National Forest Planning and Sustained Yield of the Timber Resource

Long-Term Sustained-Yield Calculations for Forest Land and Resource Management Planning

"The days have ended when the forest may be viewed only as trees and trees viewed only as timber. The soil and the water, the grasses and the shrubs, the fish and the wildlife, and the beauty of the forest must become integral parts of the resource manager's thinking and actions."

Hubert Humphrey 1976

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James A. Youtz, Regional Silviculturist
USDA, Forest Service, Southwestern Region

Don Vandendriesche, Forest Biometrician
USDA Forest Service, Washington Office, Forest Management Service Center

Introduction

This paper was developed to address several issues around the concept of sustained yield as it relates to timber management planning during the forest planning process. As Forests conduct forest plan revision, numerous questions and issues have arisen in discussions concerning the concept of sustained yield, the Long-term Sustained Yield Capacity (LTSYC) and timber management planning. There appear to be three issue areas that need further clarification:

- What is the significance of the sustained yield estimate required by the National Forest Management Act (NFMA– 16 U.S.C. 1600) and Multiple Use Sustained Yield Act (MUSYA– 16 U.S. C. 528)?
- What's the relationship between the LTSYC and a Forest Plan's Allowable Sale Quantity (ASQ)?
- What assumptions and considerations should be used when estimating LTSYC?

The Legal Requirements for LTSYC on NFS Lands, in Perspective

The relevant citations from statutes and regulations have been compiled to serve as references for the discussions and can be found in Attachment A.

There are different perspectives on the importance of the LTSYC estimate in the planning process. Some feel it's a relatively insignificant number that Forests will never be expected to achieve. Others think of LTSYC as a safeguard established in a Forest Plan to prevent Forests from cutting too much timber. This view implies a minimum amount of analytical rigor in order to develop a realistic and conservative estimate of the LTSYC. Some feel that sustained-yield is a concept that needs a comprehensive analysis in the Forest Planning process especially if a Forest is addressing significant issues about the forest vegetation management program.

Sustained yield forestry is a concept that has been around for centuries, originating the conceptual framework for establishment of the forestry profession as a scientific field. In this country, the MUSYA designated authority to establish Sustained-Yield Units within the National Forests. The purpose of the Act was:

- to stabilize communities, forest industries, employment, and taxable forest wealth;
- to assure a continuous and ample supply of forest products; and
- to secure the benefits of the forest in the regulation of water supply and stream flow, prevent soil erosion, amelioration of climate and preservation of wildlife"

The language in NFMA, Multiple Use Sustained-Yield Act of 1960 (MUSYA) places great importance on sustained yield as it relates to forest management and on sustained yield levels of timber products. The definition of "sustained yield" found in MUSYA and referenced by NFMA includes the phrase "achievement and maintenance". NFMA includes a separate discussion of the conditions under which a Forest might want to consider departing from the sustained yield level and harvest above that amount in order to achieve other multiple-use (non-timber) objectives.

From the statute language, it is apparent that Congress felt the determination of a sustained yield level of timber was intended to be a meaningful estimate in Forest Plans. There is no mention in the statutes of sustained yield levels being used as a safeguard or to be set at such a high level that it was meaningless when implementing the Forest Plan. Indeed, departures above the sustained yield level

must be justified in the context of benefiting multiple-use management. Congress would not have included this requirement in the statute unless they felt the sustained yield level of timber outputs was a meaningful estimate.

The National Forest Management Act, commonly called NFMA, is the basic law that guides land management planning on national forests and grasslands. Congress enacted NFMA in 1976 and, like all laws; it is a product of the social and political issues at that time. Beginning in the 1950s, the USDA Forest Service was called upon to provide large amounts of wood products for the marketplace and did so, using industrial forest management techniques that emphasized maximum production. As harvest levels increased over the decades, Congress and members of the public became increasingly concerned about the impacts of intensive forest management on the national forests. NFMA was enacted in response to those public concerns, most notably concerns associated with clearcutting. Consequently, the law has numerous specific timber management requirements that focus on the appropriate regulation of timber harvest practices, especially clearcutting.

The political environment and social values have substantially changed since NFMA was enacted, and the first rounds of land management plans were completed in the 1980s. The largely utilitarian views of the 1950s have given way to a more balanced and integrated view of national forest management. Timber harvest may be considered a resource use (as described in NFMA) or a tool (an activity to improve or restore healthy forest conditions). The agency now focuses land management plans on desired conditions (outcomes) rather than production of goods and services (outputs). This change in national forest management emphasis profoundly affects how the agency presently analyzes NFMA required timber harvest suitability and long term sustained yield capacity.

Timber Production Suitability Analysis

NFMA requires the agency to determine the suitability of national forest system lands for timber production, and has specific requirements for timber suitability analysis in land management plans. The agency makes a distinction between timber harvest as a resource use (timber production) and timber harvest as a management tool to achieve desired conditions. The general analysis process first identifies lands tentatively suitable for timber production:

1. Screens are applied to identify lands not suitable for timber production:

    a. Lands that cannot grow trees;
    b. Lands where current timber harvest technology would cause permanent damage to the natural environment;
    c. Lands where it's uncertain that the area can be successfully reforested after harvest;
    d. Lands that are excluded from harvest by law, by the Secretary of Agriculture, or the Chief of the Forest Service, and;
    e. Lands where trees are present, but commercial timber harvest is not economically possible (e.g., lands with volume growth less than 20 cubic feet per acre, lands with no commercial tree species present).

2. Forest lands that remain after this screening are termed "lands tentatively suitable for timber production." This classification does not vary by Forest plan alternative.

3. “Lands suitable for timber production” may be a sub-set of “tentatively suitable lands”, and may vary by Forest plan alternative. Analysis of alternatives allows the Responsible Official to identify where timber production is compatible with the desired conditions resulting from the land management planning process. The timber production objective is defined as growing, tending, harvesting, and regenerating crops of trees on a regulated basis to produce logs or other products for industrial or consumer use [1982 rule provisions section 219.16]. Identify lands as “Suitable for Timber Production” if meeting and sustaining desired conditions and objectives would involve planned, periodic timber harvest activities and also include planned regeneration of the stand. Timber production may not be a key management objective for the area. However, if periodic forest harvest and regeneration would be either be consistent with or necessary for achieving and maintaining land management goals and desired conditions (fuels conditions, wildlife habitat, etc…), these lands should be classified as suitable for timber production. Designation of “Lands Suitable for Timber Production” does not imply that management will be focused on maximizing timber yields, only that periodic harvests are expected to occur as a tool for meeting land condition outcomes.

4. “Lands not suitable for timber production” are determined through the Forest plan analysis of alternatives process. These are lands where periodic timber harvest is unpredictable, unnecessary, or undesirable to achieve management goals, but harvest is permitted where necessary to achieve plan or project-level resource objectives. Timber harvest is not scheduled as a periodic activity on these lands, and LTSYC and ASQ calculations do not apply.

Long Term Sustained Yield Capacity (LTSYC) Analysis

Lands designated as suitable for timber production provide the base for calculating the LTSYC of the Forest. These lands can either be designated by mapping or they can be expressed as a percentage of the lands classed as “Tentatively Suitable for Timber Production.” The latter approach should recognize that within larger areas that are classed “Suitable for Timber Production”, there are may be scattered inclusions of areas that are more appropriately managed as “Unsuitable for Timber Production” lands.

Questions have arisen about whether LTSYC estimates should incorporate other multiple use considerations, whether it is an estimate based only on existing inventory data or whether it should represent the highest potential yield from a Forest. Each of these methods could result in a substantially different LTSYC estimate for a given Forest. In MUSYA and NFMA, the language consistently places timber management in the context of other resource objectives and considerations. There are no references or inferences to considering the timber management program from a functional perspective. Analyzing the sustained yield level of timber, therefore, should include consideration of other resources as mentioned in NFMA; “…outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness” in the context of achievement and maintenance of desired conditions.

NFMA requires the Agency to estimate in the land management plan, the amount of commercial wood products that may be sustainably harvested over a long period. This sustainable harvest estimate assumes that lands are already in their desired condition. In reality, most forest lands are not in a desired condition so planners use mathematical models to estimate sustainable harvest levels. Short-term harvest levels on lands where timber production is a regular, predictable activity would tend to steadily increase or decrease until those lands are at a desired condition and then remain steady around that level.

Southwestern Region Approach to LTSYC Analysis

Desired conditions (and their contributions to social, economic and ecological sustainability) are the vision that drives the Forest plan revision and implementation process; for example, see the following sample of citations describing the 1982 Planning Rule procedures taken from "National Forest System Land and Resource Management Planning," 36 CFR § 219 (1999):

Sec 219.11: "Forest Plan Content. The Forest Plan shall contain the following…Forest multiple-use goals and objectives that include a description of the desired future condition of the forest or grassland…."
Sec 219.1 "Purpose and principles.

- (a)(1) "The resulting plans shall provide for multiple use and sustained yield of goods and services from the National Forest System in a way that maximizes long term net public benefits in an environmentally sound manner."
- (b)(1) "Establishment of goals and objectives for multiple-use and sustained-yield management of renewable resources without impairment of the productivity of the land;
- (b)(2) "Consideration of the relative values of all renewable resources, including the relationship of nonrenewable resources, such as minerals, to renewable resources;
- (b)(3) "Recognition that the National Forests are ecosystems and their management for goods and services requires an awareness and consideration of the interrelationships among plants, animals, soil, water, air, and other environmental factors within such ecosystems;
- (b)(4) "Protection and, where appropriate, improvement of the quality of renewable resources…."

Based upon this direction, the Southwestern Region has adopted a Regionally-consistent set of desired condition visions for all Potential Natural Vegetation Types (PNVTs). Due to these common desired condition visions, it is reasonable to analyze LTSYC in a consistent fashion for all Forests in the Southwestern Region. *These LTSYC calculations are not applicable to Forest plan alternatives that differ from the Regionally-consistent desired conditions. When planned desired conditions vary significantly from the Regional standard desired conditions, a new LTSYC analysis should be prepared.* The following assumptions were used as the basis for LTSYC analysis:

<u>LTSYC calculations are based upon uneven-aged forest management systems for the following forest PNVTs</u>:

1. Ponderosa pine (PP) and its sub-types (PP-Grass, PP-Gambel oak, PP-Evergreen oak)
2. Dry (frequent-fire) mixed conifer (assumes management favors retention of shade intolerant species)
3. Wet (infrequent-fire) mixed conifer (assumes management favors retention of wind-firm species; Douglas-fir, Southwestern white pine)
4. Spruce-fir mix (assumes management favors retention of wind-firm species; Douglas-fir, Southwestern white pine)

The uneven-aged management strategy assumed for analysis:

- group selection cutting
- 30-year cutting cycle, 6 age classes (180-year mature group age), group/patch sizes increase by PNVT , as forest conditions become progressively more mesic
- target matrix density varies by PNVT

LTSYC calculations are based upon an even-aged forest management system for the Spruce-fir (pure) forest PNVT:

- establish even-aged regeneration (natural and/or artificial)
- clear-cutting or patch-cutting (with or without reserves), uneven-aged management is not suitable due to silvics of Engelmann spruce
- rotation age at or after culmination of mean annual increment (CMAI)

Analysis Methods:

- Region-wide Forest Inventory Analysis (FIA) plot data, sorted by PNVT and site index
- Forest Vegetation Simulator (FVS) – Regionally calibrated:
    - Mortality
    - Growth
    - Seen defect
    - Merchantable cubic feet volumes (5”+ dbh, 4” minimum top dib)
    - Merchantable board feet volumes (9”+ dbh, 6” minimum top dib)

Ponderosa Pine Forest (PP/Grass PNVT)

FVS SIMULATION: PP-G_l_E_Y (Ponderosa pine/grass forest type, low site group, SI<70)
SIMULATION DONE: 02-24-2011 14:13:08

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	86	425	83	174	68	46	7.6	1488	1169	4905	348	568	431	1381	46	82	36	43	10.5	10	29	1	13.7
2019	96	258	59	126	45	46	6.4	1204	979	4799	0	0	0	0	59	126	45	46	6.4	10	35	1	14.4
2029	106	257	76	155	59	50	7.3	1543	1238	6144	0	0	0	0	76	155	59	50	7.3	10	35	1	15.4
2039	116	262	92	183	71	54	8.1	1875	1494	7494	152	690	537	2566	55	100	41	43	10.8	10	30	1	16.2
2049	126	268	69	146	51	47	6.9	1475	1187	6114	0	0	0	0	69	146	51	47	6.9	10	34	2	16.6
2059	136	271	85	173	65	51	7.7	1799	1441	7326	0	0	0	0	85	173	65	51	7.7	10	33	3	17.2
2069	146	270	100	197	76	54	8.3	2109	1686	8541	181	831	645	2973	55	98	40	44	10.7	10	27	2	17.6
2079	156	255	66	140	48	49	6.9	1531	1244	6616	0	0	0	0	66	140	48	49	6.9	10	32	3	17.7
2089	166	254	81	165	61	53	7.6	1824	1467	7786	0	0	0	0	81	165	61	53	7.6	10	31	3	17.9
2099	176	253	95	188	72	56	8.3	2102	1687	8938	169	776	598	2916	54	96	38	44	10.9	10	24	3	18.0
2109	186	250	64	136	46	48	6.8	1536	1249	6917	0	0	0	0	64	136	46	48	6.8	10	28	4	17.8
2119	196	250	78	159	58	52	7.5	1783	1433	7899	0	0	0	0	78	159	58	52	7.5	10	28	5	17.7
2129	206	248	91	180	69	55	8.2	2019	1620	8808	162	682	522	2623	54	97	39	43	10.8	10	22	4	17.7
2139	216	252	64	136	46	47	6.8	1515	1235	6856	0	0	0	0	64	136	46	47	6.8	10	28	5	17.5
2149	226	251	77	158	58	51	7.5	1738	1398	7692	0	0	0	0	77	158	58	51	7.5	10	28	6	17.3
2159	236	250	90	179	68	54	8.1	1957	1566	8478	166	656	498	2449	54	95	38	43	10.9	10	21	5	17.3
2169	246	250	63	134	45	47	6.8	1464	1192	6647	0	0	0	0	63	134	45	47	6.8	10	27	6	17.0
2179	256	249	76	156	57	50	7.5	1675	1346	7400	0	0	0	0	76	156	57	50	7.5	10	27	6	16.9
2189	266	247	89	176	67	53	8.1	1887	1510	8135	160	615	465	2283	54	96	38	43	10.7	10	21	5	16.8
2199	276	253	63	135	45	47	6.8	1434	1165	6411	0	0	0	0	63	135	45	47	6.8	10	27	5	16.6
2209	286	252	76	157	57	50	7.4	1650	1321	7179	0	0	0	0	76	157	57	50	7.4	10	27	6	16.5
2219	296	251	89	178	68	53	8.1	1866	1488	7934	163	620	467	2260	54	96	38	42	10.7	10	21	5	16.5
2229	306	252	63	134	45	46	6.8	1409	1144	6244	0	0	0	0	63	134	45	46	6.8	10	26	5	16.3
2239	316	251	76	156	57	50	7.4	1621	1295	6992	0	0	0	0	76	156	57	50	7.4	10	27	5	16.3
2249	326	250	89	177	68	53	8.1	1838	1463	7755	162	616	464	2243	54	96	38	42	10.7	10	21	4	16.3
2259	336	253	63	135	45	46	6.8	1386	1121	6084	0	0	0	0	63	135	45	46	6.8	0	0	0	14.8

Summary: Ponderosa pine/grass forest type, low site index group (30 year cutting cycle, 60 square feet basal area target matrix density)

Regulated (sustained) yield = 465 cubic feet (2,262 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (**15.5** cubic feet/acre/year) or (75.4 board feet/acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

FVS SIMULATION: PPG_h_E_Y (Ponderosa pine/grass forest type, high site group, SI=>70)
SIMULATION DONE: 02-24-2011 14:28:06

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	82	391	90	181	71	55	9.3	1899	1530	7185	315	709	556	2225	52	89	39	51	11.9	10	39	2	19.0
2019	92	255	66	139	49	54	6.9	1561	1286	6700	0	0	0	0	66	139	49	54	6.9	10	49	2	20.3
2029	102	254	87	175	67	59	8.0	2028	1639	8639	0	0	0	0	87	175	67	59	8.0	10	51	3	21.8
2039	112	258	107	206	82	64	8.8	2499	2007	10584	168	1069	836	4202	56	99	41	48	11.3	10	39	2	23.0
2049	122	254	70	147	51	54	7.1	1797	1491	7904	0	0	0	0	70	147	51	54	7.1	10	46	3	23.7
2059	132	253	90	180	69	59	8.1	2227	1817	9633	0	0	0	0	90	180	69	59	8.1	10	47	4	24.3
2069	142	250	109	208	83	64	8.9	2654	2138	11476	167	1148	898	4437	55	97	40	49	11.1	10	35	4	24.8
2079	152	249	68	142	49	55	7.1	1816	1507	8428	0	0	0	0	68	142	49	55	7.1	10	43	5	24.8
2089	162	248	87	174	66	60	8.0	2196	1797	9855	0	0	0	0	87	174	66	60	8.0	10	44	6	25.0
2099	172	247	105	202	80	64	8.8	2575	2075	11454	167	1051	817	4084	54	95	39	48	11.2	10	31	6	25.1
2109	182	245	66	138	48	54	7.0	1782	1480	8497	0	0	0	0	66	138	48	54	7.0	10	40	7	24.9
2119	192	244	84	169	64	58	7.9	2112	1727	9668	0	0	0	0	84	169	64	58	7.9	10	42	8	24.8
2129	202	243	102	196	78	63	8.7	2453	1974	11000	161	947	729	3649	54	95	39	47	11.1	10	30	7	24.7
2139	212	247	65	138	47	53	7.0	1743	1451	8334	0	0	0	0	65	138	47	53	7.0	10	39	7	24.5
2149	222	246	84	168	64	58	7.9	2068	1692	9403	0	0	0	0	84	168	64	58	7.9	10	42	8	24.4
2159	232	244	102	196	78	62	8.7	2408	1935	10725	164	926	709	3490	54	95	39	47	11.2	10	30	6	24.4
2169	242	246	65	138	47	52	7.0	1720	1432	8209	0	0	0	0	65	138	47	52	7.0	10	39	6	24.2
2179	252	245	84	169	64	57	7.9	2049	1675	9299	0	0	0	0	84	169	64	57	7.9	10	42	7	24.1
2189	262	243	102	197	78	62	8.8	2394	1922	10611	162	929	712	3512	54	95	39	46	11.1	10	30	6	24.1
2199	272	247	65	138	47	52	7.0	1704	1418	8058	0	0	0	0	65	138	47	52	7.0	10	40	6	23.9
2209	282	246	85	170	64	57	7.9	2039	1665	9157	0	0	0	0	85	170	64	57	7.9	10	42	7	23.9
2219	292	244	103	198	79	61	8.8	2386	1912	10537	164	931	712	3492	54	95	39	46	11.2	10	29	5	23.9
2229	302	246	65	138	47	52	7.0	1694	1408	8009	0	0	0	0	65	138	47	52	7.0	10	38	6	23.8
2239	312	245	84	168	63	57	7.9	2018	1647	9069	0	0	0	0	84	168	63	57	7.9	10	41	7	23.8
2249	322	243	102	196	78	61	8.7	2360	1890	10410	163	915	699	3425	54	95	38	46	11.2	10	29	5	23.8
2259	332	245	65	137	47	51	7.0	1678	1393	7928	0	0	0	0	65	137	47	51	7.0	0	0	0	21.6

Summary: Ponderosa pine/grass forest type, high site index group (30 year cutting cycle, 60 square feet basal area target matrix density)

Regulated (sustained) yield = 708 cubic feet (3,480 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (**23.6** cubic feet/acre/year) or (116 board feet/acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

Ponderosa Pine Forest (PP/Gambel oak PNVT)

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FVS SIMULATION: PPO_l_E_Y                (Ponderosa pine/Gambel oak forest type, low site group, SI<70)
SIMULATION DONE: 02-24-2011 14:32:08
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AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	95	1039	104	254	90	45	5.5	1608	1282	3597	949	807	622	1430	47	86	37	41	9.9	10	33	2	13.7
2019	105	218	62	128	49	45	7.2	1113	932	3400	0	0	0	0	62	128	49	45	7.2	10	38	3	15.0
2029	115	217	80	157	62	48	8.2	1464	1220	4660	0	0	0	0	80	157	62	48	8.2	10	38	3	16.3
2039	125	218	97	183	75	51	9.0	1811	1500	5950	125	733	598	2300	55	98	42	42	11.0	10	30	2	17.2
2049	135	219	69	140	51	45	7.7	1359	1130	4749	0	0	0	0	69	140	51	45	7.7	10	33	2	17.6
2059	145	217	84	164	64	48	8.5	1664	1378	5818	0	0	0	0	84	164	64	48	8.5	10	33	4	18.1
2069	155	216	98	186	74	50	9.2	1957	1618	6840	130	774	639	2387	55	98	40	41	10.9	10	27	4	18.5
2079	165	210	67	136	49	45	7.6	1410	1160	5336	0	0	0	0	67	136	49	45	7.6	10	30	5	18.4
2089	175	211	80	158	60	48	8.4	1661	1353	6305	0	0	0	0	80	158	60	48	8.4	10	31	6	18.4
2099	185	210	94	179	71	51	9.1	1909	1550	7235	125	710	561	2476	55	97	40	41	10.9	10	24	6	18.4
2109	195	208	65	132	47	45	7.5	1378	1129	5443	0	0	0	0	65	132	47	45	7.5	10	29	8	18.1
2119	205	207	77	153	58	48	8.3	1590	1288	6209	0	0	0	0	77	153	58	48	8.3	10	30	9	18.0
2129	215	206	90	172	68	51	8.9	1803	1454	6956	120	622	484	2204	55	97	40	41	10.9	10	23	8	17.9
2139	225	209	64	131	47	45	7.5	1333	1086	5316	0	0	0	0	64	131	47	45	7.5	10	29	8	17.6
2149	235	208	76	151	57	48	8.2	1535	1238	6022	0	0	0	0	76	151	57	48	8.2	10	31	9	17.4
2159	245	206	89	171	68	51	8.9	1753	1408	6770	120	595	458	2092	54	97	40	42	10.8	10	24	8	17.4
2169	255	210	64	131	47	45	7.5	1318	1072	5266	0	0	0	0	64	131	47	45	7.5	10	29	8	17.2
2179	265	209	77	152	58	49	8.2	1530	1229	6017	0	0	0	0	77	152	58	49	8.2	10	31	8	17.1
2189	275	207	90	172	69	52	8.9	1761	1409	6851	122	610	470	2150	54	97	39	42	10.9	10	24	7	17.1
2199	285	209	64	132	47	45	7.5	1318	1067	5332	0	0	0	0	64	132	47	45	7.5	10	29	7	16.9
2209	295	208	77	153	58	49	8.2	1539	1231	6121	0	0	0	0	77	153	58	49	8.2	10	30	7	16.9
2219	305	207	91	173	69	51	9.0	1771	1413	6944	122	617	473	2183	55	97	39	41	10.9	10	23	7	16.9
2229	315	209	64	132	47	45	7.5	1322	1068	5388	0	0	0	0	64	132	47	45	7.5	10	28	7	16.8
2239	325	208	77	152	57	48	8.2	1532	1223	6132	0	0	0	0	77	152	57	48	8.2	10	30	8	16.7
2249	335	206	89	171	68	51	8.9	1747	1390	6892	122	602	462	2128	55	97	39	41	11.0	10	23	8	16.7
2259	345	208	64	131	46	45	7.5	1300	1048	5336	0	0	0	0	64	131	46	45	7.5	0	0	0	15.3

Summary: Ponderosa pine/Gambel oak forest type, low site index group (30 year cutting cycle, 60 square feet basal area target matrix density)

Regulated (sustained) yield = 466 cubic feet (2,138 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (15.5 cubic feet/acre/year) or (71.3 board feet /acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

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FVS SIMULATION: PPO_h_E_Y                (Ponderosa pine/Gambel oak forest type, high site group, SI=>70)
SIMULATION DONE: 02-24-2011 14:38:47
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AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	89	949	109	252	88	58	6.3	2177	1782	7217	860	902	720	2479	57	100	43	54	11.1	10	43	3	19.6
2019	99	330	73	157	55	57	6.5	1673	1405	6550	0	0	0	0	73	157	55	57	6.5	10	53	4	21.2
2029	109	326	97	199	76	62	7.5	2169	1784	8467	0	0	0	0	97	199	76	62	7.5	10	53	5	22.7
2039	119	318	119	233	92	66	8.4	2654	2156	10335	202	1178	934	4338	62	111	46	48	11.2	10	41	4	23.8
2049	129	316	76	163	56	52	6.6	1842	1531	7520	0	0	0	0	76	163	56	52	6.6	10	48	7	24.1
2059	139	310	97	197	74	57	7.6	2260	1853	9057	0	0	0	0	97	197	74	57	7.6	10	49	8	24.5
2069	149	305	116	228	90	60	8.4	2665	2160	10551	210	1163	916	3946	58	102	42	48	11.2	10	36	7	24.7
2079	159	298	71	152	52	52	6.6	1790	1492	7746	0	0	0	0	71	152	52	52	6.6	10	44	10	24.5
2089	169	301	91	186	69	56	7.5	2131	1739	8866	0	0	0	0	91	186	69	56	7.5	10	47	12	24.3
2099	179	298	110	217	85	60	8.3	2483	1985	10174	201	974	745	3452	59	104	43	48	11.1	10	34	11	24.2
2109	189	300	70	152	52	53	6.5	1747	1450	7696	0	0	0	0	70	152	52	53	6.5	10	45	12	23.9
2119	199	297	90	184	69	57	7.4	2075	1686	8794	0	0	0	0	90	184	69	57	7.4	10	48	13	23.8
2129	209	293	109	215	85	61	8.2	2429	1929	10150	211	989	748	3516	56	98	40	48	11.2	10	34	10	23.8
2139	219	289	68	146	49	53	6.5	1677	1390	7546	0	0	0	0	68	146	49	53	6.5	10	44	11	23.6
2149	229	289	87	179	67	57	7.4	2007	1628	8580	0	0	0	0	87	179	67	57	7.4	10	48	11	23.5
2159	239	287	108	212	83	61	8.3	2381	1888	9997	206	983	741	3567	55	96	39	47	11.2	10	34	8	23.6
2169	249	289	67	146	49	52	6.5	1653	1368	7440	0	0	0	0	67	146	49	52	6.5	10	44	10	23.5
2179	259	288	88	180	67	56	7.4	1992	1612	8500	0	0	0	0	88	180	67	56	7.4	10	47	11	23.5
2189	269	286	108	212	83	60	8.3	2353	1860	9853	206	974	734	3484	54	95	39	46	11.2	10	33	9	23.5
2199	279	288	66	143	48	51	6.5	1611	1330	7250	0	0	0	0	66	143	48	51	6.5	10	43	11	23.4
2209	289	287	86	177	66	55	7.4	1930	1555	8234	0	0	0	0	86	177	66	55	7.4	10	47	12	23.3
2219	299	285	105	208	82	60	8.2	2276	1791	9534	206	912	676	3197	54	95	39	45	11.3	10	32	10	23.3
2229	309	287	65	142	47	51	6.5	1591	1316	7189	0	0	0	0	65	142	47	51	6.5	10	43	10	23.2
2239	319	286	85	176	65	55	7.4	1917	1547	8190	0	0	0	0	85	176	65	55	7.4	10	47	10	23.1
2249	329	285	106	209	82	60	8.2	2291	1802	9667	204	933	694	3345	54	95	39	45	11.2	10	33	8	23.1
2259	339	288	66	143	48	51	6.5	1601	1324	7215	0	0	0	0	66	143	48	51	6.5	0	0	0	21.1

Summary: Ponderosa pine/Gambel oak forest type, high site index group (30 year cutting cycle, 60 square feet basal area target matrix density)

Regulated (sustained) yield = 711 cubic feet (3,398 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (23.7 cubic feet/acre/year) or (113 board feet/acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

Ponderosa Pine Forest (PP/Evergreen oak PNVT)

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FVS SIMULATION: PPE_l_E_Y                (Ponderosa pine/Evergreen oak forest type, low site group, SI<70)
SIMULATION DONE: 02-24-2011 14:45:11
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AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	102	1067	110	255	96	35	6.3	1445	1212	2836	986	721	589	1227	49	88	39	32	10.5	10	27	5	13.7
2019	112	173	61	120	48	36	8.1	943	823	2322	0	0	0	0	61	120	48	36	8.1	10	31	6	13.6
2029	122	171	75	141	59	38	9.0	1198	1028	3128	0	0	0	0	75	141	59	38	9.0	10	33	7	14.0
2039	132	170	88	162	70	41	9.9	1458	1238	3952	75	508	425	1321	56	100	44	34	11.1	10	27	7	14.4
2049	142	177	67	131	51	37	8.5	1153	981	3301	0	0	0	0	67	131	51	37	8.5	10	31	8	14.6
2059	152	176	79	150	61	40	9.2	1380	1168	3956	0	0	0	0	79	150	61	40	9.2	10	32	9	14.8
2069	162	175	91	168	70	42	10.0	1606	1342	4736	89	560	462	1551	56	99	42	37	11.0	10	26	8	14.9
2079	172	168	66	129	50	40	8.5	1226	1026	3855	0	0	0	0	66	129	50	40	8.5	10	31	10	14.9
2089	182	179	78	148	59	44	9.1	1441	1195	4665	0	0	0	0	78	148	59	44	9.1	10	33	10	15.0
2099	192	177	90	166	69	47	9.8	1670	1367	5619	93	588	465	1943	55	98	41	39	11.1	10	25	9	15.0
2109	202	165	64	126	48	42	8.5	1246	1034	4375	0	0	0	0	64	126	48	42	8.5	10	30	9	14.9
2119	212	164	76	143	57	45	9.2	1451	1190	5166	0	0	0	0	76	143	57	45	9.2	10	32	9	14.9
2129	222	162	88	161	66	49	10.0	1680	1364	6129	76	559	443	1935	56	99	41	40	11.0	10	26	9	15.0
2139	232	168	65	128	48	43	8.5	1292	1059	4896	0	0	0	0	65	128	48	43	8.5	10	31	9	15.0
2149	242	166	78	146	58	47	9.2	1511	1229	5739	0	0	0	0	78	146	58	47	9.2	10	34	10	15.0
2159	252	164	90	165	68	50	10.0	1752	1416	6730	79	610	484	2142	55	98	40	41	11.0	10	26	8	15.2
2169	262	167	65	128	48	44	8.5	1321	1078	5287	0	0	0	0	65	128	48	44	8.5	10	31	9	15.1
2179	272	165	78	146	58	48	9.3	1540	1243	6120	0	0	0	0	78	146	58	48	9.3	10	33	9	15.2
2189	282	163	90	165	68	50	10.1	1778	1427	7134	79	614	483	2242	56	98	40	40	11.1	10	25	9	15.3
2199	292	165	65	127	47	44	8.5	1327	1079	5507	0	0	0	0	65	127	47	44	8.5	10	30	10	15.2
2209	302	164	77	145	57	47	9.3	1530	1233	6221	0	0	0	0	77	145	57	47	9.3	10	33	10	15.2
2219	312	162	89	163	67	50	10.0	1753	1407	7085	76	589	463	2153	56	98	40	40	11.0	10	25	9	15.3
2229	322	167	65	127	47	43	8.4	1324	1073	5531	0	0	0	0	65	127	47	43	8.4	10	30	10	15.2
2239	332	165	77	145	57	47	9.2	1525	1226	6232	0	0	0	0	77	145	57	47	9.2	10	32	10	15.2
2249	342	162	89	163	67	50	10.0	1747	1396	7137	78	591	463	2154	55	97	39	40	11.0	10	25	10	15.3
2259	352	175	64	126	46	43	8.3	1308	1057	5524	0	0	0	0	64	126	46	43	8.3	0	0	0	13.9

Summary: Ponderosa pine/Evergreen oak forest type, low site index group (30 year cutting cycle, 60 square feet basal area target matrix density)

Regulated (sustained) yield = 473 cubic feet (2,173 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (15.8 cubic feet/acre/year) or (72.4 board feet /acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

FVS SIMULATION: PPE_h_E_Y (Ponderosa pine/Evergreen oak forest type, high site group, SI=>70)
SIMULATION DONE: 02-24-2011 14:51:28

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	76	676	111	254	94	44	5.5	1887	1597	4513	595	934	780	1920	51	90	40	40	9.6	10	29	6	18.4
2019	86	193	60	118	47	43	7.3	1187	1025	3581	0	0	0	0	60	118	47	43	7.3	10	35	7	18.4
2029	96	240	74	142	58	48	8.1	1468	1252	4632	0	0	0	0	74	142	58	48	8.1	10	40	7	18.7
2039	106	256	91	172	72	52	9.0	1798	1512	5702	73	771	647	2635	55	104	44	39	9.7	10	35	5	19.0
2049	116	273	72	148	58	43	7.8	1327	1118	4000	0	0	0	0	72	148	58	43	7.8	10	43	6	19.3
2059	126	267	91	179	74	47	8.8	1695	1411	5149	0	0	0	0	91	179	74	47	8.8	10	46	10	19.8
2069	136	254	108	204	87	51	9.7	2056	1707	6502	170	855	704	2220	56	99	43	44	11.1	10	34	8	20.4
2079	146	167	68	133	52	48	8.7	1461	1235	5207	0	0	0	0	68	133	52	48	8.7	10	41	9	20.5
2089	156	175	84	158	64	52	9.5	1779	1487	6339	0	0	0	0	84	158	64	52	9.5	10	43	10	20.7
2099	166	173	99	180	76	55	10.3	2107	1735	7685	94	841	674	2970	56	97	41	43	11.5	10	28	10	20.9
2109	176	161	64	126	47	47	8.6	1448	1218	5502	0	0	0	0	64	126	47	47	8.6	10	33	11	20.5
2119	186	159	76	143	57	50	9.4	1670	1387	6376	0	0	0	0	76	143	57	50	9.4	10	37	12	20.2
2129	196	157	89	162	67	54	10.2	1928	1573	7506	79	642	505	2335	55	96	40	42	11.4	10	26	10	20.1
2139	206	160	64	124	47	46	8.5	1449	1217	5774	0	0	0	0	64	124	47	46	8.5	10	32	11	19.7
2149	216	159	76	142	57	50	9.3	1661	1379	6488	0	0	0	0	76	142	57	50	9.3	10	37	11	19.5
2159	226	157	89	162	67	54	10.2	1919	1574	7509	76	636	505	2249	55	97	40	43	11.2	10	27	10	19.4
2169	236	163	65	126	47	47	8.5	1463	1223	5998	0	0	0	0	65	126	47	47	8.5	10	34	10	19.2
2179	246	161	78	146	58	52	9.4	1703	1407	6796	0	0	0	0	78	146	58	52	9.4	10	38	10	19.1
2189	256	159	92	167	70	56	10.3	1987	1621	7993	78	675	534	2458	56	98	40	43	11.3	10	27	11	19.1
2199	266	163	64	126	47	47	8.5	1474	1234	6137	0	0	0	0	64	126	47	47	8.5	10	34	11	18.9
2209	276	161	77	145	57	51	9.3	1696	1402	6817	0	0	0	0	77	145	57	51	9.3	10	38	11	18.8
2219	286	159	91	165	69	55	10.2	1960	1596	7928	74	679	540	2485	55	97	40	43	11.1	10	27	10	18.8
2229	296	182	64	126	47	47	8.3	1448	1202	6065	0	0	0	0	64	126	47	47	8.3	10	34	11	18.6
2239	306	180	77	146	58	52	9.1	1681	1380	6825	0	0	0	0	77	146	58	52	9.1	10	39	11	18.5
2249	316	196	92	169	70	56	9.9	1961	1592	8015	75	671	527	2488	55	100	40	44	10.8	10	28	10	18.6
2259	326	195	66	130	49	48	8.3	1471	1216	6189	0	0	0	0	66	130	49	48	8.3	0	0	0	16.9

Summary: Ponderosa pine/Evergreen oak forest type, high site index group (30 year cutting cycle, 60 square feet basal area target matrix density)

Regulated (sustained) yield = 534 cubic feet (2,477 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (17.8 cubic feet/acre/year) or (82.6 board feet/acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

Mixed Conifer Forest (Dry mixed conifer PNVT)

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FVS SIMULATION: MCD_a_E_Y                    (Dry mixed conifer forest type, all sites)
SIMULATION DONE: 02-24-2011 14:57:50
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AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**					AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	99	1443	113	289	111	58	4.6	2242	1720	6951	1301	903	656	2235	62	117	55	54	8.9	10	39	3	18.3
2019	109	396	77	171	68	57	5.9	1695	1367	6115	0	0	0	0	77	171	68	57	5.9	10	49	5	19.3
2029	119	398	97	206	87	61	6.6	2139	1700	7651	0	0	0	0	97	206	87	61	6.6	10	50	6	20.5
2039	129	398	116	239	105	65	7.3	2576	2032	9225	235	1006	775	3203	67	128	58	55	9.2	10	39	4	21.6
2049	139	414	82	183	70	59	6.1	1914	1533	7276	0	0	0	0	82	183	70	59	6.1	10	48	5	22.0
2059	149	412	102	217	90	63	6.8	2337	1838	8609	0	0	0	0	102	217	90	63	6.8	10	48	7	22.6
2069	159	413	121	249	107	66	7.4	2746	2157	9984	261	1081	836	3362	68	129	57	54	9.3	10	36	5	23.3
2079	169	398	82	182	69	58	6.1	1970	1570	7669	0	0	0	0	82	182	69	58	6.1	10	44	6	23.4
2089	179	402	102	216	88	62	6.8	2354	1844	8793	0	0	0	0	102	216	88	62	6.8	10	45	7	23.6
2099	189	400	121	248	105	65	7.5	2738	2136	10030	263	1079	825	3256	66	124	53	53	9.5	10	32	5	23.9
2109	199	385	79	175	65	57	6.1	1929	1523	7800	0	0	0	0	79	175	65	57	6.1	10	40	5	23.7
2119	209	387	98	208	83	60	6.8	2281	1773	8871	0	0	0	0	98	208	83	60	6.8	10	42	6	23.8
2129	219	385	117	240	100	63	7.4	2640	2050	10019	252	997	755	3182	65	122	52	51	9.5	10	30	5	23.9
2139	229	383	78	174	63	55	6.1	1895	1499	7694	0	0	0	0	78	174	63	55	6.1	10	40	5	23.8
2149	239	382	98	208	83	58	6.8	2240	1742	8668	0	0	0	0	98	208	83	58	6.8	10	41	6	23.8
2159	249	381	117	240	100	61	7.5	2591	2012	9772	252	974	737	2987	64	120	51	50	9.6	10	28	5	23.9
2169	259	379	77	171	61	54	6.1	1853	1462	7591	0	0	0	0	77	171	61	54	6.1	10	38	5	23.7
2179	269	379	96	204	80	57	6.8	2181	1686	8526	0	0	0	0	96	204	80	57	6.8	10	40	6	23.6
2189	279	378	115	236	98	60	7.4	2519	1944	9590	247	921	692	2864	65	120	51	48	9.6	10	28	5	23.7
2199	289	380	77	172	61	52	6.1	1828	1440	7436	0	0	0	0	77	172	61	52	6.1	10	38	5	23.5
2209	299	379	97	206	81	55	6.8	2156	1665	8310	0	0	0	0	97	206	81	55	6.8	10	40	6	23.4
2219	309	378	116	238	98	58	7.5	2498	1924	9384	250	920	688	2777	64	120	50	47	9.6	10	27	5	23.5
2229	319	378	77	171	61	51	6.1	1806	1416	7358	0	0	0	0	77	171	61	51	6.1	10	37	5	23.3
2239	329	378	96	204	80	55	6.8	2127	1636	8237	0	0	0	0	96	204	80	55	6.8	10	39	5	23.3
2249	339	377	115	236	97	58	7.5	2463	1891	9284	247	908	678	2803	64	120	50	46	9.6	10	27	5	23.3
2259	349	379	77	171	61	50	6.1	1779	1392	7182	0	0	0	0	77	171	61	50	6.1	0	0	0	21.2

Summary: Dry mixed conifer forest type, all sites group (30 year cutting cycle, 70 square feet basal area target matrix density)

Regulated (sustained) yield = 686 cubic feet (2,815 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (22.9 cubic feet/acre/year) or (93.8 board feet/acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

Mixed Conifer Forest (Wet mixed conifer PNVT)

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FVS SIMULATION: MCW_a_E_Y                    (Wet mixed conifer forest type, all sites)
SIMULATION DONE: 02-24-2011 15:02:00
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AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**					AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	108	1298	143	346	156	66	5.2	3323	2496	10209	1115	1485	1066	3663	75	144	76	60	8.3	10	40	6	22.8
2019	118	521	90	202	90	63	5.4	2178	1695	7796	0	0	0	0	90	202	90	63	5.4	10	56	8	23.0
2029	128	523	109	238	112	67	6.0	2662	2007	9307	0	0	0	0	109	238	112	67	6.0	10	57	10	23.6
2039	138	541	129	273	133	70	6.6	3137	2333	10776	278	1253	888	4022	76	151	75	61	8.1	10	44	5	24.3
2049	148	605	93	216	93	65	5.4	2268	1729	7989	0	0	0	0	93	216	93	65	5.4	10	59	7	24.6
2059	158	611	116	259	118	68	6.1	2790	2072	9413	0	0	0	0	116	259	118	68	6.1	10	62	8	25.4
2069	168	608	140	301	143	72	6.7	3327	2464	10892	332	1215	878	3656	85	171	86	63	8.4	10	46	5	26.5
2079	178	574	102	233	102	66	5.7	2522	1912	8442	0	0	0	0	102	233	102	66	5.7	10	59	8	26.9
2089	188	568	124	271	126	70	6.3	3031	2259	9774	0	0	0	0	124	271	126	70	6.3	10	62	11	27.5
2099	198	554	145	307	148	73	6.9	3541	2642	11211	360	1457	1057	3746	77	150	73	64	8.6	10	38	6	28.1
2109	208	523	91	209	87	67	5.6	2404	1844	8519	0	0	0	0	91	209	87	67	5.6	10	51	8	28.0
2119	218	521	110	244	109	70	6.2	2828	2123	9634	0	0	0	0	110	244	109	70	6.2	10	53	11	28.0
2129	228	519	131	278	130	73	6.8	3250	2437	10733	329	1219	887	3578	76	148	72	64	8.6	10	36	8	28.2
2139	238	520	89	205	85	67	5.6	2317	1783	8071	0	0	0	0	89	205	85	67	5.6	10	49	10	28.0
2149	248	521	108	239	107	70	6.1	2706	2035	9075	0	0	0	0	108	239	107	70	6.1	10	53	11	27.9
2159	258	518	129	275	129	72	6.7	3127	2354	10192	326	1149	837	3141	75	146	70	63	8.5	10	34	10	28.0
2169	268	520	87	201	83	66	5.5	2217	1705	7804	0	0	0	0	87	201	83	66	5.5	10	47	11	27.6
2179	278	519	105	234	104	68	6.1	2572	1928	8635	0	0	0	0	105	234	104	68	6.1	10	50	12	27.4
2189	288	520	125	269	126	70	6.6	2951	2210	9569	335	1073	775	2883	73	143	69	61	8.5	10	33	10	27.4
2199	298	515	85	198	82	63	5.5	2112	1624	7355	0	0	0	0	85	198	82	63	5.5	10	47	11	27.1
2209	308	521	104	233	104	65	6.1	2477	1847	8188	0	0	0	0	104	233	104	65	6.1	10	50	10	26.9
2219	318	519	125	269	126	68	6.6	2870	2138	9152	328	1014	722	2565	74	145	69	59	8.5	10	32	8	26.9
2229	328	519	86	200	82	62	5.5	2101	1604	7305	0	0	0	0	86	200	82	62	5.5	10	46	8	26.6
2239	338	518	106	236	105	64	6.1	2488	1838	8239	0	0	0	0	106	236	105	64	6.1	10	49	8	26.5
2249	348	519	127	273	127	67	6.7	2892	2143	9256	315	1008	723	2618	77	151	71	57	8.5	10	31	9	26.6
2259	358	511	88	202	83	60	5.6	2099	1585	7222	0	0	0	0	88	202	83	60	5.6	0	0	0	24.3

Summary: Wet mixed conifer forest type, all sites group (30 year cutting cycle, 80 square feet basal area target matrix density –focus on managing for Douglas-fir dominance)

Regulated (sustained) yield = 740 cubic feet (2,689 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (24.7 cubic feet/acre/year) or (89.6 board feet/acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

Spruce-fir Forest (Spruce-fir, mixed PNVT)

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FVS SIMULATION: SFM_a_E_Y                    (Spruce-fir, mixed forest type, all sites)
SIMULATION DONE: 02-24-2011 15:05:42
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AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

		START OF SIMULATION PERIOD									REMOVALS**					AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	DOM HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	DOM HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
2009	108	1298	143	346	156	66	5.2	3323	2496	10209	1115	1485	1066	3663	75	144	76	60	8.3	10	41	14	22.8
2019	118	518	87	198	87	62	5.3	2110	1638	7553	0	0	0	0	87	198	87	62	5.3	10	55	16	22.6
2029	128	539	105	230	107	65	5.9	2496	1868	8634	0	0	0	0	105	230	107	65	5.9	10	57	19	22.6
2039	138	561	123	263	127	67	6.5	2877	2111	9635	274	1082	745	3310	75	151	75	59	8.0	10	48	14	22.8
2049	148	652	93	219	93	61	5.4	2134	1611	7274	0	0	0	0	93	219	93	61	5.4	10	65	16	23.0
2059	158	643	118	264	120	64	6.0	2624	1919	8413	0	0	0	0	118	264	120	64	6.0	10	72	19	23.6
2069	168	631	143	309	147	66	6.7	3148	2296	9713	359	1211	855	3283	84	170	84	59	8.4	10	54	14	24.7
2079	178	570	103	234	102	63	5.7	2333	1743	7677	0	0	0	0	103	234	102	63	5.7	10	71	17	25.2
2089	188	563	127	276	127	66	6.4	2871	2139	9103	0	0	0	0	127	276	127	66	6.4	10	77	21	26.2
2099	198	545	152	317	151	69	7.1	3431	2582	10752	354	1549	1142	4138	76	149	72	60	8.6	10	49	13	27.2
2109	208	520	93	211	88	64	5.7	2244	1721	7876	0	0	0	0	93	211	88	64	5.7	10	65	15	27.2
2119	218	516	116	252	112	67	6.4	2749	2076	9360	0	0	0	0	116	252	112	67	6.4	10	70	18	27.6
2129	228	511	140	294	135	69	7.1	3273	2474	10919	328	1370	1028	4073	75	145	68	58	8.7	10	43	13	28.1
2139	238	511	89	204	82	61	5.6	2196	1663	7778	0	0	0	0	89	204	82	61	5.6	10	59	15	27.8
2149	248	512	111	244	106	64	6.3	2641	1966	8862	0	0	0	0	111	244	106	64	6.3	10	65	17	27.8
2159	258	507	135	285	131	67	7.0	3121	2331	10138	329	1247	919	3357	74	142	65	56	8.7	10	39	13	28.1
2169	268	507	87	200	79	59	5.6	2128	1602	7552	0	0	0	0	87	200	79	59	5.6	10	56	14	27.8
2179	278	504	108	238	103	62	6.3	2541	1885	8532	0	0	0	0	108	238	103	62	6.3	10	61	16	27.7
2189	288	500	132	278	127	65	6.9	2990	2226	9708	325	1154	846	3053	73	141	64	54	8.8	10	37	13	27.9
2199	298	503	86	199	78	58	5.6	2079	1564	7403	0	0	0	0	86	199	78	58	5.6	10	55	14	27.6
2209	308	501	108	237	102	62	6.3	2486	1847	8320	0	0	0	0	108	237	102	62	6.3	10	61	16	27.6
2219	318	497	131	278	127	64	6.9	2939	2193	9490	321	1141	839	2986	73	141	64	54	8.7	10	37	13	27.8
2229	328	505	86	198	78	58	5.6	2039	1540	7221	0	0	0	0	86	198	78	58	5.6	10	54	13	27.5
2239	338	503	107	236	102	61	6.2	2449	1819	8147	0	0	0	0	107	236	102	61	6.2	10	61	15	27.4
2249	348	499	131	277	126	64	6.9	2901	2159	9331	325	1124	823	2929	73	141	64	54	8.8	10	36	13	27.6
2259	358	498	86	197	78	58	5.6	2014	1518	7121	0	0	0	0	86	197	78	58	5.6	0	0	0	25.0

Summary: Spruce-fir(mixed) forest type, all sites group (30 year cutting cycle, 80 square feet basal area target matrix density –focus on managing for Douglas-fir dominance)

Regulated (sustained) yield = 836 cubic feet (2,989 board feet portion) net/acre (adjusted for merchantability and seen defect), every 30-year cutting cycle. (27.9 cubic feet/acre/year) or (99.6 board feet/acre/year)

LTSYC = volume/acre/year x PNVT suitable timber production acres

Spruce-fir Forest (Spruce-fir, pure PNVT)

STAND ID: BareGrnd MGMT ID: NONE Stand BareGrnd at Default Bare Ground
(Spruce-fir plantation, Regional average site index)

SUMMARY STATISTICS (PER ACRE OR STAND BASED ON TOTAL STAND AREA)

		START OF SIMULATION PERIOD									REMOVALS					AFTER TREATMENT					GROWTH THIS PERIOD					
YEAR	AGE	NO OF TREES	BA	SDI	CCF	TOP HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	TOP HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT	FOR TYP	SS ZT
2010	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0	10	0	0	0.0	999	55
2020	10	480	0	1	0	5	0.2	0	0	0	0	0	0	0	0	1	0	5	0.2	10	2	0	0.0	265	34
2030	20	404	2	10	3	15	1.0	17	0	0	0	0	0	0	2	10	3	15	1.0	10	19	0	0.0	999	55
2040	30	342	18	52	22	28	3.1	211	0	0	0	0	0	0	18	52	22	28	3.1	10	66	0	0.0	265	34
2050	40	328	58	132	60	40	5.7	871	222	1082	0	0	0	0	58	132	60	40	5.7	10	113	2	5.6	265	24
2060	50	317	106	214	102	52	7.8	1980	1250	5641	0	0	0	0	106	214	102	52	7.8	10	154	12	25.0	265	23
2070	60	297	155	287	142	63	9.8	3403	2681	12189	0	0	0	0	155	287	142	63	9.8	10	168	29	44.7	265	12
2080	70	271	196	340	172	71	11.5	4795	4012	18551	0	0	0	0	196	340	172	71	11.5	10	156	47	57.3	265	12
2090	80	243	223	369	188	77	13.0	5886	5035	24000	0	0	0	0	223	369	188	77	13.0	10	150	62	62.9	265	12
2100	90	217	241	384	196	81	14.3	6769	5877	28554	0	0	0	0	241	384	196	81	14.3	10	150	74	65.3	265	12
2110	100	193	254	391	201	85	15.6	7524	6597	32683	0	0	0	0	254	391	201	85	15.6	10	147	82	66.0	265	12
2120	110	171	264	394	203	90	16.8	8179	7247	37075	0	0	0	0	264	394	203	90	16.8	10	135	83	65.9	265	12
2130	120	154	270	393	203	93	18.0	8695	7770	40526	0	0	0	0	270	393	203	93	18.0	10	130	86	64.8	265	12
2140	130	138	274	390	202	96	19.1	9132	8192	43639	0	0	0	0	274	390	202	96	19.1	10	128	89	63.0	265	12
2150	140	124	277	385	200	99	20.2	9524	8584	46605	0	0	0	0	277	385	200	99	20.2	10	124	89	61.3	265	12
2160	150	113	280	380	198	102	21.3	9876	8929	49598	0	0	0	0	280	380	198	102	21.3	10	119	89	59.5	265	12
2170	160	102	281	374	195	104	22.4	10176	9235	52341	0	0	0	0	281	374	195	104	22.4	10	113	88	57.7	265	12
2180	170	93	281	368	193	107	23.5	10424	9492	54967	0	0	0	0	281	368	193	107	23.5	10	110	86	55.8	265	12
2190	180	85	282	362	190	109	24.6	10659	9732	57108	0	0	0	0	282	362	190	109	24.6	10	106	88	54.1	265	12
2200	190	78	281	355	187	111	25.7	10845	9920	59227	0	0	0	0	281	355	187	111	25.7	10	100	82	52.2	265	12
2210	200	72	281	349	184	113	26.7	11027	10096	61256	0	0	0	0	281	349	184	113	26.7	10	99	85	50.5	265	12
2220	210	67	280	343	181	115	27.8	11171	10241	63059	0	0	0	0	280	343	181	115	27.8	10	96	80	48.8	265	12
2230	220	62	279	337	178	116	28.8	11325	10413	64902	0	0	0	0	279	337	178	116	28.8	10	94	80	47.3	265	12
2240	230	57	279	332	176	118	29.9	11467	10559	66665	0	0	0	0	279	332	176	118	29.9	10	88	76	45.9	265	12
2250	240	53	278	326	173	119	30.9	11596	10690	68140	0	0	0	0	278	326	173	119	30.9	10	86	77	44.5	265	12
2260	250	50	277	321	170	121	31.9	11678	10782	69304	0	0	0	0	277	321	170	121	31.9	10	85	74	43.1	265	12
2270	260	46	276	315	168	122	33.0	11781	10879	70584	0	0	0	0	276	315	168	122	33.0	10	83	72	41.8	265	12
2280	270	44	275	311	166	123	34.0	11895	10997	72004	0	0	0	0	275	311	166	123	34.0	10	80	69	40.7	265	12
2290	280	41	275	307	164	125	35.0	12005	11105	73132	0	0	0	0	275	307	164	125	35.0	10	77	66	39.7	265	12
2300	290	39	274	303	162	126	36.0	12110	11224	74343	0	0	0	0	274	303	162	126	36.0	10	75	64	38.7	265	12
2310	300	37	274	299	160	128	37.1	12219	11351	75688	0	0	0	0	274	299	160	128	37.1	0	0	0	37.8	265	12

Culmination of mean annual increment (CMAI) occurs at age 110. Selected rotation age must be equal or greater than CMAI (NFMA).

PNVT suitable timber production acres/selected rotation age = harvest acres/year
LTSYC = harvest acres/year x volume/acre at selected rotation age

LTSYC Summary by PNVT**

Forest Type (PNVT)	Uneven-aged yield (per acre/year), Board feet (9”+ dbh)	Uneven-aged yield (per acre/year) Cubic feet (5”+ dbh)	Even-aged yield per acre at CMAI* Board feet (9”+ dbh)	Even-aged yield per acre at CMAI Cubic feet (5”+ dbh)
Ponderosa pine/grass (low SI)	74.5	15.5	NA	NA
Ponderosa pine/grass (high SI)	116.0	23.6	NA	NA
Ponderosa pine/Gambel oak (low SI)	71.3	15.5	NA	NA
Ponderosa pine/Gambel oak (high SI)	113.0	23.7	NA	NA
Ponderosa pine/Evergreen oak (low SI)	72.4	15.8	NA	NA
Ponderosa pine/Evergreen oak (high SI)	82.6	17.8	NA	NA
Dry mixed conifer	93.8	22.9	NA	NA
Wet mixed conifer	89.6	24.7	NA	NA
Spruce-fir (mix)	99.6	27.9	NA	NA
Spruce-fir (pure)	NA	NA	37,075*	7,247*

* Culmination of mean annual increment occurs at age 110

** All volumes are net (merchantable minus seen defect)

Attachment A
Principle Statute and Regulation Citations, and Guidance

The following are citations from the National Forest Management Act, the Multiple-Use Sustained-Yield Act, and 36 CFR 219.16 (1999) that are relevant to discussions on sustained yield.

The National Forest Management Act of 1976 (16 U.S.C. 1600)

Section 6. National Forest System Resource Planning

(e) In developing, maintaining, and revising plans for units of the National Forest System pursuant to this section, the Secretary shall assure that such plans-

(1) provide for multiple use and sustained yield of the products and services obtained there from in accordance with the Multiple-Use, Sustained-Yield Act of 1960, and in particular, include coordination of outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness; and timber, watershed, wildlife and fish, and wilderness; and

(2) determine forest management systems, harvesting levels, and procedures in the light of all of the uses set forth in subsection (c)(1), the definition of the terms 'multiple use' and 'sustained yield' as provided in the Multiple-Use, Sustained-Yield Act of 1960, and the availability of lands and their suitability for resource management.

(f) Plans developed in accordance with this section shall-

(1) form one integrated plan for each unit of the National Forest System, incorporating in one document or one set of documents, available to the public at convenient locations, all of the features required by this section;

(2) be embodied in appropriate written material, including maps and other descriptive documents, reflecting proposed and possible actions, including the planned timber sale program and the proportion of probable methods of timber harvest within the unit necessary to fulfill the plan;

Section 13. Limitations on Timber Removal.

The Secretary of Agriculture shall limit the sale of timber from each national forest to a quantity equal to or less than a quantity which can be removed from such forest annually in perpetuity on a sustained-yield basis: Provided, That, in order to meet overall multiple-use objectives, the Secretary may establish an allowable sale quantity for any decade which departs from the projected long-term average sale quantity that would otherwise be established: Provided further, That any such planned departure must be consistent with the multiple-use management objectives of the land management plan. Plans for variations in the allowable sale quantity must be made with public participation as required by section 6(d) of this Act.

In addition, within any decade, the Secretary may sell a quantity in excess of the annual allowable sale quantity established pursuant to this section in the case of any national forest so long as the average sale quantity of timber from such national forest over the decade covered by the plan do not exceed

such quantity limitation. In those cases where a forest has less than two hundred thousand acres of commercial forest land, the Secretary may use two or more forests for purposes of determining the sustained yield.

(b)Nothing in subsection (a) of this section shall prohibit the Secretary from salvage or sanitation harvesting of timber stands which are substantially damaged by fire, windthrow, or other catastrophe, or which are in imminent danger from insect or disease attack. The Secretary may either substitute such timber for timber that would otherwise be sold under the plan or, if not feasible, sell such timber over and above the plan volume. (16 U.S.C. 1611)

The Multiple-Use Sustained Yield Act of 1960 (16 U.S. C. 528)

SEC. 2. 16 U.S.C. 529À
The Secretary of Agriculture is authorized and directed to develop and administer the renewable surface resources of the national forests for multiple use and sustained yield of the several products and services obtained therefrom. In the administration of the national forests due consideration shall be given to the relative values of the various resources in particular areas.

SEC. 5. 16 U.S.C. 528.
(b) ''Sustained yield of the several products and services'' means the achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land.

1. Estimate of the long-term sustained-yield capacity. During plan development or plan revision and, as appropriate, for plan amendment, the Responsible Official shall estimate the amount of timber that could be harvested annually in perpetuity on a sustained-yield basis from land where timber harvest could occur, once these lands are in their desired condition.

2. Limitation on timber sold. Except as provided at paragraph 3 and 4 of this section, within any decade, the Responsible Official must limit the quantity of timber sold during that decade from the "land where timber harvest could occur" to a quantity equal to or less than that estimated as provided in paragraph 1 of this section

1982 Planning Rule (section 219.16)

<u>Sec. 219.14 Timber resource land suitability</u>

During the forest planning process, lands which are not suited for timber production shall be identified in accordance with the criteria in paragraphs (a) through (d) of this section.

(a) During the analysis of the management situation, data on all National Forest System lands within the planning area shall be reviewed, and those lands within any one of the categories described in paragraphs (a) (1) through (4) of this section shall be identified as not suited for timber production--

(1) The land is not forest land as defined in Sec. 219.3.

(2) Technology is not available to ensure timber production from the land without irreversible resource damage to soils productivity, or watershed conditions.

(3) There is not reasonable assurance that such lands can be adequately restocked as provided in Sec. 219.27(c)(3).

(4) The land has been withdrawn from timber production by an Act of Congress, the Secretary of Agriculture or the Chief of the Forest Service.

(b) Forest lands other than those that have been identified as not suited for timber production in paragraph (a) of this section shall be further reviewed and assessed prior to formulation of alternatives to determine the costs and benefits for a range of management intensities for timber production. For the purpose of analysis, the planning area shall be stratified into categories of land with similar management costs and returns. The stratification should consider appropriate factors that influence the costs and returns such as physical and biological conditions of the site and transportation requirements. This analysis shall identify the management intensity for timber production for each category of land which results in the largest excess of discounted benefits less discounted costs and shall compare the direct costs of growing and harvesting trees, including capital expenditures required for timber production, to the anticipated receipts to the government, in accordance with Sec. 219.12 and paragraphs (b)(1) through (b)(3) of this section.

(1) Direct benefits are expressed as expected gross receipts to the government. Such receipts shall be based upon expected stumpage prices and payments-in-kind from timber harvest considering future supply and demand situation for timber and upon timber production goals of the regional guide.

(2) Direct costs include the anticipated investments, maintenance, operating, management, and planning costs attributable to timber production activities, including mitigation measures necessitated by the impacts of timber production.

(3) In addition to long-term yield, the financial analysis must consider costs and returns of managing the existing timber inventory.

(c) During formulation and evaluation of each alternative as required in Sec. 219.12 (f) and (g), combinations of resource management prescriptions shall be defined to meet management objectives for the various multiple uses including outdoor recreation, timber, watershed, range, wildlife and fish, and wilderness. The formulation and evaluation of each alternative shall consider the costs and benefits of alternative management intensities for timber production as identified pursuant to paragraph (b) of this section in accordance with Sec. 219.12(f). Lands shall be tentatively identified as not appropriate for timber production to meet objectives of the alternative being considered if--

(1) Based upon a consideration of multiple-use objectives for the alternative, the land is proposed for resource uses that preclude timber production, such as wilderness;

(2) Other management objectives for the alternative limit timber production activities to the point where management requirements set forth in Sec. 219.27 cannot be met; or

(3) The lands are not cost-efficient, over the planning horizon, in meeting forest objectives, which include timber production.

(d) Lands identified as not suited for timber production in paragraph (a) of this section and lands tentatively identified as not appropriate for timber production in paragraph (c) of this section shall be designated as not suited for timber production in the preferred alternative. Designation in the plan of lands not suited for timber production shall be reviewed at least every 10 years. Such lands may be reviewed and redesignated as suited for timber production due to changed conditions at any time, according to the criteria in paragraphs (a) and

(c) of this section, and according to the procedures for amendment or revision of the forest plan in Sec. 219.10 (f) and (g).

Sec. 219.16 Timber resource sale schedule

In a forest plan, the selected forest management alternative includes a sale schedule which provides the allowable sale quantity. The sale schedule of each alternative, including those which depart from base sale schedules, shall be formulated in compliance with Sec. 219.12(f) and paragraphs (a) and (b) of this section.

(a) Alternatives shall be formulated that include determinations of the quantity of the timber that may be sold during each decade. These quantity determinations shall be based on the principle of sustained yield and shall meet the management requirements in Sec. 219.27. For each alternative, the determination shall include a calculation of the long-term sustained-yield capacity and the base sale schedule and, when appropriate, a calculation of timber sale alternatives that may depart from the base sale schedule as provided in paragraphs (a)(1) through (a)(3) of this section.

(1) For the base sale schedules, the planned sale for any future decade shall be equal to, or greater than, the planned sale for the preceding decade, provided that the planned sale is not greater than the long-term sustained-yield capacity consistent with the management objectives of the alternative.

(2) The determinations of the appropriate long-term sustained-yield capacities, base sale schedules, and departure alternatives to the base sale schedules shall be made on the basis of the guidelines which follow:

(i) For the long-term sustained-yield capacities and the base sale schedules, assume intensities of management and degree of timber utilization consistent with the goals, assumptions, and requirements contained in, or used in, the preparation of the current RPA Program and regional guide. For the base sale schedule, the management and utilization assumptions shall reflect the projected changes in practices for the four decades contained in, or used in, the preparation of the current RPA Program and regional guide. Beyond the fourth decade, the assumptions shall reflect those projected for the fourth decade of the current RPA Program, unless there is a basis for a different assumption;

(ii) For alternatives with sale schedules which depart from the corresponding base sale schedule, assume an appropriate management intensity;

(iii) In accordance with the established standards, assure that all even-aged stands scheduled to be harvested during the planning period will generally have reached the culmination of mean annual increment of growth. Mean annual increment shall be based on expected growth, according to management intensities and utilization standards assumed in paragraphs (a)(2) (i) and (ii) of this section and on forest type and site quality. Mean annual increment shall be expressed in cubic measure.

Alternatives which incorporate exceptions to these standards shall be evaluated if it is reasonable to expect that overall multiple use objectives would be better attained. Alternatives which incorporate exceptions to these standards are permitted for the use of sound silvicultural practices, such as thinning or other stand improvement measures; for salvage or sanitation harvesting of timber stands which are substantially damaged by fire, windthrow, or other catastrophe, or which are in imminent danger from insect or disease attack; for cutting for experimental and research purposes; or for removing particular species of trees, after consideration has been given to the multiple uses of the area being planned and after completion of the public participation process applicable to the preparation of a forest plan; and

(iv) Each sale schedule shall provide for a forest structure that will enable perpetual timber harvest which meets the principle of sustained-yield and multiple-use objectives of the alternative.

(3) Alternatives with sale schedules which depart from the principles of paragraph (a)(1) of this section and which will lead to better attaining the overall objectives of multiple-use management shall be evaluated when any of the following conditions are indicated:

(i) None of the other alternatives considered provides a sale schedule that achieves the assigned goals of the RPA Program as provided in Sec. 219.4(b);

(ii) High mortality losses from any cause can be significantly reduced or prevented or forest age-class distribution can be improved, thereby facilitating future sustained-yield management; or

(iii) Implementation of the corresponding base sale schedule would cause a substantial adverse impact upon a community in the economic area in which the forest is located.

(iv) It is reasonable to expect that overall multiple-use objectives would otherwise be better attained.

(b) The sale schedule of the management alternative selected in accordance with Sec. 219.12 provides the allowable sale quantity for the first plan period.

Sec. 219.27 Management requirements

The minimum specific management requirements to be met in accomplishing goals and objectives for the National Forest System are set forth in this section. These requirements guide the development, analysis, approval, implementation, monitoring and evaluation of forest plans.

(a) Resource protection. All management prescriptions shall--

(1) Conserve soil and water resources and not allow significant or permanent impairment of the productivity of the land;

(2) Consistent with the relative resource values involved, minimize serious or long-lasting hazards from flood, wind, wildfire, erosion, or other natural physical forces unless these are specifically excepted, as in wilderness;

(3) Consistent with the relative resource values involved, prevent or reduce serious, long lasting hazards and damage from pest organisms, utilizing principles of integrated pest management. Under this approach all aspects of a pest-host system should be weighed to determine situation-specific

prescriptions which may utilize a combination of techniques including, as appropriate, natural controls, harvesting, use of resistant species, maintenance of diversity, removal of damaged trees, and judicious use of pesticides. The basic principle in the choice of strategy is that, in the long term, it be ecologically acceptable and compatible with the forest ecosystem and the multiple use objectives of the plan;

(4) Protect streams, streambanks, shorelines, lakes, wetlands, and other bodies of water as provided under paragraphs (d) and (e) of this section;

(5) Provide for and maintain diversity of plant and animal communities to meet overall multiple-use objectives, as provided in paragraph (g) of this section;

(6) Provide for adequate fish and wildlife habitat to maintain viable populations of existing native vertebrate species and provide that habitat for species chosen under Sec. 219.19 is maintained and improved to the degree consistent with multiple-use objectives established in the plan;

(7) Be assessed prior to project implementation for potential physical, biological, aesthetic, cultural, engineering, and economic impacts and for consistency with multiple uses planned for the general area;

(8) Include measures for preventing the destruction or adverse modification of critical habitat for threatened and endangered species;

(9) Provide that existing significant transportation and utility corridors and other significant right-of-ways that are capable and likely to be needed to accommodate the facility or use from an additional compatible right-of-way be designated as a right-of-way corridor. Subsequent right-of-way grants will, to the extent practicable, and as determined by the responsible line officer, use designated corridors;

(10) Ensure that any roads constructed through contracts, permits, or leases are designed according to standards appropriate to the planned uses, considering safety, cost of transportation, and effects upon lands and resources;

(11) Provide that all roads are planned and designed to re-establish vegetative cover on the disturbed area within a reasonable period of time, not to exceed 10 years after the termination of a contract, lease or permit, unless the road is determined necessary as a permanent addition to the National Forest Transportation System; and

(12) Be consistent with maintaining air quality at a level that is adequate for the protection and use of National Forest System resources and that meets or exceeds applicable Federal, State and/or local standards or regulations.

(b) Vegetative manipulation. Management prescriptions that involve vegetative manipulation of tree cover for any purpose shall--

(1) Be best suited to the multiple-use goals established for the area with potential environmental, biological, cultural resource, aesthetic, engineering, and economic impacts, as stated in the regional guides and forest plans, being considered in this determination;

(2) Assure that lands can be adequately restocked as provided in paragraph (c)(3) of this section, except where permanent openings are created for wildlife habitat improvement, vistas, recreation uses and similar practices;

(3) Not be chosen primarily because they will give the greatest dollar return or the greatest output of timber, although these factors shall be considered;

(4) Be chosen after considering potential effects on residual trees and adjacent stands;

(5) Avoid permanent impairment of site productivity and ensure conservation of soil and water resources;

(6) Provide the desired effects on water quantity and quality, wildlife and fish habitat, regeneration of desired tree species, forage production, recreation uses, aesthetic values, and other resource yields; and

(7) Be practical in terms of transportation and harvesting requirements, and total costs of preparation, logging, and administration.

(c) Silvicultural practices. The following management requirements apply to timber harvest and cultural treatments:

(1) No timber harvesting shall occur on lands classified as not suited for timber production pursuant to Sec. 219.14 except for salvage sales, sales necessary to protect other multiple-use values or activities that meet other objectives on such lands if the forest plan establishes that such actions are appropriate. These lands shall continue to be treated for reforestation purposes if necessary to achieve the multiple-use objectives of the plan.

(2) The selected sale schedule provides the allowable sale quantity for the first planning period. Within the planning period, the volume of timber to be sold in any one year may exceed the average annual allowable sale quantity so long as the total amount sold for the planning period does not exceed the allowable sale quantity. Nothing in this paragraph prohibits salvage or sanitation harvesting of timber stands which are substantially damaged by fire, windthrow, or other catastrophe, or which are in imminent danger of insect or disease attack and where such harvests are consistent with silvicultural and environmental standards. Such timber may either substitute for timber that would otherwise be sold under the plan or, if not feasible, be sold over and above the planned volume.

(3) When trees are cut to achieve timber production objectives, the cuttings shall be made in such a way as to assure that the technology and knowledge exists to adequately restock the lands within 5 years after final harvest. Research and experience shall be the basis for determining whether the harvest and regeneration practices planned can be expected to result in adequate restocking. Adequate restocking means that the cut area will contain the minimum number, size, distribution, and species composition of regeneration as specified in regional silvicultural guides for each forest type. Five years after final harvest means 5 years after clearcutting, 5 years after final overstory removal in shelterwood cutting, 5 years after the seed tree removal cut in seed tree cutting, or 5 years after selection cutting.

(4) Cultural treatments such as thinning, weeding, and other partial cutting may be included in the forest plan where they are intended to increase the rate of growth of remaining trees, favor commercially

valuable tree species, favor species or age classes which are most valuable for wildlife, or achieve other multiple-use objectives.

(5) Harvest levels based on intensified management practices shall be decreased no later than the end of each planning period if such practices cannot be completed substantially as planned.

(6) Timber harvest cuts designed to regenerate an even-aged stand of timber shall be carried out in a manner consistent with the protection of soil, watershed, fish and wildlife, recreation, and aesthetic resources, and the regeneration of the timber resource.

(7) Timber harvest and other silvicultural treatments shall be used to prevent potentially damaging population increases of forest pest organisms. Silvicultural treatments shall not be applied where such treatments would make stands susceptible to pest-caused damage levels inconsistent with management objectives.

(d) Even-aged management. When openings are created in the forest by the application of even-aged silviculture, the following management requirements apply:

(1) Openings shall be located to achieve the desired combination of multiple-use objectives. The blocks or strips cut shall be shaped and blended with the natural terrain, to the extent practicable, to achieve aesthetic, wildlife habitat, or other objectives established in the plan. Regional guides shall provide guidance on dispersion of openings in relation to topography, climate, geography, local land use patterns, forest types or other factors. As a minimum, openings in forest stands are no longer considered openings once a new forest is established. Forest plans may set forth variations to this minimum based on site- specific requirements for achieving multiple-use objectives. Regional guides shall provide guidance for determining variations to this minimum in the forest plan, based on requirements for watershed, wildlife habitat, scenery or other resource protection needs, or other factors.

(2) Individual cut blocks, patches, or strips shall conform to the maximum size limits for areas to be cut in one harvest operation established by the regional guide according to geographic areas and forest types. This limit may be less than, but will not exceed, 60 acres for the Douglas-fir forest type of California, Oregon, and Washington; 80 acres for the southern yellow pine types of Alabama, Arkansas, Georgia, Florida, Louisiana, Mississippi, North Carolina, South Carolina, Oklahoma, and Texas; 100 acres for the hemlock-sitka spruce forest type of coastal Alaska; and 40 acres for all other forest types except as provided in paragraphs (d)(2)(i) through (iii) of this section:

(i) Cut openings larger than those specified may be permitted where larger units will produce a more desirable combination of net public benefits. Such exceptions shall be provided for in regional guides. The following factors shall be considered in evaluating harvest cuts of various sizes and shapes to determine size limits by geographic areas and forest types: Topography; relationship of units to other natural or artificial openings and proximity of units; coordination and consistency with adjacent forests and regions; effect on water quality and quantity; visual absorption capability; effect on wildlife and fish habitat; regeneration requirements for desirable tree species based upon the latest research findings; transportation and harvesting system requirements; environmental and forest pest hazards to regeneration, residual trees, and surrounding stands; and the relative total costs of preparation and administration, transportation requirements, harvesting, site preparation, planting, stocking control, and future stand tending of harvest cuts of various sizes and shapes. Specification for exceptions shall

include the particular conditions under which the larger size is permitted and shall set a new maximum size permitted under those conditions.

(ii) Size limits exceeding those established in paragraphs (d)(2) and (d)(2)(i) of this section are permitted on an individual timber sale basis after 60 days' public notice and review by the Regional Forester.

(iii) The established limit shall not apply to the size of areas harvested as a result of natural catastrophic condition such as fire, insect and disease attack, or windstorm.

(e) Riparian areas. Special attention shall be given to land and vegetation for approximately 100 feet from the edges of all perennial streams, lakes, and other bodies of water. This area shall correspond to at least the recognizable area dominated by the riparian vegetation. No management practices causing detrimental changes in water temperature or chemical composition, blockages of water courses, or deposits of sediment shall be permitted within these areas which seriously and adversely affect water conditions or fish habitat. Topography, vegetation type, soil, climatic conditions, management objectives, and other factors shall be considered in determining what management practices may be performed within these areas or the constraints to be placed upon their performance.

(f) Soil and water. Conservation of soil and water resources involves the analysis, protection, enhancement, treatment, and evaluation of soil and water resources and their responses under management and shall be guided by instructions in official technical handbooks. These handbooks must show specific ways to avoid or mitigate damage, and maintain or enhance productivity on specific sites. These handbooks may be regional in scope or, where feasible, specific to physiographic or climatic provinces.

(g) Diversity. Management prescriptions, where appropriate and to the extent practicable, shall preserve and enhance the diversity of plant and animal communities, including endemic and desirable naturalized plant and animal species, so that it is at least as great as that which would be expected in a natural forest and the diversity of tree species similar to that existing in the planning area. Reductions in diversity of plant and animal communities and tree species from that which would be expected in a natural forest, or from that similar to the existing diversity in the planning area, may be prescribed only where needed to meet overall multiple-use objectives. Planned type conversion shall be justified by an analysis showing biological, economic, social, and environmental design consequences, and the relation of such conversions to the process of natural change.

Optional Agency Direction –Recommended Guidance

FSH 2409.13 - TIMBER RESOURCE PLANNING HANDBOOK, CHAPTER 30 - TIMBER SALE SCHEDULING

WO AMENDMENT 2409.13-92-1, EFFECTIVE 8/3/92

Timber sale scheduling requires the calculation of the base sale schedule and, where appropriate, the departure schedule through use of an optimizing model* that leads toward long-term sustained yield capacity (LTSYC) for suitable lands in each alternative. The calculation shall be in cubic feet; converted to board feet for selected periods in the planning horizon.

The sale schedule in the approved forest plan establishes the allowable sale quantity (ASQ) for the first decade and projected ASQ for future periods.

31 - LONG-TERM SUSTAINED-YIELD CAPACITY. Determine the long-term sustained yield capacity (LTSYC) in conjunction with the calculation of the allowable sale quantity for a given alternative. Base this determination on the yield by prescription from regenerated stands, including where appropriate, intermediate yields selected in the solution of that alternative.

32 - ROTATION. In even-aged management, the selection of rotation age or ages materially affects the length of time required to achieve the desired distribution of age classes and LTSYC. Within the requirements described in FSH 2409.13-32.1, a range of rotation ages or timing options is preferable for analysis of present and future stands. A variety of rotation ages provides a means of progressing toward the regulated forest as well as providing the variety of tree sizes required to meet the needs of other resources. For most species and forest types, select rotations that produce sawtimber and veneer products, unless otherwise provided for in the forest plan.

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* Note to the reader: In the early decades of Forest planning, linear programming (LP) optimization software (first called “FORPLAN” and then later called “Spectrum”)was used to formulate and evaluate land allocations and activities and output scheduling over the planning horizon. So the word “optimizing” in this paragraph comes from that era. In this round of Forest plan revision, analysis uses state and transition models employing the VDDT simulation software in more of a heuristic, or trial and error, approach to developing the proposed land allocation that will best move the forest toward desired conditions.

32.1 - Culmination of Mean Annual Increment. Rotation ages must meet the requirement that all even-aged stands scheduled for harvest generally will have reached the culmination of mean annual increment (CMAI) of growth. Permit the harvest of trees or stands before CMAI for: (1) sound silvicultural practices such as thinnings or other stand improvement measures; (2) salvage or sanitation harvesting of stands substantially damaged by fire, windthrow, or other catastrophes, or stands that are in imminent danger from insect or disease attack; (3) experimental and research purposes; and (4) removal of particular species of trees, after consideration of the multiple-use objectives of the forest plan alternative.

Base the determination of CMAI on the yield from regeneration harvest and any additional yields from intermediate harvests, consistent with the selected management prescription. In general, base minimum rotation age on the length of time required to achieve volume production equivalent to at least 95 percent of CMAI as expressed in cubic measure. (FSH 2409.13-22).

During analysis of the management situation, alternatives to CMAI may be evaluated in the establishment of benchmarks.

33 - BASE SALE SCHEDULE. The base sale schedule (BSS) reflects a constant or increasing level of planned timber sale offerings, consistent with the principle of nondeclining flow (36 CFR 219.16 (1999) (a)(i)). Calculate the BSS far enough into the future to provide for a forest structure that will ensure a perpetual sale schedule at long-term sustained yield capacity (LTSYC). The BSS reflects the intensities of management and the degree of timber utilization, consistent with the goals, assumptions, and standards contained or used in the preparation of the current Resources Planning Act (RPA) program and Regional guide. For the BSS, the management and utilization assumptions reflect the projected changes in practices for the five decades contained or used in the preparation of the current Resources Planning Act program and Regional guide.

Sale schedules coincide with each of the decades in the RPA planning horizon. For the remaining portion of the planning horizon, decades may be grouped in a manner suitable for analysis of their long-term effects.

34 - DEPARTURE FROM BASE SALE SCHEDULE. The purpose of analyzing departures is to determine whether or not it is possible to better meet multiple-use objectives by regulating the planned sale and harvest of timber volume in a manner that deviates from the principle of nondeclining flow (36 CFR 219.16 (1999) (a)(3)).

34.1 - Criteria for Analysis and Selection of Departures. Evaluate departure opportunities in forest planning when any one of the following conditions do, or are likely to, exist: (1) it is possible to reduce significantly or prevent high mortality losses from any cause;

(2) it is possible to improve timber age or size class distribution, thereby facilitating the attainment of the forest growing at its LTSYC; (3) implementation of the corresponding base sale schedule (BSS) would have a substantial adverse impact upon a community in the economic area in which the forest is located; (4) none of the alternatives under consideration provide a BSS that achieves the goals of the

Resources Planning Act (RPA) program; or (5) it is reasonable to expect that it would be better to attain overall multiple-use objectives in other ways.

The RPA program, Regional guide, and the forest plans under development set forth the multiple-use objectives, which incorporate physical, biological, economic, and social considerations.

Analyze departure opportunities as a means of attaining 90 percent of the average annual growth rate at the LTSYC by the year 2030, as specified in the revised RPA statement of policy (FSM 2410.3-7).

34.2 - Calculation of Departures

1. Departures are discrete alternatives in that they may be selected individually as the preferred alternative; however, link them to the BSS of a given alternative. Accordingly, the BSS constitutes the basis for analyzing departures in determining whether or not departures meet the criteria set forth above.

The basic configuration of a departure can take two forms: (1) the departure schedule temporarily exceeds the BSS and subsequently drops below the BSS before eventually reaching it; and (2) the departure schedule temporarily exceeds the BSS and subsequently drops down to, but not below, the BSS. When the BSS for the first decade equals the long-term sustained yield capacity (LTSYC), explore the possibility of the latter configuration in the departure analysis.

In determining the magnitude, duration, incremental change, and minimum sale level for departures, consider, but do not limit consideration to such factors as: (1) consistency with multiple-use objectives; (2) environmental impacts; (3) community stability; (4) installed mill capacity; and (5) projected timber supplies from other ownerships. Exercise judgment in developing sale schedules that do not fluctuate drastically from decade to decade over the planning horizon. If appropriate, limit the magnitude of the change in consideration of the above factors and to provide for an orderly transition to a forest growing at its LTSYC. Consider Regional guidance regarding permissible decade fluctuations.

2. Use the same LTSYC associated with the BSS of a given alternative in examining a departure. The BSS establishes this LTSYC. Exceptions to this requirement are allowable in the analysis of the management situation, whereby a departure sale schedule not linked to any BSS may be established for informational and trade-off analysis purposes. (FSM 2410.3).

3. Use the same tentatively suitable acres, multiple-use objectives, and range of management prescriptions to establish the BSS of a given alternative and a departure. However, the resulting land uses, suitable acres, and selected management prescriptions may differ in their respective solutions.

4. Hold the following variables in the calculation of the BSS constant in the calculation of departures:

a. Ending inventory volume that will enable perpetual timber harvest at the LTSYC, consistent with the multiple-use objectives.

b. Maximum size limits on openings.

c. Requirements for management practices as set forth in 36 CFR 219.27 (1999).

d. Tentatively suitable acres.

e. Minimum utilization standards.

NOTE: Any changes in the foregoing variables constitute the creation of a new alternative for which it is necessary to establish a new BSS in order to examine departures.

5. Relax the following base sale schedule (BSS) requirements in the calculation of departures.

a. Planned sale for any decade equal to or greater than planned sale and harvest for preceding decade (nondeclining flow).

b. Periodic harvests at or below LTSYC.

6. Permit the following outputs established in the BSS to vary in the calculation of departures:

a. Management Intensity. Use the same range of management prescriptions as input to the formulation of a BSS and departures. However, the appropriate timing and mix of prescriptions chosen may differ from those selected in the establishment of the BSS.

b. Land Use. Use the same tentatively suitable forest land base used in the BSS calculation. However, the resulting amount of land suitable for timber production may vary in the departures.
c. Management Objectives. Use the same management objectives of the alternative in formulation of a departure. Analyze with respect to the objectives of the alternative any changes in land use that the departure may cause. Objectives or targets, such as dispersed recreation visitor days may be met, but the location of the activity may change. Evaluate the significance and acceptability of the changed location.

d. Multiple-Use Objectives. The set of multiple-use objectives, other than timber, used as input to the BSS calculation establishes the minimum/maximum levels for the departure. Specified targets, such as the number of recreation visitor days, constitute the minimum level of output permitted in a departure. Specified limitations, such as the tons of sediment produced, are the maximum level of output permitted in a departure.

e. Rotations. Several rotation lengths may be used to balance timber yields in the BSS calculation. Provide the same set for the departure; however, the lengths selected may vary from the BSS as long as it is possible to meet the culmination of mean annual increment requirement (FSH 2409.13-32.1).

<u>34.3 - Departure Analysis</u>. Analyze a departure according to how well it achieves:

1. Multiple-use objectives of the associated nondeparture alternative.

2. Land uses of the base sale schedule (BSS).

3. Criteria specified in FSH 2409.13-34.1 (36 CFR 219.16 (1999) (a)(3)).

4. Factors contributing to the increase of net public benefits. Consider flow limits if the schedule obtained will cause adverse economic impacts or require significant industry investments to expand capacity. In those instances where more than one National Forest or other land owner contributes to a market area, the Regional Forester must coordinate flow to minimize adverse economic impacts and to provide a planning base for industry investment.

34.4 - Display of the Analysis. Describe the departures in the environmental impact statement, either as an alternative eliminated from detailed study or as a viable alternative. For those departures eliminated from detailed study, identify the rationale.

35 - ALLOWABLE SALE QUANTITY. The allowable sale quantity (ASQ) includes only those volumes used in the yield projection calculation of the sale schedule for suitable lands (these volumes are chargeable). It may include volume in salvage or mortality sales but only if included in the yield projection calculations. Conversely, volume not included in the calculation, such as unsound material or any planned sales in unsuitable land, is not part of the ASQ (these volumes are nonchargeable). Where a firm or intermittent market exists for unsound or dead material, the estimated amount of this class of material expected to be available during the plan period may be shown as additional volume and included in the timber sale program quantity, but it is not a part of the ASQ.

In the implementation of the forest plan, unforeseen conditions may warrant selling as fuelwood some volume that was included in the allowable sale quantity, for example, timber severely damaged by fire or insects. In such cases, fuelwood volume is chargeable.

Calculations of the ASQ shall include only trees utilized to the standards specified in the Regional guide. The ASQ includes the volume of all timber products from these trees, to the specified utilization standards. When the product mix is of interest to the wood products industry or others, the corresponding volume components may be identified subsequently in the forest plan. Do not include any other material planned for sale in the ASQ, for example, cull material and fuelwood.

Normally, make adjustments in the allowable sale quantity to reflect differences between planned budget needs and actual funds received, success in implementing planned timber management practices, or changes in timber conditions or markets at the time of forest plan revision at the end of the 10-year planning period. However, if the differences or changes are significant and are likely to continue throughout the planning period, adjust the ASQ and amend or revise the forest plan (36 CFR 219.10(e)-(g)).

36 - TIMBER SALE PROGRAM QUANTITY. The timber sale program quantity includes the allowable sale quantity (ASQ) for the first decade and any additional volume planned for sale during the first decade. Volume in addition to the ASQ is nonchargeable and may be harvested from suitable and/or unsuitable land, for example, fuelwood. In the execution of the timber sale program, there may be situations where volume included in the ASQ is sold as fuelwood. In these cases, charge the fuelwood volume to the ASQ.

Attachment B
Modeling Assumptions

Table 1. Regional Seen Defect –Timber

Summary based on 62 R3 sales from the past 4-5 years, weighted on expanded volume for the number of sample trees shown

Consider adding 5% to the 30-inch value for 35-40-45-50 inch classes (compiled by Jeff Hogg, R3 Mensurationist, 2010 (retired)

Species Dclass	Plan Defect	Def Rounded	CalcDef Wt'dAvg	Sample Count	Expanded SumCFgrsExp	Expanded SumCFnetExp	Notes
M		0.03	0.035	25325	41428989	39996756	Total
DF		0.03	0.035	2020	1312366	1266604	
5	0.00	0.00	0.003	383	256788	256045	
10	0.03	0.02	0.024	638	489824	478083	
15	0.06	0.05	0.048	624	385431	366933	
20	0.10	0.06	0.064	236	116695	109253	
25	0.15	0.11	0.106	92	37435	33464	
30	0.20	0.13	0.129	47	26193	22826	
ES & BS		0.04	0.038	1447	301930	290396	
5	0.00	0.00	0.000	491	44634	44634	
10	0.03	0.03	0.025	573	151980	148119	
15	0.06	0.07	0.067	264	82772	77263	
20	0.10	0.08	0.079	84	13269	12226	
25	0.15	0.11	0.114	28	6562	5816	
30	0.20	0.14	0.138	7	2714	2339	
PP		0.04	0.038	19521	35450731	34118747	Add Red Rot, No indicators
5	0.00	0.00	0.003	3556	3195318	3185474	
10	0.03	0.03	0.032	9705	16180156	15658154	
15	0.06	0.04	0.042	4843	12739633	12200540	
20	0.10	0.06	0.057	1092	2760519	2603267	
25	0.15	0.15	0.152	233	435673	369456	
30	0.20	0.27	0.269	92	139432	101856	
WF		0.07	0.075	533	517875	479237	
5	0.00	0.00	0.000	80	56914	56914	
10	0.05	0.07	0.068	240	200154	186531	
15	0.10	0.08	0.077	151	205266	189528	
20	0.15	0.17	0.168	44	40998	34118	
25	0.20	0.14	0.141	16	12640	10859	keep progression, too few samples
30	0.30	0.32	0.324	2	1903	1287	
WP		0.04	0.041	319	53226	51025	
5	0.00	0.00	0.004	70	8604	8567	
10	0.03	0.03	0.030	128	20424	19813	
15	0.06	0.04	0.041	80	14972	14354	
20	0.10	0.10	0.101	31	8084	7269	
25	0.15	0.11	0.109	9	1009	899	
30	0.20	0.08	0.080	1	133	123	
CF		0.01	0.007	42	34731	34478	
5	0.00	0.00	0.000	14	24753	24753	
10	0.05	0.02	0.017	11	8831	8682	
15	0.10	0.00	0.004	8	304	303	
20	0.15	0.10	0.101	7	553	497	
25	0.20	0.16	0.160	2	291	244	
30	0.30						no samples
AS		0.24	0.238	118	7479	5696	
5	0.05	0.34	0.338	66	3847	2548	
10	0.10	0.12	0.118	46	3254	2868	
15	0.20	0.14	0.145	5	310	265	
20	0.60	0.78	0.781	1	68	15	