Individual Tree Mortality Equations

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2024-02-12

Equation Fitting

We fit a survival equation (probability of survival) of a Gompit form to observations for each species found in the `tree.csv` data set provided by John Kershaw.

$p_{live} = 1 - e^{-e^{-\beta_1 + \beta_2 \frac{dbh}{(bal+1)}}}$

where: dbh = diameter at breast height (cm), bal = basal area per hectare in larger trees (m^2/ha).

The equation was fit using an iterative fitting algorithm over each year of the remeasurement interval. The error minimized was the trees per hectare (`tph`) prediction error at the end of the remeasurement interval.

Species

The species in Table 1 had enough (≥ 3000) observations to fit the survival equation:

Table 1: Species Available for Survival Equation

Species Code	FIA Code	N	Common Name
BF	12	192016	balsam fir
RM	316	80731	red maple
RS	97	77277	red spruce
BS	95	53467	black spruce
PB	375	41097	paper birch
WS	94	25287	white spruce
SM	318	24258	sugar maple
YB	371	19383	yellow birch
WC	241	18029	arborvitae
QA	746	17925	quaking aspen
WP	129	14065	eastern white pine
AB	531	13666	American beech
EH	261	12502	eastern hemlock
TA	71	6468	tamarack
RO	833	5106	northern red oak
GB	379	5105	gray birch
BT	743	3657	bigtooth aspen
WA	541	3506	white ash
ST	315	3299	striped maple

JP		105	3203	jack pine

Parameter Estimates

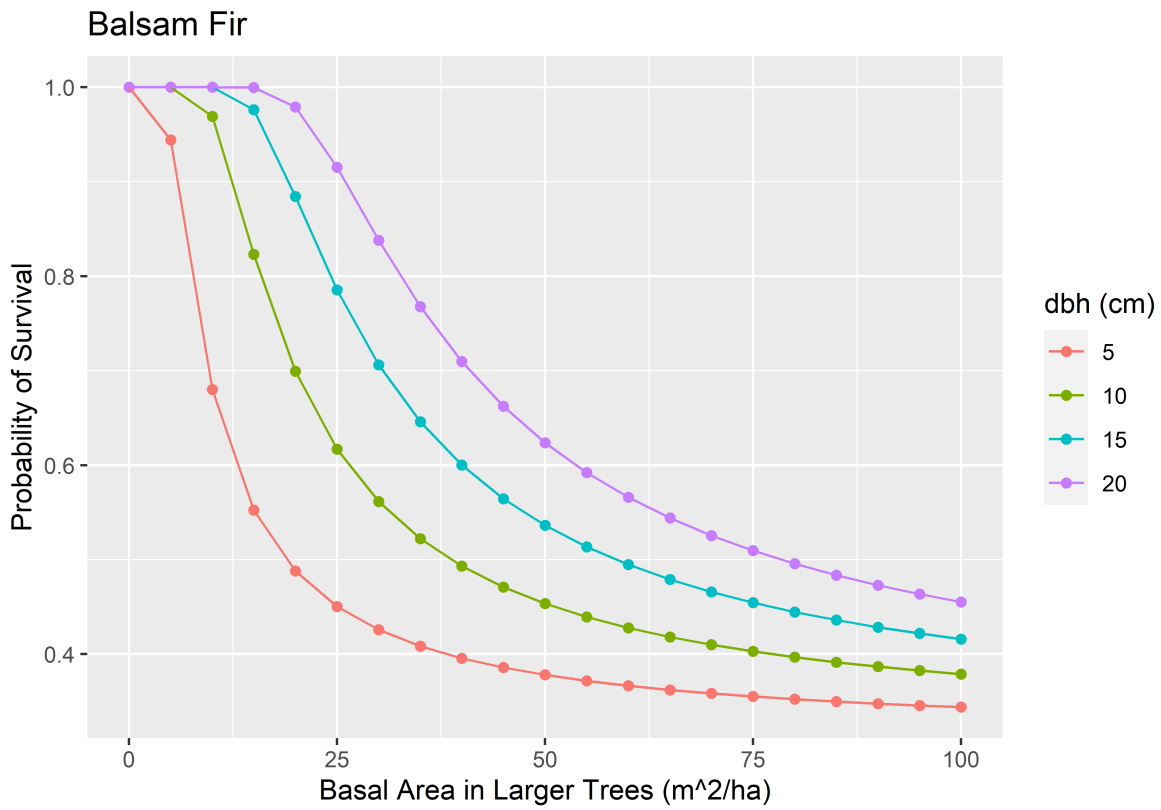
The fit statistics and parameter estimates for the species in Table 1 are in Table 2. All but one species (American Beech) yielded biologically reasonable parameter estimates (`AB`'s β_2 estimate was negative).

Table 2: Survival Equation Parameter Estimates

Species	n	MSE	b1	b2
BF	192016	4892.91	-0.9848889	2.4538404
RM	80731	3739.91	-1.0230532	1.3399131
RS	77277	1858.39	-1.1597231	1.4785670
BS	53467	895.85	-1.3061188	0.2059971
PB	41097	5023.45	-1.1116438	0.4892944
WS	25287	725.67	-1.0513270	1.1465263
SM	24258	2087.40	-1.3070506	0.3769953
YB	19383	4727.49	-1.2749088	0.3492432
WC	18029	2298.47	-1.1297922	2.3463067
QA	17925	7312.70	-0.6830581	0.8195510
WP	14065	4034.24	-1.1721183	0.1789451
AB	13666	4141.47	-1.4749027	-0.0112703
EH	12502	1521.70	-0.8272376	7.7904162
TA	6468	1080.67	-1.0125441	0.7750982
RO	5106	3369.09	-1.0642648	0.6277842
GB	5105	13011.32	-1.0252523	0.4272135
BT	3657	10090.58	-0.3307587	3.1555996
WA	3506	6984.87	-1.1875509	0.4689389
ST	3299	39200.67	-1.1682185	0.0751795
JP	3203	54.82	-0.5034037	1.4953034
OC	193297	6493.10	-1.0743350	1.7994506
OH	120437	12147.23	-1.1484391	0.2932605

Equation Peformance

The following graph shows survival probability predictions for Balsam Fir to demonstrate the effect of `dbh` and `bal`. The effect of larger trees on survival decreases as trees get larger; a small tree (say 5 cm) with 50 m^2/ha `bal` has a greater chance of dying than a large tree (say 15 cm).


Balsam Fir
1.0
0.8
0.6
0.4
Probability of Survival
0
25
50
75
100
Basal Area in Larger Trees (m^2/ha)
dbh (cm)
5
10
15
20