LPMPB: A VARIABLE DENSITY LODGEPOLE PINE GROWTH AND YIELD MODEL FOR MOUNTAIN PINE BEETLE IMPACT EVALUATION

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Smithers (1961) published yield tables for lodgepole pine in Alberta and B.C. While these tables permitted estimation of growth and yield up to age 160, they did not include variable density effects. Johnstone (1976), on the other hand, produced variable density yield tables for lodgepole pine in Alberta, but the equations on which these equations were based only permit prediction up to age 100. Thomson (1987) showed how these yield tables were comparable to a large extent.

Based on the results of the analyses leading to the 1987 paper, I developed a variable density lodgepole pine growth and yield model that covered ages 20-200 in unmanaged stands. The model is table-driven, based on Smithers' (1961) tables extrapolated to age 200. The table values are modified for density effects by correction factors calculated from Johnstone's (1976) tables.

The model generates diameter distributions which can be affected by mountain pine beetle (MPB) effects. The manner in which this modification works has not yet been documented, but is based on probability of mortality being a function of a trees position in the diameter distribution, and on the severity of the MPB.

There are only a few inputs required to run the model (Fig. 1), and these reflect the kind of information that might be available from normal sampling. Stand age and density (stems per hectare) must be defined, and a reference age provided for site index output. If a zero-valued Beetle Pressure Index is entered, the system functions purely as a lodgepole growth and yield model. The output file name has a default value of "OUT", which is used in conjunction with different type extensions for the various yield tables produced. Up to four different yield tables are produced (Fig. 2); only the first two of these tables occur when a zero-valued Beetle Bressure Index is used.

If a non-zero value for Beetle Pressure Index is entered, an additional entry field for the starting year of the outbreak is included. This permits a stand to be defined at one point in time and the impact of an outbreak at a different time evaluated. Note that the impact is only in terms of mortality at the time of the outbreak. There is no projection of stand growth beyond 10 years after the outbreak starts.

On pressing <RETURN> to continue, a second data entry screen is presented.Having specified the age and density, a third parameter is required to fully specify the stand growth. This third parameter can be either dbh, height, basal area, volume or site index. When the appropriate selection is made, an entry field is presented, with guidance on the upper and lower limits to the values appropriate for the age and density specified. By specifying age, density and a third parameter, the stand trajectory from age 20 to age 200 is defined.

The stand table generated for the values in Fig. 1 is illustrated in Fig. 2. The diameter distribution in 5-cm classes is given at 10 year intervals (Fig. 3), with a line in the table, flagged by an asterisk, showing the conditions entered. A graph of the distribution at up to three ages can be produced (Fig. 4). The yield table (not illustrated) shows dbh, height, basal area and volume changes with age. These can also be graphed.

When a non-zero Beetle Pressure Index is used, the model projects changing index values over a ten year period and applies them to the diameter distribution (Fig. 5). A graph of three of these years shows the larger trees rapidly succumbing to beetle attack (Fig. 6).

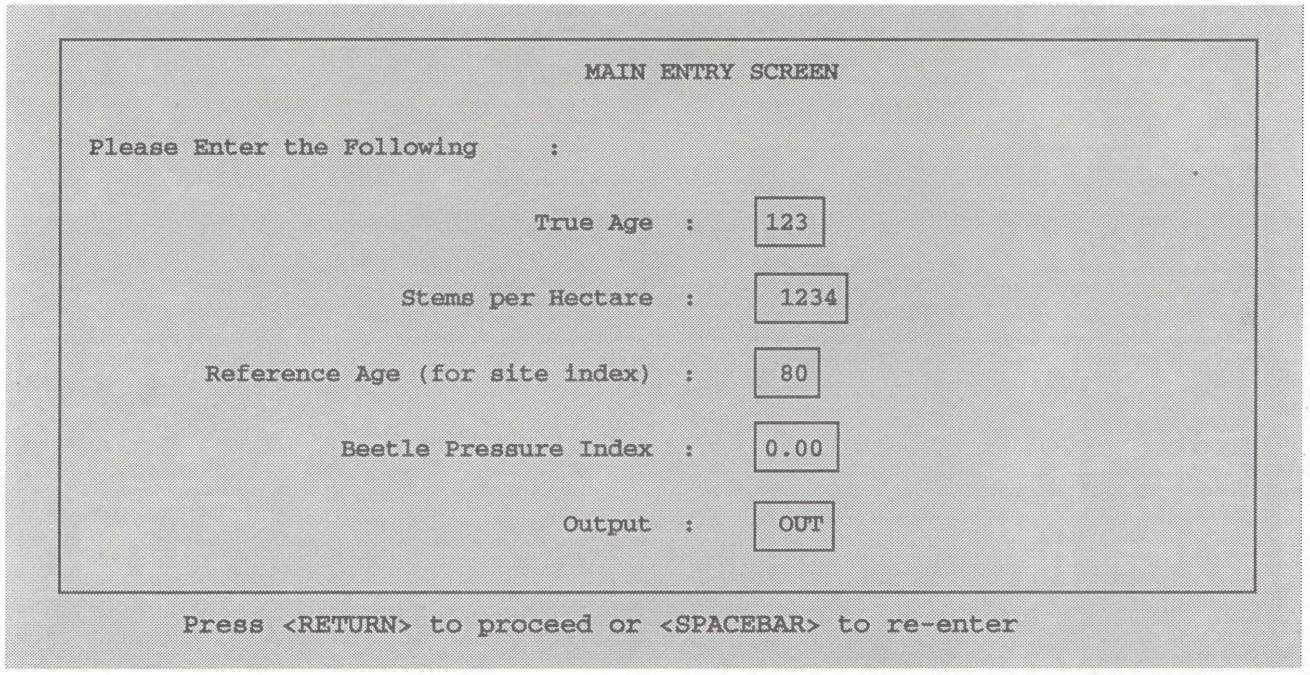

Figure 1. The main data entry screen.

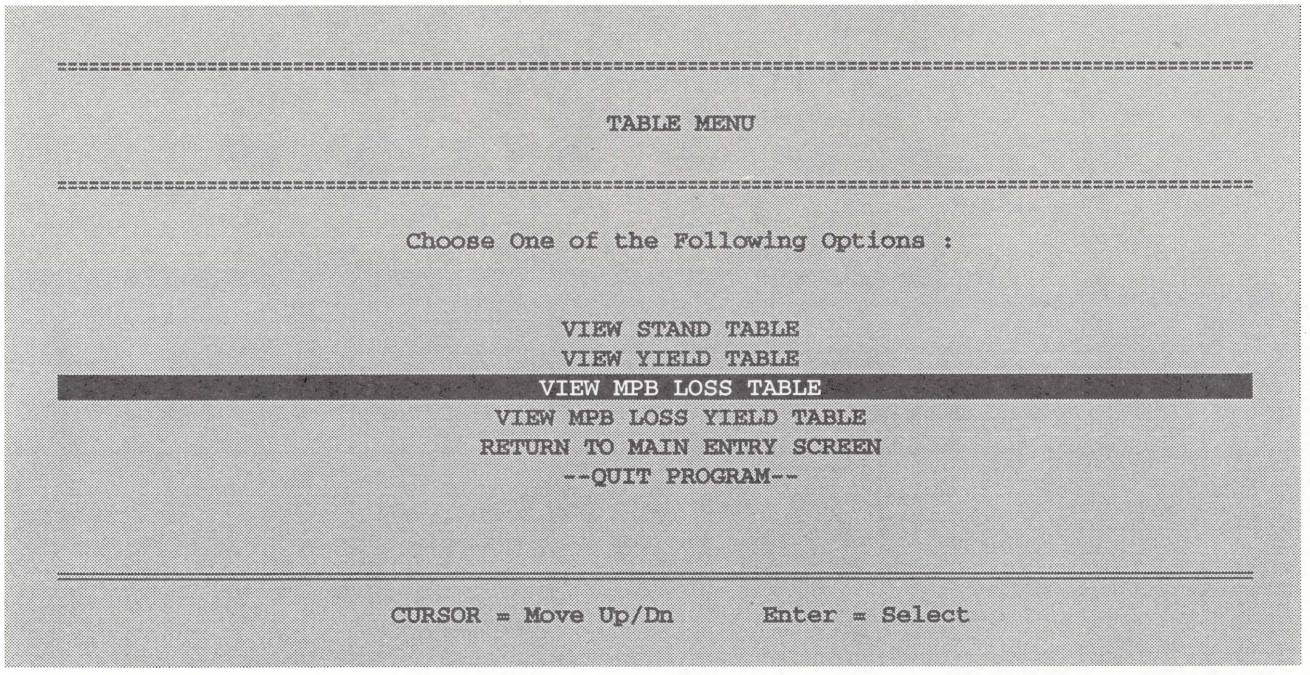

Figure 2. The output table selection screen.

Summary

LPMPB is an easy-to-use variable density lodgepole pine growth and yield model for unmanaged stands. By specifying conditions at one point in time, the model can project back to age 20 and forward to age 200 to provide a complete stand trajectory through that point. Mountain pine beetle effects can be simulated to generate impacts in the ten years following the initial attack.

			Diameter Classes											SI (Ref. Age 80) = 18.9
DBH	AGE	SPH	5	10	15	20	25	30	35	40	45	50	55	60
4.7	20	6939	5955	984	0	0	0	0	0	0	0	0	0	0
8.3	30	3883	1651	1873	359	0	0	0	0	0	0	0	0	0
10.7	40	2869	602	1505	717	45	0	0	0	0	0	0	0	0
12.7	50	2345	237	981	923	204	0	0	0	0	0	0	0	0
14.6	60	2006	93	575	899	397	42	0	0	0	0	0	0	0
15.9	70	1791	50	368	769	496	108	0	0	0	0	0	0	0
17.3	80	1611	26	236	604	542	191	12	0	0	0	0	0	0
18.3	90	1489	16	158	487	548	241	39	0	0	0	0	0	0
19.3	100	1384	0	118	380	519	292	75	0	0	0	0	0	0
20.1	110	1311	0	90	309	484	320	102	6	0	0	0	0	0
20.8	120	1252	0	68	263	444	332	129	16	0	0	0	0	0
*21.0	123	1234	0	64	253	433	332	133	19	0	0	0	0	0
21.3	130	1192	0	57	228	406	332	143	26	0	0	0	0	0
21.8	140	1145	0	49	196	375	334	155	36	0	0	0	0	0
22.4	150	1098	0	42	168	340	334	168	46	0	0	0	0	0
22.9	160	1058	0	37	147	307	326	181	58	2	0	0	0	0
23.3	170	1023	0	33	133	283	317	187	65	5	0	0	0	0
23.6	180	992	0	30	122	264	309	190	69	8	0	0	0	0
23.8	190	965	0	27	113	248	301	193	73	10	0	0	0	0
24.1	200	942	0	25	106	236	294	194	74	13	0	0	0	0

Produce Graph Return to Table Menu

Figure 3. The stand table for the inputs in Figure 1.

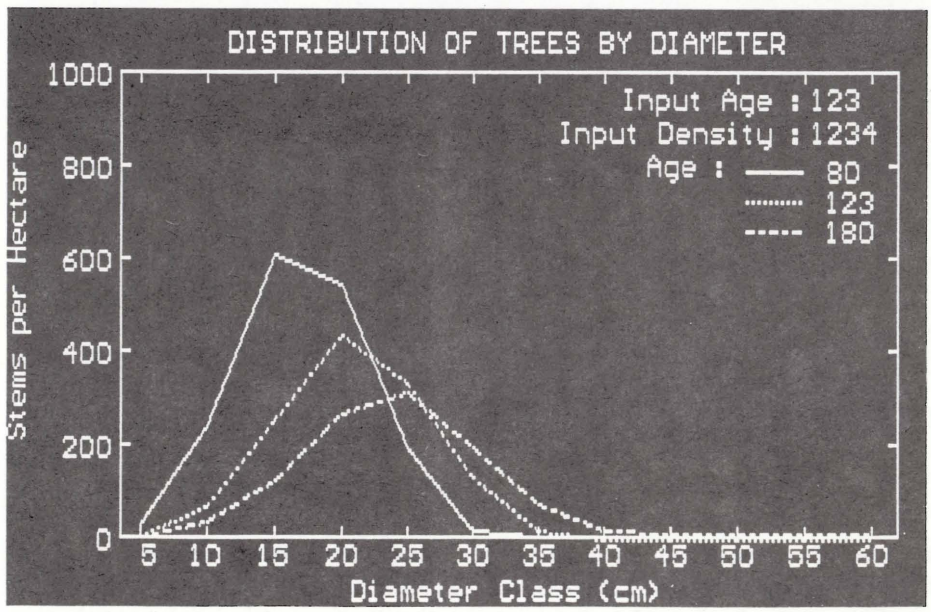

Figure 4. The diameter distributions from three ages in Figure 3.

10 YEAR MPB LOSS TABLE

AGE = 120 BPI = 0.60 SI = 18.9 (Ref. Age 80)

YEAR	SPH	DBH	Diameter Classes 5	10	15	20	25	30	35	40	45	50	55	60
0	1252	21.0	0	68	263	444	332	129	16	0	0	0	0	0
1	1112	19.9	0	68	263	444	290	46	1	0	0	0	0	0
2	988	19.1	0	68	263	444	205	8	0	0	0	0	0	0
3	898	18.5	0	68	263	444	122	1	0	0	0	0	0	0
4	838	18.0	0	68	263	444	63	0	0	0	0	0	0	0
5	804	17.7	0	68	263	444	29	0	0	0	0	0	0	0
6	787	17.5	0	68	263	444	12	0	0	0	0	0	0	0
7	780	17.5	0	68	263	444	5	0	0	0	0	0	0	0
8	777	17.4	0	68	263	444	2	0	0	0	0	0	0	0
9	733	17.3	0	68	263	402	0	0	0	0	0	0	0	0
10	687	17.1	0	68	263	356	0	0	0	0	0	0	0	0

Produce Graph . Return to Table Menu

Figure 5. The mountain pine beetle loss table from an outbreak starting at age 120.

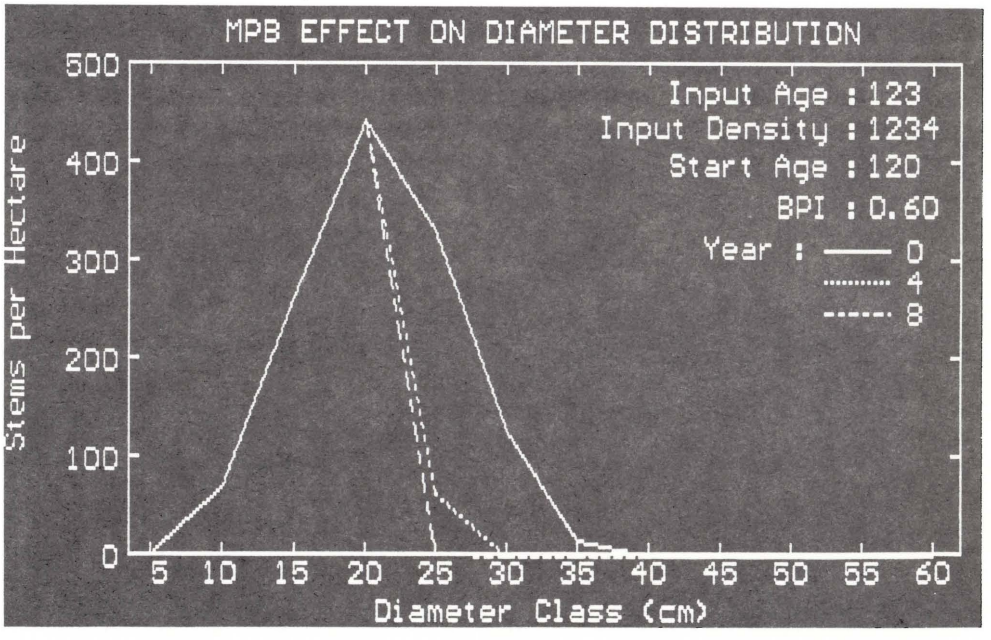

Figure 6. The changing diameter distribution during the outbreak represented in Figure 5.

REFERENCES

Johnstone, W.D. 1976. Variable-density yield tables for natural stands of lodgepole pine in Alberta. Can. Dep. Fish. Environ. Can. For. Serv. Tech. Rep. No. 20.

Smithers, L.A. 1961. Lodgepole pine in Alberta. Can. Dep. For. Bull. No. 127.

Thomson, A.J. 11987. Comparison of lodgepole pine yield tables. Can. J. For. Res. 17: 1110-1114.

Figure 5. The mountain pine beetle loss table from an outbreak starting at age 120.

Figure 6. The changing diameter distribution during the outbreak represented in Figure 5.