LAND USE PLANNING NOTES <<<<

NUMBER 3 X APRIL 1998

"STEWARDSHIP IN FORESTRY"

PURPOSE: This technical bulletin has been developed to help landowners and local governments when they must use an alternative to the USDA Soil Survey to determine the productivity of forestland. Under OAR 660-06-005 "where SCS data are not available or are shown to be inaccurate, an alternative method for determining productivity may be used. An alternative method must provide equivalent data and be approved by the Department of Forestry." This paper describes the methodology that the Department approves and provides guidance and other information necessary to use that methodology. We have also included some background information to answer some commonly asked questions about the cubic foot productivity class system.

Why use the average annual cubic foot production in land use decisions?

The Department of Forestry advises using the USDA Cubic Foot Productivity Class[1] system, as opposed to other systems of measure, when making land use planning decisions because it measures the relative productivity of the soil, it is not dependent upon the condition of the forest or the species of trees currently growing on the site, and it is more consistent than other measures.

The cubic foot productivity class system ranks soils based upon the mean annual increment measured in cubic feet at the point in time where the culmination of mean annual increment (maximum average annual growth) occurs. This is the average growth rate of the timber over the life of the stand measured at the peak of that average growth rate. The table below shows the potential timber yields of productivity classes 1 - 5 in cubic feet per acre per year (cuft/ac/yr).

[1]Field instructions for forest surveys in Washington, Oregon, and Northern California. USDA Forest Service, PNW Range and Experiment Station.

CUBIC FOOT PRODUCTIVITY CLASSES

CODE	POTENTIAL YIELD-MEAN ANNUAL INCREMENT
1	225 or more cuft/ac/yr
2	165 to 224 cuft/ac/yr
3	120 to 164 cuft/ac/yr
4	85 to 119 cuft/ac/yr
5	50 to 84 cuft/ac/yr

Cubic foot productivity class was developed to compare the relative productivity of different soils. Other measures which might be used to compare different parcels, such as site class or site index, are not consistent between species and authors. Site class is commonly used on the west side to describe the productivity of Douglas-fir forests, but site class is only used for Douglas-fir and not for other species. Site index is calculated as tree height divided by tree age at a base age of 100 or 50. Since on the same area, in the same length of time, different species grow to different heights, site index is not consistent between species.

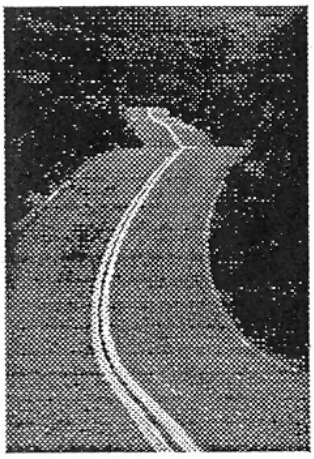
For example cubic foot productivity class III can produce between 120 and 164 cubic feet per acre per year from a fully stocked natural stand. In the next column is a comparison with several species and site indexes.

CUBIC FOOT PRODUCTIVITY CLASS 3
(120 - 164 cuft/ac/yr)

Site Index Equal to Productivity Class III

Douglas-fir	
(100 yr Site Index)	130 - 160
Western Hemlock	
(100 yr Site Index)	100 - 110
Ponderosa Pine	
(100 yr Site Index)	120 - 130
White Fir	
(50 yr Site Index)	60 - 70
Engelmann Spruce	
(50 year Site Index)	80 - 90

Another advantage of using cubic foot productivity class is that the ratings are available for most forestland without professional assistance. The published soil surveys contain a rating which can be used by county planners or private landowners to rate productivity and using the information does not require visiting the site or taking measurements.



Why don't we use board feet instead of cubic feet?

Cubic foot volume is a form of measurement commonly used in forestry research and forest management planning. It is a physical measurement based upon the actual volume of wood. On the other hand, board foot volume is based upon a series of rules. The board foot rules were developed to try to determine the amount of lumber which could be sawed (at that time) from a range of different diameter logs. Although its predictive abilities are out of date (1 board foot of log now produces from 1.7 - 2 board feet of lumber), board foot rules continue to be the most common measure used to buy and sell logs in the Northwest. The problem with converting cubic feet to board feet is that the conversion factor is not a constant. Because board foot volume is determined by a rule, one cubic foot of wood from a log with a scaling diameter (small end diameter) of 6 inches contains 3.32 board feet, while one cubic foot of wood from a log with a scaling diameter (small end diameter) of 30 inches contains 6.86 board feet. Therefore as the average diameter of a stand increases in size, the board foot/cubic foot ratio of the stand also increases. To complicate matters further, the length of the logs cut from the tree effects the conversion from cubic feet to board feet. Since trees are tapered and board foot is measured from the small end of the log, cutting the tree into different length logs changes the number of board feet contained in the tree. Because of this difference, the exact number of board feet contained in a stand of timber cannot be determined without knowing how the trees will be bucked into logs.

Because the board feet contained in a stand of timber depends on the average diameter of the stand and the way the trees are bucked into logs, the ratio of board feet to cubic feet is not constant. Comparisons such as soil productivity are much easier to make based upon a constant volume measure such as cubic feet. That is why it is more commonly used in the more technical forestry applications.

General Procedures to Challenge the Site Productivity Listed in the Soil Survey

Before deciding to use an alternative method of measuring the productivity of forestland, documentation should be produced showing that an attempt has been made to use the soil survey and either the soil(s) in question have no rating, or reasons exist indicating that the soil survey may be inaccurate. Where either of these two circumstances exist, a soil scientist from the USDA Natural Resource Conservation Service (NRCS, formerly SCS) should be contacted.

In many cases soils that are primarily used for agriculture were not given ratings for forestry. However, this does not mean they are not capable of growing trees. On the contrary, they may be highly productive, and a NRCS soil scientist may be able to provide a rating of that soil's forest capability. An NRCS soil scientist should also be able to advise you about the procedures used to conduct the soil survey and the accuracy of that survey as it relates to the property and soils in question. The advice received may save both the land owner and local official time and money.

Because the soil survey is not site specific information, The Department of Forestry has agreed to approve methods that would allow a land owner to use site specific information to determine the productivity of the land when applying for a dwelling or other land use decision.

The process should work something like this:

1. The Department of Forestry has approved a methodology for calculating site productivity (the details are described below in this document). When the landowner contacts the county with concerns about the productivity rating of their property, they are provided with information about the required methodology.

2. The landowner must have an independent, knowledgeable person, like a consulting forester, measure the trees on the property and calculate the cubic foot site class using the approved methods. Plots must be taken to measure the productivity of each different soil type and aspect on the property. The consultant must use care when selecting site trees to obtain an accurate measurement, and the consultant's report must provide adequate detail to determine whether the approved methods were followed.

3. The consultant shall provide a copy of the report to the county to use in making land use decisions. If the county has questions about whether the consultant followed the methodology, the Department of Forestry may need to review the report. However, because this is a land use decision, the county must make the final decision to accept or reject the work of the consultant.

Methodology Approved by the Department of Forestry for Calculating Site Productivity

The Department of Forestry does not measure sites for landowners. The landowner needs to have an independent qualified person, such as a consulting forester, take the measurements and calculate the cubic foot site class. The methodology the Department of Forestry approves to determine the productivity of an area is contained in the *Field instructions for forest surveys in Washington, Oregon, and Northern California. USDA Forest Service, PNW Range and Experiment Station.* Equivalent published methodology is more widely available from a Weyerhaeuser research paper, by King[2]. These papers describe how to select site-trees and calculate site index. A second paper, from the US Department of Agriculture[3], uses site index information

[2]King, James E. 1966. Site index curves for Douglas-fir in the Pacific Northwest. Weyerhaeuser Forestry Paper No. 8. Weyerhaeuser Forestry Research Center, Centralia, WA.

[3]USDA. 1986. Culmination of mean annual increment for commercial forest trees of Oregon.

(continued on next page)

as determined from on-site measurements to reference a set of cubic foot productivity tables. We approve this method because it is based on site specific measurements and it will produce results that are consistent with the Soil Survey.

A summary of the methodology and the necessary tables to calculate site class for the three most common forest types are included below. The methods listed in this paper can be used in combination with other published site index and yield tables if the site is not suited to one of these species. However, the use of other tables or the use of other species to determine site index must be approved by the Department of Forestry on a case by case basis.

Plots must be taken to measure the productivity of each different soil type and aspect on the property. Selection of site-trees (trees selected to determine site index) is a critical part of accurately determining the productivity of the land. To be used, site-trees must have remained in a dominant or co-dominant position throughout their life. If the land has been selectively harvested in the past, most or all of the dominant trees in the stand may have been removed. Basing site index calculations on the remaining trees, grown in lower crown positions, will not accurately measure site productivity. In some cases it may be difficult to find enough site trees on the property to accurately determine productivity. If insufficient dominant trees exist on the property to determine the site index, site-trees may be selected from adjacent properties with the same aspect, elevation, and soil type.

If the parcel is a forest site and no trees are available for site index calculations, or if the site index cannot be determined accurately from the existing timber in the area, then soil survey methodology will be required to accurately assess the site productivity. To map the area and provide site specific data that is more accurate than the USDA Soil Survey will require the landowner to employ a soil scientist to do a higher intensity soil survey. The qualifications and procedures for conducting such a survey are contained in OAR 603-80-0040 (3). This survey must provide detailed information on the soil types represented on the property.

General Rules for Selecting Site Trees

1. If possible, use the species that dominates the area. Height from 15 to 20 dominant and co-dominant trees and age counts on about 10 trees should be sufficient to determine site index if the area is homogeneous. Additional plots will need to be taken to represent different soil types and aspects across the property.

2. You may select site trees of different species as long as they use the same site table.

Technical Note No. 2. USDA, Soil Conservation Service, Portland, OR. (Note: the SCS - Soil Conservation Service is now the NRCS - Natural Resource Conservation Service)

3. Site index should not vary by more than 20 or 30 between site trees (as indicated on each site table), unless the difference can be explained by actual site variation. Use the site index tables below to compare site measurements.

4. If you select Douglas-fir or grand fir site trees use the site tree selection method for King's Douglas-fir table, outlined below. For other site tree species, use the site tree selection criteria for other species.

Method for Selecting Site Trees for King's Site Index Table
(Use for Douglas-fir and grand fir)

1. Within the plot area, locate an approximately circular area that encompasses 25 trees (the "site index clump") and that is representative of the site being sampled. When there is a choice, favor well-stocked areas over sparse areas. When counting trees, include only Douglas-fir with normally-formed tops; do not include understory trees that are both younger and shorter than the general crown canopy.

2. Of these 25 trees, select the 5 with the largest dbh as site trees.

3. Any site tree with a clear history of suppression should be rejected, and the next largest tree selected **if** it is suitable. However, you may select a suppressed tree over a shorter, suppression-free tree of the same age.

4. If a 25-tree clump is not available, a smaller clump may be used. You should still limit the site tree subsample to the 1/5 of the trees in the clump with the largest dbh **unless** this gives you less than three site trees.

Method for Selecting Site Trees for Other Site Index Tables

1. Select trees that are or have been free from suppression for their entire lives. A tree that has been suppressed will have closely-spaced annual growth rings on all or part of its increment core.

2. Select dominant trees.

3. Trees less than 50 years old are undesirable if older trees are available. For ponderosa pine, trees 60 to 120 years old are most desirable.

4. Site trees should be evenly distributed across the plot area.

5. Select trees that show no signs of top-out, such as crooks or forks, **unless** these trees are taller than normally-formed trees of the same dbh.

6. If no suitable site trees are available from the property, select dominant trees from a nearby area with the same general aspect, elevation, and soil type. Note the location of the site trees in your report.

Site Tables:

Depending on the species of site tree selected, use the appropriate table to determine site index.

1. King's Douglas-fir table. Use for Douglas-fir and grand fir.

2. Barnes western hemlock table. Use for western hemlock and Sitka spruce.

3. Meyer's ponderosa pine table. Use for ponderosa pine and Jeffrey pine. Use this table when in stands that are predominantly pine, or when pine site trees are all that are available (except in the Willamette Valley).

How to use site tables:

The following site index tables are "upper limit tables." This means that when a tree height indicates a site index that falls between two site indices listed you should use the higher one. Example: Site tree is Douglas-fir, 75 years old at breast height, 115 feet tall. King's Douglas-fir site index table indicates that a height of 115 feet at age 75 falls between site index 80 and 90. Site index is therefore 90.

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PONDEROSA PINE SITE TABLE

SITE INDEX TABLE

HT IN FEET

BH AGE	40	50	60	70	80	90	100	110	120	130	140	150
30	2.95	10.17	17.39	24.61	31.82	39.04	46.26	53.15	60.37	67.59	74.80	82.02
40	12.14	20.01	27.56	35.43	42.98	50.85	58.40	66.27	73.82	81.69	89.24	97.11
50	20.34	28.54	36.75	44.95	53.15	61.02	69.23	77.43	85.63	93.83	102.03	110.24
60	27.56	36.09	44.62	53.15	61.68	70.21	78.74	87.27	95.80	104.33	112.86	121.39
70	33.46	42.32	51.18	60.04	69.23	78.08	86.94	95.80	104.66	113.52	122.70	131.56
80	38.39	47.57	56.76	65.94	75.46	84.65	93.83	103.35	112.53	121.72	130.91	140.42
90	41.99	51.84	61.35	70.87	80.71	90.22	99.74	109.58	119.09	128.94	138.45	147.97
100	44.95	55.12	64.96	75.13	84.97	95.14	104.99	115.16	125.00	134.84	145.01	154.86
110	47.24	57.41	67.91	78.08	88.58	99.08	109.25	119.75	130.25	140.42	150.92	161.09
120	48.56	59.38	69.88	80.71	91.54	102.36	113.19	123.69	134.51	145.34	156.17	166.99
130	49.21	60.37	71.52	82.68	93.83	104.99	116.14	127.30	138.45	149.61	160.76	171.92
140	50.85	62.34	73.82	85.30	96.78	108.27	119.75	131.23	142.72	154.20	165.68	176.84
150	52.17	63.98	75.79	87.27	99.08	110.89	122.70	134.51	146.33	158.14	169.62	181.43
160	53.48	65.29	77.43	89.57	101.71	113.52	125.66	137.79	149.93	161.74	173.88	186.02
170	54.46	66.93	79.07	91.54	104.00	116.14	128.61	141.08	153.21	165.68	177.82	190.29
180	55.77	68.24	81.04	93.50	106.30	118.77	131.56	144.03	156.82	169.29	182.09	194.55
190	56.76	69.55	82.68	95.47	108.27	121.39	134.19	146.98	160.10	172.90	185.69	198.82
200	57.74	71.19	84.32	97.44	110.56	123.69	137.14	150.26	163.39	176.51	189.63	202.76
210	59.05	72.51	85.96	99.41	112.86	126.31	139.76	153.21	166.67	180.12	193.57	207.02
220	60.04	73.82	87.60	101.38	114.83	128.61	142.39	156.17	169.95	183.40	197.18	210.96
230	61.02	75.13	89.24	103.02	117.13	130.91	145.01	159.12	172.90	187.01	201.11	214.89
240	62.34	76.44	90.55	104.99	119.09	133.53	147.64	162.07	176.18	190.29	204.72	218.83
250	63.32	77.76	92.19	106.63	121.39	135.83	150.26	164.70	179.13	193.90	208.33	222.77
260	64.30	79.07	93.83	108.60	123.36	138.12	152.89	167.65	182.41	197.18	211.94	226.71
270	65.29	80.38	95.47	110.24	125.33	140.42	155.51	170.60	185.37	200.46	215.55	230.64
280	66.27	81.69	96.78	112.20	127.30	142.72	158.14	173.23	188.65	203.74	219.16	234.25
290	67.26	83.00	98.42	113.84	129.59	145.01	160.43	176.18	191.60	207.02	222.44	238.19
300	68.24	84.32	100.07	115.81	131.56	147.31	163.06	178.81	194.55	210.30	226.05	241.80

Allowable difference in site index - 30

COASTAL DOUGLAS-FIR SITE TABLE

SITE INDEX TABLE

HT IN FEET

BH AGE	40	50	60	70	80	90	100	110	120	130	140	150	160	170
30	32.15	39.04	45.93	52.49	59.38	66.27	73.16	79.72	86.61	93.50	100.07	106.96	113.84	120.41
40	39.37	47.90	56.43	64.96	73.49	82.02	90.55	99.08	107.61	116.14	124.67	133.20	141.40	149.93
50	44.95	55.12	64.96	75.13	84.97	95.14	104.99	114.83	125.00	134.84	145.01	154.86	165.03	174.87
60	49.54	60.70	71.85	83.33	94.49	105.64	116.80	128.28	139.44	150.92	162.07	173.56	185.04	196.19
70	53.48	65.62	77.76	90.22	102.36	114.83	126.97	139.44	151.90	164.37	176.84	189.63	202.10	214.89
80	56.76	69.55	82.68	95.80	108.92	122.37	135.83	148.95	162.40	176.18	189.63	203.41	217.19	230.97
90	59.38	73.16	86.94	100.72	114.83	128.94	143.04	157.48	171.92	186.35	200.79	215.55	230.31	245.08
100	61.68	76.12	90.55	104.99	119.75	134.51	149.61	164.70	179.79	195.21	210.63	226.05	241.80	257.55
110	63.65	78.74	93.50	108.92	124.34	139.76	155.18	171.26	187.01	203.08	219.16	235.56	252.30	269.03
120	65.29	80.71	96.46	112.20	127.95	144.03	160.43	176.84	193.24	209.97	227.03	244.09	261.48	278.87
130	66.93	83.00	98.75	115.16	131.56	147.97	165.03	181.76	199.15	216.53	233.92	251.97	269.68	288.06
140	68.24	84.65	101.05	117.78	134.51	151.57	168.96	186.35	204.07	222.11	240.48	258.86	277.56	296.26
150	69.55	86.29	103.02	120.08	137.47	154.86	172.57	190.62	208.66	227.36	246.06	265.09	284.45	303.80
160	70.87	87.60	104.66	122.05	139.76	157.81	175.85	194.23	212.93	231.95	251.31	270.67	290.68	310.69
170	71.85	88.91	106.30	124.02	142.06	160.43	178.81	197.83	216.86	236.22	255.90	275.92	296.26	316.93
180	72.51	90.22	107.94	125.98	144.36	162.73	181.76	200.79	220.47	240.16	260.50	280.84	301.84	322.83
190	73.49	91.21	109.25	127.62	146.00	165.03	184.38	203.74	223.75	243.77	264.43	285.43	306.76	328.41
200	74.15	92.19	110.56	128.94	147.97	166.99	186.68	206.36	226.71	247.37	268.04	289.37	311.35	333.33
210	74.80	93.18	111.55	130.25	149.61	168.96	188.65	208.99	229.33	250.33	271.65	293.31	315.29	337.93
220	75.46	93.83	112.53	131.56	150.92	170.60	190.62	211.29	231.95	253.28	274.93	296.92	319.22	342.19
230	76.12	94.82	113.52	132.87	152.23	172.24	192.58	213.25	234.25	255.90	277.89	300.20	323.16	346.46
240	76.77	95.47	114.50	133.86	153.54	173.88	194.23	215.22	236.55	258.53	280.51	303.48	326.44	350.06
250	77.43	96.13	115.16	134.84	154.86	175.20	195.87	217.19	238.84	260.83	283.14	306.43	329.72	353.67
260	77.76	96.78	116.14	135.83	155.84	176.51	197.51	218.83	240.81	263.12	285.76	309.05	332.68	356.95
270	78.08	97.44	116.80	136.81	157.15	177.82	198.82	220.47	242.45	265.09	288.06	311.68	335.63	360.24
280	78.74	97.77	117.45	137.47	158.14	178.81	200.13	222.11	244.09	267.06	290.35	313.98	338.25	363.19
290	79.07	98.42	118.11	138.45	158.79	180.12	201.44	223.42	245.73	268.70	292.32	316.27	340.88	366.14
300	79.40	98.75	118.77	139.11	159.78	181.10	202.76	224.74	247.37	270.67	294.29	318.57	343.17	368.77

Allowable difference in site index-20

Western Hemlock - 263 and Mountain Hemlock - 264[1]

Upper Limits of Site Indices--Dominant and Codominant Trees

Use for all true firs except white and grand fir and for all cedars except incense

Age years	Site index																
	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
	Total height in feet																
10	2	4	4	4	5	6	6	6	8	8	8	9	10	10	11	12	12
20	9	12	14	16	18	20	22	24	26	28	30	32	34	37	39	41	43
30	17	21	24	28	32	36	40	44	47	51	55	59	63	66	70	74	78
40	23	28	34	39	44	50	54	60	66	70	76	81	86	92	96	102	107
50	29	35	42	48	55	61	67	74	80	86	93	99	106	112	118	124	132
60	34	41	49	56	64	71	79	86	93	101	108	116	123	131	138	145	153
70	37	45	53	61	70	78	86	94	103	111	119	127	136	144	152	160	171
80	39	48	57	66	75	84	93	102	110	119	128	137	147	156	164	173	182
90	42	52	61	71	80	90	99	108	118	128	137	146	156	165	175	185	194
100	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205
110	47	58	68	79	89	99	110	120	131	141	152	162	173	183	194	204	215
120	49	60	70	81	92	103	113	124	135	146	156	167	178	189	190	210	221
130	50	61	72	83	94	105	116	127	138	149	160	171	183	194	205	216	227
140	51	62	74	85	96	107	118	129	141	152	163	174	186	197	208	220	231
150	52	63	75	86	97	109	120	131	143	154	166	177	189	200	212	223	235
160	52	64	76	87	99	110	121	133	145	156	168	179	191	203	214	226	238
180	53	65	77	89	101	112	123	136	148	159	171	183	195	207	219	230	242
200	54	66	78	90	102	113	125	138	150	161	173	186	197	210	221	233	245
220	54	66	78	90	103	114	127	139	151	163	175	187	199	211	224	235	247
240	55	67	79	91	103	115	127	139	152	164	176	188	200	212	225	237	249
260	55	67	79	91	104	116	128	140	152	164	176	188	200	213	225	238	250
280	55	67	80	92	104	116	128	140	153	165	177	189	201	214	226	239	251
300	55	67	80	92	104	117	129	141	153	166	178	190	202	215	227	240	252
Cubic-foot site class	7	6	5		4		3			2		1					

[1]Source: Barnes, George H., 1961. USDA Technical Bulletin 1273. PNW Experiment Station.

SITE INDEX	CMAI FOR WESTERN HEMLOCK 100 YR. TABLE (TSHE) 990-BARNES	CMAI FOR PONDEROSA PINE 100 YR. TABLE (PIPO) 600-MEYER	CMAI FOR DOUGLAS-FIR WEST SIDE 50 YR. (PSME) 795-KING
	Cu. Ft./Ac./Yr.		
40		30	
41		31	
42		31	
43		32	
44		33	
45		34	
46		34	
47		35	
48		36	
49		37	
50		38	
51		38	
52		39	
53		40	
54		41	
55		42	
56		42	
57		43	
58		44	
59		45	
60		46	
61		47	
62		48	
63		49	
64		50	
65		50	
66		51	
67		52	

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69		54	
70		55	79
71		56	81
72		58	83
73		59	84
74		60	86
75		62	89
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80		69	98
81		70	100
82		72	102
83		74	103
84		75	105
85		77	107
86		78	109
87		80	111
88		82	113
89		83	114
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98		99	132
99		101	134
100	142	102	136
101	144	104	138
102	145	106	140
103	147	108	141
104	149	110	143
105	151	112	145
106	153	114	147
107	154	116	149
108	156	118	150
109	158	120	152
110	160	122	154
111	162	124	156
112	164	126	158
113	166	128	160
114	168	130	162
115	170	132	163
116	172	134	167
117	174	136	169
118	176	137	171
119	178	139	173
120	180	141	175
121	182	144	176
122	184	146	178
123	186	149	180
124	188	151	182
125	190	154	184

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127	194	159	188
128	196	161	190
129	198	164	191
130	200	166	193
131	202	168	195
132	204	170	197
133	205	173	199
134	207	175	201
135	209	177	203
136	211	179	207
137	213	181	209
138	214	183	210
139	216	185	212
140	218	188	214
141	220	190	216
142	222	192	218
143	224	194	220
144	226	197	222
145	228	199	224
146	230	201	226
147	232	203	227
148	234	205	229
149	236	208	231
150	238	210	233
151	240	212	235
152	241	215	237
153	243	217	239
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155	246	222	243
156	248	224	244
157	249	227	246
158	251	229	248
159	252	232	250
160	254	234	252
161	256		
162	258		
163	260		
164	262		
165	264		
166	266		
167	268		
168	270		
169	272		
170	274		
171	276		
172	278		
173	279		
174	281		
175	283		
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177	287		
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185	301		
186	303		
187	305		
188	306		
189	308		
190	310		
191	312		
192	314		
193	316		
194	318		
195	320		
196	322		
197	324		
198	326		
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201	332		
202	333		
203	335		
204	336		
205	338		
206	340		
207	341		
208	343		
209	344		
210	346		