regardless of site productivity. Any further addition of trees above this maximum value means that trees will die as a result of tree-to-tree competition. The SDI_{max} value is larger for shade tolerant species such as the firs. The smaller the SDI_{max} value, the more seral or shade intolerant the tree species.

1/3/2003 – Because VSS ratings have been incorporated into various Forest Plans and the MSO guidelines, Forest and District users have asked that RMSTAND calculate a VSS class for all stands regardless if they are even aged or uneven aged. With the release of RMSTAND version 2002.9.25, RMSTAND will assign a VSS class to all stands. For stands that are uneven aged, the program will output a warning that the stand is uneven aged and VSS may not be the best method to determine structural stage.

6. **Stephanie A. Rebain, 2009, "FVS VSS post processor". U.S. Department of Agriculture – Forest Management Service Center, Forest Vegetation Simulator, E-mail correspondence.**

From: Stephanie A Rebain/WO/USDAFS
Sent: Tuesday, November 17, 2009 11:18 AM
To: Norman Thornton
Subject: Re: FVS VSS post processor

Norman,

We should definitely read the *.out file because if users have their input data in a database, the *.key file isn't going to have some of the fields listed below, such as Stdlnfo and SiteCode.

SiteCode/Site Index This should be read from the Options Selected by Default section. (see notes below)

'Stdident' This can be read from the Options Selected by Input section of the *.out file.
'Stdlnfo' This can be read from the Options Selected by Default section of the *.out file.
'Process ' If this is just to determine when one stand is done and another starts, we might need a new way to decide this.

The only tricky part I see is the reading of site index. This is what the output looks like in the Options Selected by Default section of the *.out file:

```
SITECODE SITE INDEX INFORMATION:
WB= 45.; LM= 45.; DF= 45.; __= 45.; __= 45.; AS= 45.; LP= 45.; ES= 45.; AF= 45.;
  __= 45.; OT= 45.
SITE SPECIES=DF CODE= 3
```

We list a site index for every species in the variant. So you need to look at the site species (in this case DF for Douglas-fir) and then go back up and read that the site index for DF is 45. In this case all the species are 45 but in many cases each species will get a different site index.

Let me know if you have any questions. Steph

Stephanie Rebain
USDA Forest Service
Forest Management Service Center- FVS Group phone: (970) 295-5793
FVS helpdesk: (970) 295-5770

7. **Stephanie A. Rebain, 2010, "VSS calculations". U.S. Department of Agriculture – Forest Management Service Center, Forest Vegetation Simulator, E-mail correspondence.**

From: Stephanie A Rebain/WO/USDAFS
Sent: Thursday, October 07,2010 10:05 AM
To: Georgi Porter
Subject: Re: VSS calculations

Georgi,

We need the FVS VSS post processor program to be updated. Here is the list of known problems:

1 - The code needs to be updated to include the expanded Central Rockies species list
2 - The code needs to be updated to include the expanded Utah species list
3 - The code needs to be updated to include the expanded Tetons species list
4 - The code currently reads site index, StandID, the Region number, and the Process keyword from the *.key file.
    - This won't work if data is read in from a database since some of this information won't be in the *.key file. These attributes should be read in from the *.out file instead.
5 - The program needs to be expanded to handle R4 cover types not originally included, such as lodgepole pine. The latest Central Rockies variant has 38 species instead of 24. The latest Utah variant has 24 species instead of 14. The latest Teton variant has 18 species instead of 8.

Thanks, and let us know if you have any questions,
Steph

Stephanie Rebain
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Forest Management Service Center- FVS Group
phone: (970) 295-5793
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From: Georgi Porter/R3/USDAFS
Sent: Tuesday, October 05,2010 11:06 AM
To: Stephanie A Rebain
Subject: VSS calculations

Hi Stephanie

It has come to our attention that due to my request to have FSVeg look at how they calculate VSS (there were some discrepancies between RMSTAND and FSVeg reports) that you may have requested some information from Norman or myself. I apologize for any possible miscommunication, what is it you need form us?

Georgi