

# Mixed Regional Shifts In Conifer Productivity Under 21<sup>st</sup>-Century Climate Projections In Canada's Northeastern Boreal Forest

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## Supplementary Materials

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## **1. Plot ‘scaling’ in preparation for input into JABOWA-3**

As noted in the accompanying manuscript, permanent sample plots (PSPs) range in size from 0.002 to 0.1 ha in the province of Newfoundland and Labrador (NL), including an array of intermediate sizes. PSP size is not fixed in NL, and commonly increases as a plot matures over remeasurement intervals, and stem density naturally declines. Increases to PSP area are at the discretion of the field crew measuring the plot. Differing plot areas would impact JABOWA’s density and light-level subroutines, which assume a 0.01 ha plot area. Through the data formatting process, all PSP measurements were scaled to 0.01 ha.

The scaling process was applied to each PSP measurement that was not from a 0.01 ha plot and involved one of two approaches: (i) ‘down sampling’, where the plot area was  $> 0.01$  ha a series of randomly selected trees from the plot proportionate to the difference between the 0.01 ha and the plot area were *deleted* from the plot; and (ii) ‘up sampling’, where the plot area was  $< 0.01$  ha a series of randomly selected trees from the plot proportionate to the difference between the 0.01 ha and the plot area were *duplicated* within the plot record. When up sampling, if the difference between the plot area and 0.01 ha exceeded 200%, the entire population of tree observations within the plot would be duplicated before additional random selection and duplication was employed to accommodate the remaining proportional difference. Further, the entire plot would first be duplicated twice for plot area differences exceeding 300%, three times for differences exceeding 400%, and so forth.

The random nature of tree selection through scaling does not guarantee the composition, age, or size structure of the original plot record is reflected in the scaled plot record; this is a limitation of this work. Still, in applying a truly randomized scaling technique to individual PSPs within a large provincial dataset would generally ensure that the composition of the PSP program is maintained through the scaling process. Being as this study yields a provincial and ecoregion analysis, the integrity of the scaled datasets at the provincial and ecoregion levels are of most significant. That is, erroneous composition introduced through random sampling at a plot level is less of a concern.

## **2. Adjustment of JABOWA’s species DD<sub>Max</sub> and DD<sub>Min</sub> parameter values**

In JABOWA’s default parameterizations, coarse temperature isotherms and realized niche are used to generalize species upper and lower degree-day tolerance (DD<sub>Max</sub> and DD<sub>Min</sub>, respectively). These parameters are utilized in JABOWA-3 through unimodal temperature response functions [1] where optimal temperature response is precisely midway between DD<sub>Max</sub> and DD<sub>Min</sub>. When climate inputs lend to a simulation year where the value for degree-days (DEGD) is outside that range defined by the corresponding DD<sub>Max</sub> and DD<sub>Min</sub> values, JABOWA determines that the tree experiences no growth, regardless of the status of any other model inputs. Multiple years of no growth result in an exponential increase in a tree’s probability of dying [1].

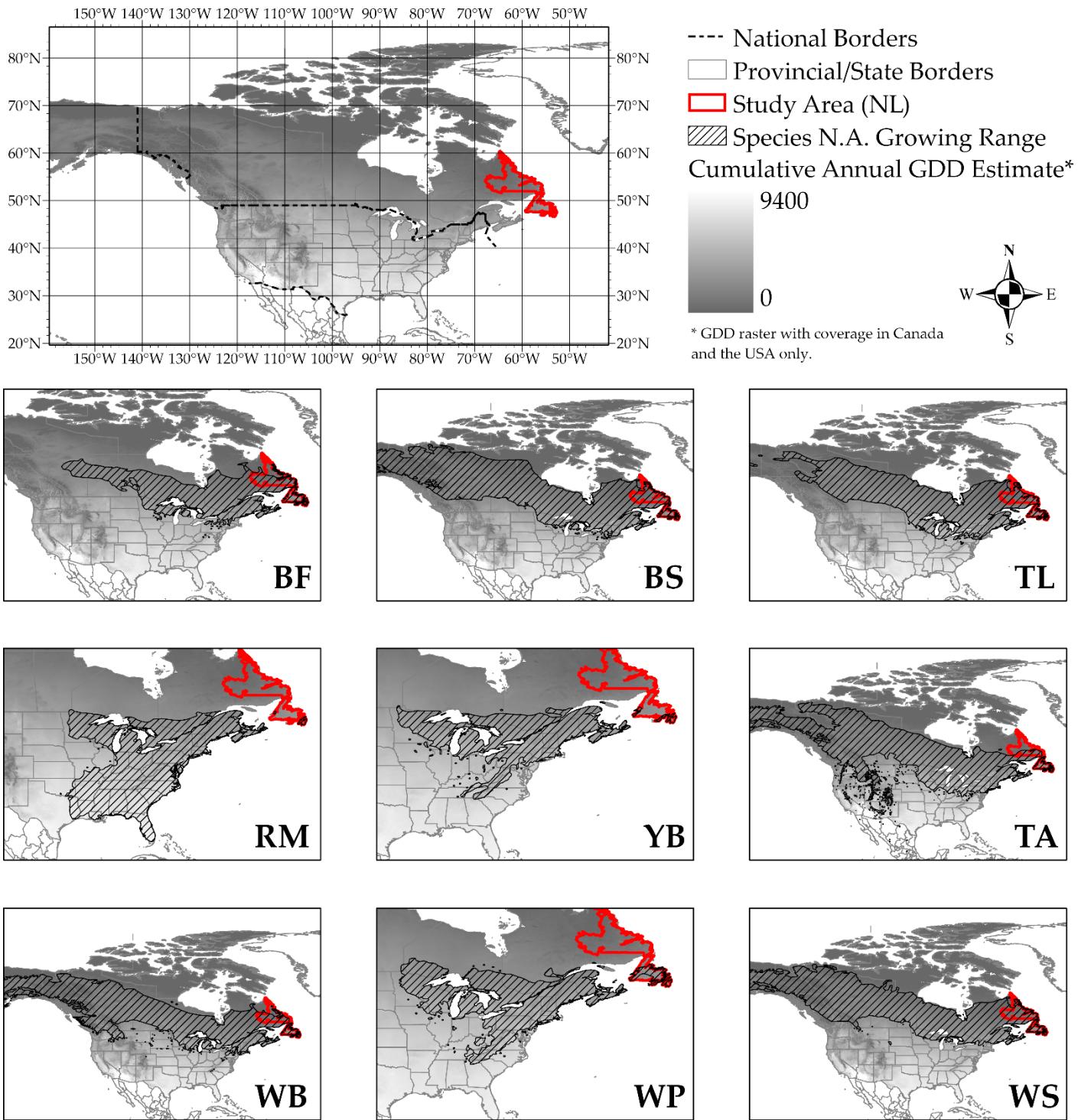
Through JABOWA’s default parameterization, DD<sub>Max</sub> and DD<sub>Min</sub> were derived from coarse-scale isotherm information which approximates northerly and southerly realized niche. This derivation of the DD<sub>Max</sub> and DD<sub>Min</sub> can prove problematic where climatic inputs passed into JABOWA often entail local growing conditions outside the generalized isotherm range informing the DD<sub>Max</sub> and DD<sub>Min</sub> parameters. As noted, sequential years of zero growth lend to increased rate of tree mortality. This can result in the unintended simulation of mass die-off events.

To resolve this, JABOWA’s DD<sub>Max</sub> and DD<sub>Min</sub> parameters were updated for each of the nine species included in this study using a common method (Table S1). A cumulative annual degree-day raster surface was first calculated with coverage of North America. The raster was based on normal mean daily minimum and mean daily maximum temperature surfaces obtained from WorldClim [2] and used in the annual DEGD estimation function employed in the JABOWA family of models [1]:

$$[Eq. S1] \quad DEGD = \frac{365}{2\pi} (T_{july} - T_{jan}) - \frac{365}{2} \left( 4.4 - \frac{T_{july} + T_{jan}}{2} \right) + \frac{365}{\pi} \left[ \frac{\left( 4.4 - \frac{T_{july} + T_{jan}}{2} \right)^2}{T_{july} - T_{jan}} \right]$$

where  $DEGD$  is the estimated cumulative annual  $GDD$ ,  $T_{july}$  is the mean monthly temperature in July, and  $T_{jan}$  is the mean monthly temperature in January, and  $4.4^{\circ}\text{C}$  is the base temperature below which growth is assumed to be negligible. The species ranges identified through Little's [3] species growing extents, as digitized by Prasad and Iverson [4], was then used to determine a new  $DD_{\text{Max}}$  and  $DD_{\text{Min}}$  parameter for each of the nine species in this study (Figure S1, Table S1).

The WorldClim monthly normal climate datasets are derived from a network of between 9,000 and 60,000 weather stations. Datasets are interpolated using thin-plate splines with covariates which include elevation, distance to the coast as well as satellite-derived covariates obtained from the MODIS satellite platform. WorldClim's freely available raster datasets, and those used in this study for the determination of  $DD_{\text{Max}}$  and  $DD_{\text{Min}}$ , have a spatial resolution is 2.5 arc-minutes ( $\sim 21 \text{ km}^2$ ). Global cross-validation correlations were  $\geq 0.99$  for temperature and humidity and 0.86 for precipitation [2].



**Figure S1.** Species North American growing extent using Little's [3] mapping as digitized by Prasad and Iverson [4] and corresponding GDD envelope estimated using WorldClim climate normals [2] and JABOWA's sinusoidal annual GDD functions [1].

### 3. JABOWA-3 parameter settings used in this study

**Table S1.** Summary of the JABOWA-3 parameter values employed. Default JABOWA parameter values are denoted by brackets () and adjusted values by **bold** font. For a comprehensive description of model parameters, functions, and formulations see Botkin [1,5].

COM_NAME	SCI_NAME	S	N	SAP	G	C	D <sub>Max</sub>	H <sub>Max</sub>	A <sub>Max</sub>
Yellow Birch	<i>Betula alleghaniensis</i>	(2)	(2)	(15)	(143.6)	(0.486)	(100)	(3050)	(300)
Balsam Fir	<i>Abies balsamea</i>	(3)	(3)	(2)	(102.7) <b>162.0</b>	(2.5)	(86)	(2290)	(200)
White Birch	<i>Betula papyrifera</i>	(1)	(3)	(10)	(190.1)	(0.486)	(76)	(3050)	(140)
Red Maple	<i>Acer rubrum</i>	(2)	(3)	(3)	(213.8)	(1.57)	(150)	(3660)	(150)
White Spruce	<i>Picea glauca</i>	(3)	(1)	(2)	(91.8)	(2.5)	(53)	(3350)	(200)
Black Spruce	<i>Picea mariana</i>	(2)	(3)	(2)	(32) <b>185.0</b>	(2.5)	(46)	(2740)	(250)
White Pine	<i>Pinus strobus</i>	(2)	(3)	(4)	(141.2)	(2)	(101)	(4570)	(450)
Trembling Aspen	<i>Populus tremuloides</i>	(1)	(2)	(10)	(173.7)	(0.486)	(100)	(3050)	(100)
Eastern Larch	<i>Larix laricina</i>	(1)	(2)	(10)	(86.3)	(2)	(85)	(3050)	(200)

COM_NAME	SCI_NAME	b <sub>2</sub>	b <sub>3</sub>	AINC	DD <sub>Min</sub>	DD <sub>Max</sub>	DT	WL <sub>T<sub>Max</sub></sub>	L <sub>T<sub>Min</sub></sub>
Yellow Birch	<i>Betula alleghaniensis</i>	(58.3)	(0.291)	(0.01)	(2000) <b>1000</b>	(5300) <b>5700</b>	(0.6)	(0.245)	(0.9)
Balsam Fir	<i>Abies balsamea</i>	(50.1)	(0.291)	(0.01)	(700) <b>400</b>	(3700) <b>5000</b>	(0.2111)	(0.245)	(0)
White Birch	<i>Betula papyrifera</i>	(76.6)	(0.504)	(0.01)	(700)	(4000)	(0.3222)	(0.378)	(0.8)
Red Maple	<i>Acer rubrum</i>	(47)	(0.156)	(0.01)	(2000)	(12400)	(0.3222)	(0.45)	(0.9)
White Spruce	<i>Picea glauca</i>	(121.2)	(1.14)	(0.01)	(600)	(3750)	(0.5444)	(0.245)	(0.9)
Black Spruce	<i>Picea mariana</i>	(113.9)	(1.24)	(0.01)	(600) <b>200</b>	(3850) <b>4700</b>	(0.1556)	(0.13)	(0.9)
White Pine	<i>Pinus strobus</i>	(87.8)	(0.435)	(0.01)	(2100) <b>1000</b>	(6000)	(1)	(0.45)	(0.9)
Trembling Aspen	<i>Populus tremuloides</i>	(58.3)	(0.291)	(0.01)	(600)	(5600)	(0.7)	(0.45)	(0)
Eastern Larch	<i>Larix laricina</i>	(68.5)	(0.403)	(0.01)	(600)	(3800)	(0.1556)	(0.05)	(0)

#### 4. Summary of historical climate dataset

**Table S2.** Summary of the historical climate dataset [6,7]. Mean, minimum, maximum, and the standard deviation of cumulative annual precipitation (mm) and cumulative annual growing degree-days (GDD) by ecoregion (Table 2). Summary information relates to the temporal period specified. GDD as estimated from mean minimum and maximum monthly temperature as through JABOWA's cumulative annual sinusoidal functions [1].

Period	Climatic Variable	Ecoregion													
		114	115	112	113	108	109	107	106	105	80	77	85	79	104
<b>1960-1979</b>															
<i>Precipitation</i>															
Mean	1343	1266	1077	993	1128	1180	1013	983	932	1000	1007	942	941	959	941
Min.	879	1070	774	752	869	811	899	724	820	876	788	857	856	905	905
Max.	1750	1499	1660	1427	1657	1639	1357	1160	1119	1215	1150	1047	1191	1223	1098
SD	134	14	100	84	75	56	43	22	26	22	11	18	61	36	66
<i>GDD</i>															
Mean	1289	1152	1166	1152	889	1132	874	744	777	693	639	626	518	510	475
Min.	727	803	487	474	426	655	394	405	459	431	423	416	250	200	251
Max.	1772	1459	1706	1636	1486	1627	1436	1038	1034	958	819	756	792	822	693
SD	62	24	104	79	129	74	103	34	71	57	36	24	44	37	29

Table S2 Cont'd

Period	Climatic Term	Ecoregion														
		114	115	112	113	108	109	107	106	105	80	77	85	79	104	103
<b>1980-1999</b>																
<i>Precipitation</i>																
Mean		1415	1314	1154	1068	1224	1309	1083	1064	958	1044	1053	968	1010	1025	995
Min.		943	1101	942	860	992	1087	917	945	777	871	886	788	866	889	877
Max.		2043	1557	1282	1201	1343	1458	1192	1213	1132	1213	1221	1127	1117	1134	1120
SD		141	16	107	87	97	68	64	22	29	25	13	21	73	41	50
<i>GDD</i>																
Mean		1261	1394	1413	1435	1104	1342	1104	937	903	814	761	740	672	662	629
Min.		672	1237	1037	1059	760	1010	755	749	566	557	532	565	365	318	467
Max.		1755	1581	1837	1705	1571	1638	1498	1182	1308	1226	1064	982	1063	1086	856
SD		62	28	94	82	138	74	109	33	68	52	34	38	47	34	42
<b>2000-2015</b>																
<i>Precipitation</i>																
Mean		1321	1275	1110	1050	1167	1210	1019	991	916	990	1001	920	951	963	903
Min.		837	1130	951	907	1070	1026	940	900	850	929	944	860	893	887	769
Max.		1739	1455	1267	1161	1387	1483	1152	1120	994	1064	1079	977	1068	1070	964
SD		120	17	86	72	81	72	59	21	25	21	11	29	102	53	59
<i>GDD</i>																
Mean		1514	1570	1594	1631	1234	1480	1237	1067	1099	995	946	905	844	828	778
Min.		1156	1314	979	986	788	1068	765	750	748	741	715	725	545	491	529
Max.		1923	1792	1990	1973	1820	1882	1736	1339	1387	1296	1135	1026	1041	1046	944
SD		65	29	120	101	140	80	113	38	77	61	38	29	46	38	33

## 5. Summaries of climate projection datasets

**Table S3.** Summary of the RCP 2.6 climate dataset which leverages the CANESM2 GCM [8] as implemented by McKenney et al. [6,7]. Mean, minimum, maximum, and the standard deviation of cumulative annual precipitation (mm) and cumulative annual growing degree-days (GDD) by ecoregion (Table 2). Summary information relates to the temporal period specified. GDD as estimated from mean minimum and maximum monthly temperature as through JABOWA's cumulative annual sinusoidal functions [1].

Period	Climatic Term	Ecoregion									
		114	115	112	113	108	109	107	106	105	
<b>2020-2039</b>											
<i>Precipitation</i>											
Mean	1536	1454	1237	1131	1371	1481	1271	1301	1097	1186	
Min.	944	1081	814	760	1013	919	850	1037	734	846	
Max.	2116	1840	1902	1572	2017	2055	1522	1518	1341	1411	
SD	216	150	167	132	164	182	107	103	118	117	
<i>GDD</i>											
Mean	1803	1859	1863	1888	1500	1762	1532	1370	1378	1235	
Min.	1388	1607	1281	1326	880	1239	884	877	714	665	
Max.	2261	2221	2420	2372	2269	2356	2213	1782	1955	1826	
SD	151	143	191	183	223	175	215	195	235	215	

Table S3 Cont'd

Period	Climatic Term	Ecoregion									
		114	115	112	113	108	109	107	106	105	
<b>2040-2059</b>											
<i>Precipitation</i>											
Mean	1571	1519	1235	1132	1348	1453	1249	1282	1092	1179	
Min.	1003	1219	873	831	1084	971	918	1108	907	978	
Max.	2084	1909	1786	1575	1836	1860	1469	1446	1365	1035	
SD	205	137	162	130	152	164	90	81	97	1432	
<i>GDD</i>											
Mean	1918	1997	1976	2017	1601	1839	1663	1508	1472	1330	
Min.	1400	1660	1330	1405	1023	1239	1033	1031	1000	945	
Max.	2415	2283	2574	2526	2282	2433	2312	1895	1826	1712	
SD	162	159	200	193	202	162	207	192	169	153	
<b>2060-2079</b>											
<i>Precipitation</i>											
Mean	1570	1483	1265	1159	1377	1483	1279	1312	1079	1166	
Min.	1015	1203	837	786	937	911	847	924	775	883	
Max.	2209	1883	1981	1560	2048	2070	1706	1710	1349	1409	
SD	243	186	191	153	202	226	153	114	122	122	
<i>GDD</i>											
Mean	1911	1977	1975	2005	1609	1873	1656	1491	1471	1323	
Min.	1382	1530	1348	1408	1062	1310	1070	1067	801	775	
Max.	2413	2355	2543	2499	2304	2432	2322	1978	2027	1897	
SD	167	171	200	195	230	178	235	218	252	235	

Table S3 Cont'd

Period	Climatic Term	Ecoregion													
		114	115	112	113	108	109	107	106	105	80	77	85	79	104
<b>2080-2099</b>															
<i>Precipitation</i>															
Mean	1507	1443	1203	1105	1330	1421	1246	1279	1116	1202	1212	1136	1123	1147	1157
Min.	940	1113	689	726	805	757	696	796	801	835	882	878	729	743	777
Max.	2041	1799	1851	1464	1942	1977	1583	1579	1461	1500	1506	1427	1470	1483	1368
SD	229	166	185	150	203	219	171	175	131	139	141	129	145	148	154
<i>GDD</i>															
Mean	1927	2007	1979	2016	1591	1852	1635	1474	1433	1286	1206	1195	1108	1100	1050
Min.	1250	1388	1245	1272	958	1207	964	971	920	883	854	864	685	626	669
Max.	2510	2446	2628	2593	2493	2606	2469	2038	2095	1952	1710	1687	1548	1568	1428
SD	232	238	250	241	254	224	244	217	245	226	213	219	203	196	194

**Table S4.** Summary of the RCP 6.5 climate dataset which leverages the CANESM2 GCM [8] as implemented by McKenney et al. [6,7]. Mean, minimum, maximum, and the standard deviation of cumulative annual precipitation (mm) and cumulative annual growing degree-days (GDD) by ecoregion (Table 2). Summary information relates to the temporal period specified. GDD as estimated from mean minimum and maximum monthly temperature as through JABOWA's cumulative annual sinusoidal functions [1].

Period	Climatic Term	Ecoregion														
		114	115	112	113	108	109	107	106	105	80	77	85	79	104	103
<b>2020-2039</b>																
<i>Precipitation</i>																
Mean		1527	1452	1221	1122	1336	1435	1245	1282	1078	1164	1178	1096	1118	1143	1158
Min.		1050	1193	877	832	1098	979	925	1094	839	916	969	912	922	925	1027
Max.		2053	1749	1827	1515	1907	1938	1495	1499	1323	1413	1371	1245	1283	1361	1306
SD		198	137	149	119	141	150	90	84	95	96	95	93	90	86	79
<i>GDD</i>																
Mean		1746	1819	1792	1816	1433	1692	1470	1320	1338	1193	1118	1111	1011	999	937
Min.		1279	1543	1190	1232	875	1094	884	879	738	710	678	719	530	482	565
Max.		2377	2316	2417	2365	2286	2382	2243	1860	2007	1857	1604	1564	1405	1460	1276
SD		208	200	248	251	271	227	278	263	272	256	245	238	244	242	242

Table S4 Cont'd

Period	Climatic Term	Ecoregion													
		114	115	112	113	108	109	107	106	105	80	77	85	79	104
<b>2040-2059</b>															
<i>Precipitation</i>															
Mean	1606	1512	1292	1181	1424	1545	1318	1351	1105	1194	1212	1122	1166	1195	1217
Min.	1031	1143	894	838	1076	962	917	1143	834	914	966	897	938	941	1060
Max.	2171	1835	1956	1572	2070	2109	1752	1752	1385	1476	1433	1340	1409	1535	1494
SD	232	171	174	133	186	198	134	135	121	130	129	117	115	118	119
<i>GDD</i>															
Mean	2045	2125	2097	2130	1727	1991	1779	1617	1582	1433	1347	1328	1229	1226	1175
Min.	1583	1724	1464	1504	1072	1441	1075	1068	823	801	769	799	617	577	710
Max.	2680	2621	2800	2766	2594	2761	2646	2330	2314	2179	1906	1793	1800	1853	1657
SD	194	200	225	223	256	202	275	268	302	283	276	259	276	270	264
<b>2060-2079</b>															
<i>Precipitation</i>															
Mean	1555	1510	1232	1137	1340	1422	1263	1306	1085	1171	1191	1100	1140	1166	1184
Min.	1065	1189	923	878	1059	1025	933	1042	902	963	1018	970	929	930	1002
Max.	2025	1832	1743	1563	1837	1877	1652	1657	1373	1433	1395	1299	1356	1472	1435
SD	193	153	145	120	140	149	116	123	94	97	98	87	109	109	114
<i>GDD</i>															
Mean	2104	2177	2172	2206	1810	2077	1863	1696	1668	1517	1428	1413	1294	1292	1240
Min.	1610	1788	1558	1597	1190	1504	1195	1186	1000	980	942	973	742	688	802
Max.	2659	2599	2720	2668	2520	2627	2493	2102	2216	2082	1843	1795	1744	1801	1591
SD	193	199	214	204	232	201	191	222	202	189	190	190	180	180	175

Table S4 Cont'd

Period	<i>Climatic Term</i>	Ecoregion									
		114	115	112	113	108	109	107	106	105	
2080-2099											
<i>Precipitation</i>											
Mean	1555	1453	1267	1161	1414	1507	1329	1372	1143	1235	
Min.	868	999	781	721	1078	944	907	1141	909	1042	
Max.	2288	1959	1976	1686	2022	2043	1641	1638	1388	1458	
SD	266	190	207	173	188	214	136	120	98	97	
<i>GDD</i>											
Mean	2175	2259	2234	2274	1866	2126	1931	1770	1746	1591	
Min.	1500	1677	1448	1618	1283	1390	1333	1349	1212	1197	
Max.	2700	2651	2848	2801	2660	2771	2632	2277	2354	2194	
SD	243	245	265	262	267	238	265	240	237	217	

**Table S5.** Summary of the RCP 8.5 climate dataset which leverages the CANESM2 GCM [8] as implemented by McKenney et al. [67]. Mean, minimum, maximum, and the standard deviation of cumulative annual precipitation (mm) and cumulative annual growing degree-days (GDD) by ecoregion (Table 2). Summary information relates to the temporal period specified. GDD as estimated from mean minimum and maximum monthly temperature as through JABOWA's cumulative annual sinusoidal functions [1].

Period	Ecoregion						103
	114	115	112	113	108	109	
2020-2039							
<i>Precipitation</i>							
Mean	1521	1460	1203	1103	1307	1413	1245
Min.	1042	1256	793	795	921	884	908
Max.	2026	1715	1866	1445	1945	1966	1518
SD	186	106	155	120	166	173	118
<i>GDD</i>							
Mean	1791	1863	1848	1879	1488	1732	1536
Min.	1317	1536	1265	1335	975	1193	998
Max.	2204	2141	2256	2220	2110	2191	2079
SD	153	149	185	173	204	163	200

Table S5 Cont'd

Period	Climatic Term	Ecoregion													
		114	115	112	113	108	109	107	106	105	80	77	85	79	104
<b>2040-2059</b>															
<i>Precipitation</i>															
Mean	1619	1524	1306	1200	1431	1533	1335	1370	1139	1229	1243	1165	1183	1212	1236
Min.	1133	1246	908	913	1102	987	933	1133	924	1017	1072	1002	986	992	1065
Max.	2108	1864	1866	1531	1959	1998	1628	1625	1454	1518	1497	1405	1417	1472	1416
SD	206	140	155	119	153	165	106	109	101	101	98	106	95	95	98
<i>GDD</i>															
Mean	2118	2195	2184	2225	1825	2070	1895	1740	1712	1562	1472	1453	1341	1341	1292
Min.	1592	1763	1530	1632	1234	1469	1244	1245	1059	1018	991	1011	852	798	894
Max.	2735	2679	2884	2842	2592	2777	2674	2415	2453	2309	2022	1924	1928	1960	1783
SD	224	238	241	236	244	214	251	230	252	231	218	212	217	210	207
<b>2060-2079</b>															
<i>Precipitation</i>															
Mean	1623	1519	1314	1206	1452	1542	1368	1418	1206	1296	1320	1223	1265	1288	1295
Min.	1118	1313	900	819	1188	1067	1020	1179	934	1030	1091	998	1029	1023	1095
Max.	2079	1838	1866	1610	1925	1959	1633	1640	1472	1520	1528	1427	1483	1515	1468
SD	202	122	158	122	152	175	108	101	110	109	112	112	119	111	100
<i>GDD</i>															
Mean	2526	2613	2596	2642	2239	2501	2316	2147	2107	1948	1849	1823	1693	1697	1647
Min.	1964	2286	1867	1915	1509	1834	1516	1521	1337	1310	1275	1292	1117	1074	1135
Max.	3106	3049	3217	3176	3007	3148	3023	2658	2684	2534	2257	2186	2172	2210	2023
SD	195	193	228	217	254	216	266	247	277	258	245	237	251	242	239

Table S5 Cont'd

Period	Climatic Term	Ecoregion													
		114	115	112	113	108	109	107	106	105	80	77	85	79	104
<b>2080-2099</b>															
<i>Precipitation</i>															
Mean	1590	1477	1302	1200	1456	1519	1398	1467	1267	1357	1383	1286	1317	1343	1351
Min.	1063	1208	904	869	1086	989	924	1121	993	1071	1136	1073	1051	1068	1119
Max.	2045	1771	1812	1559	1905	1954	1821	1829	1583	1658	1649	1496	1684	1720	1659
SD	208	126	162	128	164	183	157	161	131	136	141	123	146	145	150
<i>GDD</i>															
Mean	2941	3047	3022	3087	2673	2910	2791	2628	2617	2444	2337	2311	2154	2158	2098
Min.	2316	2473	2230	2351	1892	2155	1907	1913	1629	1597	1557	1575	1349	1284	1432
Max.	3686	3628	3730	3687	3541	3692	3558	3195	3201	3050	2746	2640	2592	2635	2449
SD	260	275	270	254	269	257	278	250	292	270	255	257	245	236	233

## 6. Additional supplementary tables

Two additional tables have been provided as supplementary data in .xlsx format rather than as part of this document due to their size. These two tables contain of the following supporting information:

**Table S6.** A summary of simulated BA by year, scenario, ecoregion, and species at an annual timestep.

Data Dictionary:

ECRG: Ecoregion code, see Table 1.

SCEN: Modelling scenario.

YEAR: Simulation year.

SPEC: Species code, see Table 2.

BAsm: Simulated BA ( $m^2 ha^{-1}$ )

BAmx: Maximum BA in an individual plot ( $m^2 ha^{-1}$ )

DBmx: Maximum individual tree DBH (cm)

DBav: Average individual tree DBH (cm)

DBsd: Standard deviation of individual tree DBH (cm)

**Table S7.** Climate modifiers by scenario, ecoregion, and species. Climate modifiers at 20-year intervals.

Data Dictionary:

ECRG: Ecoregion code, see Table 1.

SCEN: Modelling scenario.

YRMN: First year of modifier applicability.

YRMX: Final year of modifier applicability.

SPEC: Species code, see Table 2.

MODF: Growth modifier value ( $Ck_{c,i,t}$ ; see Eqs. 4 & 5).

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