Appendix

Appendix A.

Characteristics of the selected fir stands, damaged by the four-eyed fir bark beetle on all SPs, each fir tree was evaluated according to a six-point scale categorizing tree status, which describes the impact of Polygraphus proximus on Abies sibirica (Krivets et al. 2015b). Explanations: F – Siberian fir, S – Siberian pine, Sp – Siberian spruce, P – Scots pine, B – Silver birch, A – Aspen; mg – medium grass, lg – low grass, hg – high grass. Evaluation of the impact on stand structure SP 61, 62; evaluation of the impact on ontogenetic structure: SP 50–63; evaluation of the single tree stability against the beetle SP 5, 30, 32–43, 45–48; evaluation of the natural regeneration SP 1–6, 30, 32–34, 45, 50–63

№ SP	Stand composition, units	AWTS, units	DBH, cm	Height, m	Age, years	Density, units	Yield class	Forest type
Larinsky landscape reserve								
1	8F1S1Sp	6.0	28.6 ± 0.9	24.1 ± 0.9	94 ± 4.6	1.1	II	hg
2	3S6F1Sp	3.8	18.6 ± 0.8	17.6 ± 0.7	57 ± 5.1	0.9	II	mg
3	5Sp4F1S	4.7	30.5 ± 1.3	22.7 ± 0.7	95 ± 4.9	1.2	II	mg
4	7F2S1Sp	5.4	30.2 ± 1.1	26.5 ± 0.6	97 ± 5.5	1.0	II	hg
Tomskoe lesnichestvo (Forest unit)								
5	10F	3.1	27.9 ± 0.8	24.7 ± 0.7	58 ± 3.2	1.0	I	mg
6	5F3Sp2S	4.0	27.9 ± 1.5	20.1 ± 1.2	70 ± 5.3	1.2	II	mg
30	10F	2.0	26.6 ± 1.1	19.8 ± 1.1	64 ± 3.5	1.2	I	mg
31	8A1F1B	4.8	13.7 ± 0.6	13.8 ± 1.2	65 ± 3.9	0.7	I	mg
Kornilovskoe lesnichestvo (Forest unit)								
32	6F3Sp1S	3.0	21.3 ± 1.1	19.1 ± 0.6	110 ± 14.4	0.5	II	lg
33	4Sp3F3B	2.9	22.0 ± 0.8	21.2 ± 0.9	85 ± 4.7	0.7	II	mg
34	9F1Sp	1.8	29.2 ± 0.6	24.5 ± 0.4	73 ± 2.7	0.9	I	mg
Asinovskoe lesnichestvo (Forest unit)								
35	6F2Sp1S1B	2.2	28.7 ± 1.1	22,0 ± 1,5	127 ± 24.1	0.5	III	hg
36	4F2Sp2S1B1A	2.0	31.2 ± 1.3	22.2 ± 1.1	66 ± 4.5	0.5	I	hg
37	4F2Sp2B2A	2.0	31.0 ± 1.4	18.9 ± 1.3	82 ± 5.2	0.5	II	hg
Pervomajskoe lesnichestvo (Forest unit)								
38	7B1F1Sp1A	4.1	29.0 ± 1.4	24.9 ± 1.3	82 ± 6.8	0.6	III	mg
39	4F4Sp1S1B	1.8	26.1 ± 1.1	23.7 ± 1.2	86 ± 5.3	0.6	II	mg
40	3F2Sp1S4A	1.7	20.7 ± 0.5	20.2 ± 1.0	84 ± 5.6	0.7	II	mg

41	5F1Sp3A1B	2.8	18.7 ± 0.9	20.5 ± 1.1	82 ± 4.1	0.6	II	mg
Teguldetskoe lesnichestvo (Forest unit)								
42	5F3A1Sp1B	3.8	26.4 ± 0.3	23.3 ± 0.6	106 ± 5.9	0.7	III	lg
43	6F3B1S	5.8	21.3 ± 0.9	20.1 ± 1.2	71 ± 1.8	0.6	III	lg
45	10F	5.7	19.7 ± 0.9	18.5 ± 0.9	64 ± 2.6	0.6		hg
46	5F1Sp1S3B	1.6	20.1 ± 0.7	17.7 ± 0.8	124 ± 12.9	0.6	IV	lg
47	4F1Sp5B	4.6	19.8 ± 0.7	20.3 ± 1.6	108 ± 11.3	0.5	III	lg
48	6F2Sp2B	4.0	21.7 ± 0.9	20.1 ± 1.1	87 ± 5.3	0.7	III	lg
Krivosheinskoe lesnichestvo (Forest unit)								
50	2F2P1S1Sp3A1B	4.6	16.9 ± 0,8	16.0 ± 1.4	901 ± 2.0	0.8	III	lg
51	8F2Sp	3.2	21.6 ± 1.0	19.2 ± 1.4	89 ± 5.1	0.7	II	mg
52	8F1B1A	2.4	22.4 ± 1.1	21.0 ± 1.4	87 ± 6.3	0.6	II	lg
Chainskoe lesnichestvo (Forest unit)								
53	4F3Sp1S2A	5.2	21.8 ± 0.7	21.8 ± 1.3	99 ± 4.6	0.7	III	lg
Poskoyevsky zoological reserve								
54	6F1S1Sp2B	1.6	15.9 ± 0.7	16.9 ± 1.1	80 ± 1.5	0.6	II	lg
Shegarskoe lesnichestvo (Forest unit)								
55	6F1S1Sp2B	3.0	22.3 ± 1.1	17.9 ± 1.8	70 ± 2.9	0.6	II	lg
Bakcharskoe lesnichestvo (Forest unit)								
56	9F1B	5.1	20.9 ± 0.8	20.1 ± 1.2	72 ± 4.0	1.0	II	mg
57	6F2Sp1B1A	4.7	22.4 ± 0.8	20.9 ± 1.4	80 ± 3.7	0.9	II	lg
58	7F1Sp2B	3.8	19.0 ± 0.7	19.8 ± 0.4	94 ± 13.8	0.8	III	mg
59	8F1Sp1B	4.7	20.8 ± 0.9	22.3 ± 1.3	102 ± 3.8	0.8	III	lg
Tomsk zoological reserve								
60	9F1Sp	1.4	21.1 ± 0.7	19.5 ± 1,3	92 ± 1.9	0.9	III	lg
Timiryazevskoe lesnichestvo (Forest unit)								
61	6F1S3B	2.2	17.2 ± 0.7	16.0	70 ± 3.9	0.6	II	lg
Kaltaiskii zoological reserve								
62	5F2Sp3B	2.4	19.0 ± 0.6	20.4 ± 0.5	90 ± 3.2	0.8	II	mg
63	2F2Sp6B	4.4	15.0 ± 0.5	16.6 ± 0.6	78 ± 2.7	0.7	II	mg

Appendix B.
Characteristics of living and dead fir trees, damaged by the four-eyed fir bark beetle

No. SP	AWTS, units	Characteristics of living trees				Characteristics of dead trees			
		Occurrence of heart rot, %	Age, year	DBH, cm	Bark thickness, mm	Occurrence of heart rot, %	Age, year	DBH, cm	Bark thickness, mm
1	6.0	0	84.4 ± 9.6	26.6 ± 3.9	9.2 ± 1.0	20	71.8 ± 3.6	19.5 ± 2.1	7.4 ± 1.7
2	3.8	30	53.3 ± 11.8	25.6 ± 3.1	5.6 ± 0.4	60	71.4 ± 20.6	29.2 ± 3.2	7.0 ± 0.9
3	4.7	10	68.6 ± 7.6	28.6 ± 3.0	7.8 ± 0.9	40	73.0 ± 10.1	30.6 ± 2.8	7.2 ± 0.7
4	5.4	20	67.4 ± 9.5	24.9 ± 2.7	6.6 ± 0.6	80	106.0 ± 3.5	34.0 ± 2.2	8.4 ± 0.6
5	3.1	15	83.0 ± 7.7	37.3 ± 1.9	8.5 ± 0.6	45	66.3 ± 4.7	27.4 ± 1.4	6.0 ± 0.3
30	2.0	20	55.1 ± 5.1	35.8 ± 3.4	10.6 ± 1.3	10	42.2 ± 2.5	21.2 ± 2.6	5.0 ± 0.7
32	3.0	20	69.2 ± 3.8	28.0 ± 4.0	7.4 ± 1.2	20	87.6 ± 11.9	26.4 ± 4.3	7.4 ± 1.4
33	2.9	0	82.4 ± 3.6	26.8 ± 3.5	7.6 ± 0.8	0	76.0 ± 4.9	21.6 ± 1.2	6.0 ± 0.6
34	1.8	30	63.3 ± 3.2	30.4 ± 2.0	8.9 ± 0.9	0	60.2 ± 2.9	22.8 ± 2.2	5.9 ± 0.6
35	2.2	60	94.3 ± 6.1	31.0 ± 3.0	7.6 ± 1.1	0	73.2 ± 10.8	22.6 ± 3.3	5.8 ± 0.8
36	2.0	40	63.2 ± 7.2	36.7 ± 4.5	8.4 ± 0.9	0	48.0 ± 3.3	18.7 ± 7.0	4.8 ± 1.1
37	2.0	0	68.2 ± 9.4	41.9 ± 3.6	11.8 ± 1.4	0	74.2 ± 5.2	32.8 ± 5.6	7.8 ± 1.4
38	4.1	20	39.8 ± 1.8	18.2 ± 3.3	6.6 ± 1.1	40	63.0 ± 8.5	24.2 ± 4.1	5.4 ± 0.6
39	1.8	20	62.4 ± 9.0	26.4 ± 4.8	7.4 ± 0.9	0	81.2 ± 3.3	18.0 ± 1.6	4.6 ± 0.6
40	1.7	0	72.2 ± 8.1	25.7 ± 1.6	7.0 ± 0.3	20	81.8 ± 8.0	16.1 ± 1.8	5.8 ± 0.6
41	2.8	0	79.8 ± 1.6	23.0 ± 3.9	6.8 ± 0.7	20	63.4 ± 6.6	17.4 ± 2.1	4.6 ± 0.2
42	3.8	0	99.0 ± 5.7	27.3 ± 2.1	7.8 ± 0.4	40	88.4 ± 10.5	25.0 ± 2.3	6.6 ± 1.0
43	5.8	0	51.8 ± 1.6	13.5 ± 2.3	5.0 ± 0.4	20	55.8 ± 5.2	22.4 ± 2.9	4.6 ± 0.7
46	1.6	0	132 ± 22.3	24.4 ± 1.1	9.4 ± 1.0	0	97.8 ± 9.4	18.0 ± 2.6	6.2 ± 0.7
47	4.6	0	109 ± 16.1	30.9 ± 3.8	9.6 ± 0.9	40	79.0 ± 5.9	20.6 ± 2.3	5.8 ± 0.6
48	4.0	0	84.4 ± 9.6	26.6 ± 3.9	9.2 ± 1.0	20	71.8 ± 3.6	19.5 ± 2.1	7.4 ± 1.7

Appendix C.
Characteristics of the regeneration in fir forests damaged by the four-eyed fir bark beetle. Explanations: Composition: F – Siberian fir Abies sibirica Ledeb., S – Siberian pine Pinus sibirica Du Tour, Sp – Siberian spruce Picea obovata Ledeb., A – Aspen Populus tremula L., B – Silver birch Betula pubescens Roth., P – Scots pine Pinus sylvestris L. Size categories: I – small (< 0.59 m), II – medium (0.60–1.59 m), III – large (> 1.6 m) [1]

No. SP	Compo-sition, %	Size category	Age, year	Height, cm	DBH, cm	Crown length, cm	Crown width, cm	Axial height growth, cm	Growth in lateral direction, cm
1	89F8Sp3S	I	10 ± 3	46 ± 11	0.8 ± 0.1	30 ± 11	37 ± 9	2.3 ± 0.9	5.0 ± 0.6
		1	17 ± 3	109 ± 10	1.8 ± 0.2	83 ± 10	87 ± 22	10.7 ± 2.7	10.0 ± 1.1
		2	33 ± 7	307 ± 79	4.6 ± 1.0	212 ± 50	198 ± 42	35.7 ± 5.8	13.0 ± 0.6
2	94F6Sp	I	11 ± 2	33 ± 3	0.5 ± 0.1	22 ± 1	23 ± 5	1.7 ± 0.3	4.7 ± 0.7
		4	17 ± 1	98 ± 14	1.9 ± 0.3	78 ± 15	78 ± 13	3.7 ± 0.9	6.3 ± 0.3
		5	27 ± 4	309 ± 64	3.7 ± 0.9	216 ± 35	127 ± 22	16.0 ± 2.9	10.0 ± 1.1
3	99F1S	I	9 ± 2	31 ± 2	0.7 ± 0.1	20 ± 1	19 ± 3	3.7 ± 0.6	6.0 ± 1.0
		30	18 ± 1	87 ± 3	1.7 ± 0.2	73 ± 3	69 ± 4	14.0 ± 2.5	10.8 ± 1.3
		32	20 ± 1	190 ± 5	3.0 ± 0.3	173 ± 10	120 ± 5	22.0 ± 3.9	12.0 ± 1.1
4	99F1S	I	13 ± 1	43 ± 6	0.8 ± 0.1	31 ± 5	30 ± 5	5.8 ± 1.4	7.2 ± 0.6
		34	21 ± 2	73 ± 6	1.2 ± 0.1	43 ± 5	51 ± 3	5.7 ± 1.4	6.8 ± 1.3
		45	44 ± 5	302 ± 78	4.8 ± 0.8	189 ± 49	127 ± 10	33.0 ± 4.5	16.3 ± 0.3
5	84F16Sp	I	20 ± 1	33 ± 4	0.6 ± 0.1	20 ± 3	31 ± 6	2.5 ± 0.5	4.3 ± 0.5
		51	26 ± 1	98 ± 8	1.6 ± 0.1	63 ± 7	71 ± 7	7.3 ± 1.6	7.5 ± 1.0
		52	29 ± 1	217 ± 15	3.6 ± 0.3	149 ± 15	150 ± 9	18.7 ± 5.2	10.9 ± 2.0
6	100F	I	-	12 ± 1	0.3 ± 0.1	-	-	-	-
		55	-	60 ± 7	0.7 ± 0.1	25 ± 5	45 ± 5	1.5 ± 0.5	3.7 ± 0.2
		57	28 ± 3	378 ± 44	5.1 ± 0.6	231 ± 35	180 ± 12	11.7 ± 2.3	8.8 ± 0.7
30	87F13Sp	I	15 ± 1	36 ± 3	0.6 ± 0.1	16 ± 2	30 ± 3	1.3 ± 0.3	3.2 ± 0.3
		60	26 ± 1	87 ± 6	1.3 ± 0.1	36 ± 4	64 ± 7	3.4 ± 0.9	4.8 ± 0.5
			37 ± 1	260 ± 29	3.2 ± 0.3	114 ± 18	167 ± 16	5.2 ± 1.4	7.1 ± 1.7
32	89F9Sp2S	I	10 ± 1	39 ± 3	0.6 ± 0.1	26 ± 4	24 ± 5	2.0 ± 0.1	2.8 ± 0.4
		II	21 ± 2	87 ± 11	1.5 ± 0.3	61 ± 12	58 ± 10	4.7 ± 0.9	6.0 ± 0.6
		III	35 ± 1	215 ± 5	2.5 ± 0.1	113 ± 10	125 ± 10	12.0 ± 1.0	9.0 ± 1.0

33	91F9Sp	I	11 ± 1	42 ± 3	0.7 ± 0.1	21 ± 3	25 ± 3	1.5 ± 0.5	3.3 ± 0.9
		II	25 ± 4	83 ± 25	1.5 ± 0.4	57 ± 23	73 ± 29	2.0 ± 1.0	4.7 ± 0.9
		III	38 ± 2	201 ± 35	2.9 ± 0.3	131 ± 30	135 ± 5	4.0 ± 1.1	5.0 ± 1.0
34	100F	I	14 ± 2	59 ± 2	1.0 ± 0.1	43 ± 3	60 ± 3	4.7 ± 0.7	5.7 ± 0.7
		II	23 ± 2	116 ± 15	1.9 ± 0.3	71 ± 5	83 ± 7	5.5 ± 2.2	6.3 ± 1.3
		III	29 ± 5	210 ± 18	2.8 ± 0.2	179 ± 17	128 ± 11	7.3 ± 3.2	7.7 ± 2.3
45	100F	I	3 ± 1	13 ± 3	0.4 ± 0.1	-	-	-	-
50	89F5S5A1Sp	I	14 ± 2	36 ± 5	0.6 ± 0.1	20 ± 3	33 ± 5	2.2 ± 0.3	-
		II	27 ± 3	94 ± 13	1.4 ± 0.2	64 ± 9	78 ± 8	4.2 ± 0.9	-
51	96F2S2Sp	I	11 ± 1	34 ± 5	0.6 ± 0.1	28 ± 4	29 ± 4	3.8 ± 0.7	-
		II	20 ± 2	81 ± 11	1.4 ± 0.3	64 ± 10	57 ± 9	9.4 ± 1.8	-
52	87F9A4Sp	I	6 ± 2	27 ± 5	0.5 ± 0.2	16 ± 4	26 ± 6	1.7 ± 0.7	-
		II	24 ± 4	96 ± 14	1.5 ± 0.2	47 ± 5	73 ± 7	4.1 ± 0.5	-
54	81F19Sp	I	11 ± 1	32 ± 1	0.6 ± 0.1	17 ± 1	35 ± 4	1.8 ± 0.9	-
		II	29 ± 3	102 ± 17	1.8 ± 0.2	62 ± 8	94 ± 12	3.4 ± 0.5	-
		III	31 ± 2	185 ± 17	2.4 ± 0.4	88 ± 27	100 ± 10	3.7 ± 1.2	-
55	92F7S1A	I	8 ± 2	26 ± 4	0.4 ± 0.1	18 ± 1	23 ± 3	4.0 ± 0.5	-
57	98F2A	II	22 ± 2	76 ± 8	1.2 ± 0.1	39 ± 6	59 ± 6	3.1 ± 0.8	-
		III	45 ± 4	179 ± 7	2.4 ± 0.1	108 ± 5	126 ± 8	5.7 ± 1.7	-
58	94F4S1Sp1A	I	13 ± 1	35 ± 1	0.5 ± 0.1	23 ± 1	26 ± 1	4.2 ± 0.2	-
		II	27 ± 3	83 ± 10	1.3 ± 0.2	61 ± 10	62 ± 8	7.0 ± 1.7	-
60	94F4S1Sp1P	I	8 ± 3	22 ± 5	0.4 ± 0.1	15 ± 5	28 ± 3	3.5 ± 1.0	-
		II	22 ± 2	60 ± 3	1.0 ± 0.4	35 ± 2	42 ± 8	2.6 ± 0.7	-

[1] Main parameters adopted in the work and characterizing viable regeneration (Uspensky 1987) are the ratio of the current linear growth in axial shoot and side shoot of the first order, the so-called ecological crown coefficient (more than 0.5 for small saplings, 0.7 for medium and 1 for large), the length of the crown along the trunk (more than 61%), the ratio of the length of the crown to the width (more than 0.9). The values of the ecological coefficient of the crown adopted in this work are different from those generally accepted in Russian forest science, due to the characteristics of the ontogeny of Siberian fir (Makhatkov 1991). In the early and late immature states, which are applicable to the small and medium category of the height of fir saplings, respectively, the growth of the lateral branches above the axial shoot is typically considered.