

Contents

Foreword	xv
Preface	xvii
Acknowledgements	xix
List of Contributors	xxi
1 An overview of fire in northern ecosystems	1
<i>R.W. Wein and D.A. MacLean</i>	
1.1 Introduction	1
1.2 The Northern Environment	3
1.2.1 Physical parameters	3
1.2.2 Biological parameters	6
1.3 The Fire Environment	10
1.4 Use of Fire as a Resource Management Technique	11
1.5 The State-of-the-Science	15
1.6 References	15
SECTION I: PAST AND PRESENT FIRE FREQUENCIES	
2 The post-glacial fire record	21
<i>K. Tolonen</i>	
2.1 Introduction	21
2.2 Lake Sediment Records	22
2.2.1 General methodological possibilities	22
2.2.2 Example 1: Ancient fire regime in spruce- dominated forests in south Finland	24
2.2.3 Example 2: Lake Laukunlampi in eastern Finland	29
2.2.4 Regional comparison of lake sediment records	31
2.3 Charcoal in Peat Profiles	33
2.3.1 General	33
2.3.2 North America and Greenland	33
2.3.3 Europe	35
2.4 Chronological and Geographical Variation in the Post-glacial Fire Frequency	36

2.5	Archaeological Aspects	37
2.6	Conclusions	39
2.7	References	40
3	Fire Frequencies during the suppression period	45
	<i>R.J. Barney and B.J. Stocks</i>	
3.1	Introduction	45
3.2	Pre-suppression Period Fires	47
3.3	Fire Frequencies During the Active Suppression Period	49
3.3.1	The USSR	49
3.3.2	Alaska, the Yukon and the Northwest Territories	50
3.3.3	The Prairie Provinces: Alberta, Saskatchewan, and Manitoba	54
3.3.4	Ontario and Quebec	55
3.3.5	Sweden	56
3.3.6	Finland	57
3.4	Discussion	58
3.5	Acknowledgements	60
3.6	References	61
 SECTION II: PHYSICAL EFFECTS OF FIRE 		
4	Fire behaviour in northern conifer forests and shrublands	65
	<i>C.E. Van Wagner</i>	
4.1	Introduction	65
4.2	Fire Behaviour Principles	65
4.3	Fire Description	66
4.4	Northern Fuels	67
4.5	Weather and Climate	68
4.6	Kinds of Fire	69
4.7	Prediction of Fire Behaviour	70
4.8	Fire Regimes and Ecology	73
4.9	Flammability Versus Age	76
4.10	Conclusions	78
4.11	References	79
5	Fire behaviour and ecological effects in organic terrain	81
	<i>R.W. Wein</i>	
5.1	Introduction	81
5.2	Frequency of Fires in Organic Terrain	83
5.3	Fire Behaviour	84

5.3.1	Laboratory Studies	84
5.3.2	Field Studies	86
5.4	Ecological Implications	89
5.4.1	Ecological relationships in the soil organic matter layer	89
5.4.2	Paludification–fire–nutrient release hypothesis	90
5.4.3	Plant community patterns caused by organic soil removal	91
5.5	Future Research Suggestions	92
5.6	Acknowledgements	93
5.7	References	93
6	Effects of fire on the permafrost ground thermal regime	97
	<i>The late R.J.E. Brown</i>	
6.1	Introduction	97
6.2	Characteristics and Distribution of Permafrost	98
6.3	Immediate Effects of Fire on Permafrost	99
6.4	Long-term Effects of Fire on Permafrost	100
6.4.1	Effects of fire on the active layer	101
6.4.2	Effects of fire on ground temperatures	105
6.4.3	Effects of fire on the ground–surface energy exchange	107
6.5	Conclusions	107
6.6	References	108
7	Fire and nutrient cycling	111
	<i>D.A. MacLean, S.J. Woodley, M.G. Weber, and R.W. Wein</i>	
7.1	Introduction	111
7.2	Nutrient Cycling in Undisturbed Northern Ecosystems	112
7.2.1	Principles	112
7.2.2	Current data availability for northern ecosystems	113
7.2.3	Succession and nutrient cycling	117
7.2.4	Nutrient distribution in relation to increasing latitude	118
7.2.5	Nitrogen fixation in northern ecosystems	118
7.3	Effects of Fire on Nutrient Distribution and Cycling	119
7.3.1	Nutrient redistribution during fire	119
7.3.2	Post-fire nutrient cycling	122
7.3.3	Nutrient cycling in relation to fire frequency and intensity	125
7.4	Conclusions and Future Research Needs	126
7.5	References	127

SECTION III: CONCEPTS OF FIRE EFFECTS ON
INDIVIDUALS AND SPECIES

8	Concepts of fire effects on plant individuals and species	135
	<i>J.S. Rowe</i>	
8.1	Introduction	135
8.2	Patterns of Fire in Space and in Time	135
8.3	Life-forms, Functions, and Fire	138
8.4	Functional Adaptations of Plants	141
8.4.1	Invaders	141
8.4.2	Evaders	142
8.4.3	Avoiders	143
8.4.4	Resisters	143
8.4.5	Endurers	144
8.5	Succession	146
8.6	Discussion	148
8.7	Conclusions	150
8.8	Acknowledgements	150
8.9	References	151
9	Post-fire succession of small-mammal and bird communities	155
	<i>J.F. Fox</i>	
9.1	Introduction	155
9.2	Methods	156
9.3	Small Mammals	157
9.3.1	Geographical distribution of studies	157
9.3.2	Aggregate community properties	158
9.3.3	Species sequence and natural history	160
9.3.4	Small mammals in the far North	160
9.3.5	Effects of logging versus fires	161
9.3.6	Future studies	162
9.4	Bird Communities	163
9.4.1	Geographical distribution of studies	163
9.4.2	Aggregate community properties	164
9.4.3	Post-disturbance responses	170
9.4.4	Bird communities in the boreal forest and the Far North	170
9.4.5	Latitude and bird community similarity	171
9.5	Discussion	173
9.6	Acknowledgements	175
9.7	References	176

SECTION IV: FIRE EFFECTS IN SELECTED VEGETATION ZONES

10	The ecological role of fire in jack pine forests	183
	<i>J.H. Cayford and D.J. McRae</i>	
10.1	Introduction	183
10.2	Fire and Jack Pine	184
10.2.1	Cone serotiny	185
10.2.2	Cone opening and seed dissemination	186
10.2.3	Germination and seedling development	186
10.2.4	Post-fire successional patterns	187
10.3	Fire Effects	188
10.4	Wildfire Characteristics	190
10.5	Prescribed Fire	192
10.6	Conclusions	195
10.7	References	195
11	The effects of fire in black spruce ecosystems of Alaska and northern Canada	201
	<i>L.A. Viereck</i>	
11.1	Introduction	201
11.2	Climate	202
11.3	Fire Regime in the Black Spruce Type	202
11.4	Adaptation to Fire	204
11.5	Effect of Severity of Burn	206
11.6	Revegetation Following Fire in the Black Spruce Type	207
11.6.1	The black spruce–feathermoss type	207
11.6.2	The black spruce–lichen woodland	209
11.7	Relationship With Other Vegetation Types	209
11.8	Succession and Climax	211
11.9	Effects of Fire on Ecosystem Components and Processes	213
11.10	Summary	217
11.11	References	217
12	Fire influences in <i>Abies</i>-dominated forests	221
	<i>V.V. Furyaev, R.W. Wein, and D.A. MacLean</i>	
12.1	Introduction	221
12.2	Fire Frequencies	222
12.2.1	Natural fire frequencies	222
12.2.2	The insect–wildfire hypothesis	224
12.3	Fire Behaviour	225
12.4	Effects of Fire on Ecosystem Components	226

12.4.1	Primary producers	226
12.4.2	Secondary producers	229
12.4.3	Physical environment	230
12.5	Fire Management	231
12.6	Conclusions and Research Needs	231
12.7	Acknowledgements	232
12.8	References	232
13	The role of fire in lichen-dominated tundra and forest-tundra	235
	<i>A.N.D. Auclair</i>	
13.1	Introduction	235
13.1.1	Predisposition to fire	235
13.1.2	Fire occurrence	236
13.1.3	Vegetation distribution	237
13.2	Vegetation Flammability and Behaviour of Fire	237
13.2.1	Extrinsic factors	237
13.2.2	Intrinsic factors	238
13.3	Fire-induced Changes	240
13.3.1	Combustion and mineralization of organic material	240
13.3.2	Changes in surface and soil microclimate	242
13.3.3	Alteration of soil stability and hydrology	244
13.4	Post-fire Regeneration	246
13.4.1	Plant succession	246
13.4.2	Changes in soil decomposers	249
13.4.3	Changes in insect, bird, and mammal species	251
13.5	Future Research Needs	252
13.6	References	253
SECTION V: FIRE CONTROL AND MANAGEMENT		
14	Measures for fire prevention on peat deposits	259
	<i>V.I. Chistjakov, A.I. Kuprijanov, V.V. Gorshkov, and E.S. Artsybashev</i>	
14.1	Introduction	259
14.2	Peat Fires on Undisturbed Peat Deposits	259
14.2.1	Characteristics of peat fires	259
14.2.2	Fire hazard	260
14.2.3	Fire suppression	261
14.3	Fire Hazard During Peat Deposit Exploitation	262
14.3.1	Spontaneous ignition in peat stockpiles	263
14.3.2	Fires in peat harvest fields	263

14.3.3	Measures for fire prevention in peat stockpiles	265
14.3.4	Measures for restriction of fire spread	266
14.4	Fire Suppression on Peat Production Areas	267
14.4.1	Techniques of peat fire suppression	267
14.4.2	Suppression of large peat fires	269
14.5	Acknowledgements	270
14.6	Bibliography	270
15	Fire management in wilderness areas, parks, and other nature reserves	273
	<i>M.E. Alexander and D.E. Dubé</i>	
15.1	Introduction	273
15.2	Forest Fire Programme in Northern Circumpolar Nature Reserves	275
15.2.1	Alaska	275
15.2.2	Northwestern Canada	277
15.2.3	Western and Central Canada	278
15.2.4	North-central United States	279
15.2.5	Eastern Canada	281
15.2.6	Fennoscandia and USSR	283
15.3	Discussion	285
15.4	Concluding Remarks	289
15.5	Acknowledgements	290
15.6	References	291
	Glossary	299
	Author Index	305
	Geographic Index	315
	Subject Index	317

