

Contents

1	Soundscape and Landscape Ecology	1
1.1	Introduction	2
1.2	A Semantic Caveat: Sound, Sonic, Acoustic	2
1.3	The Definition of Soundscape	3
1.4	A Brief History of Soundscape Ecology: Origins and Perspectives	5
1.5	The Disciplinary Contribution to the Soundscape Ecology	6
1.6	The Three Sources of the Sonic Environment	7
1.6.1	Geophonies	8
1.6.2	Biophonies	8
1.6.3	Anthrophonies	10
1.6.4	The Relationships Between Geophonies, Biophonies and Anthrophonies	11
1.7	Foreground and Background Sonic Environment	11
1.8	Hi-Fi and Lo-Fi Soundscapes	13
1.9	Landscape: Emerging Patterns and Dynamics	15
1.9.1	Some Definitions and Relevant Patterns	15
1.10	Sonic Patterns in Soundscape Ecology	17
1.10.1	Definition of Sonotope	17
1.10.2	Definition of Soundtope	19
1.10.3	Definition of Sonotone	19
1.11	The Relationship Between Landscape Structure and Soundscape Patterns	21
1.12	The Sonic Components of the Environment and the General Theory of Resources	22
1.13	Definition of a Sonic Eco-Field	22
1.14	Landscape Fragmentation and Soundscape Processes	23
	References	27

2	Sonic Characteristics of the Landscape	29
2.1	Introduction	29
2.2	Weather Conditions and Sound Propagation	29
2.3	Climatic Patterns and Sounds	30
2.4	Elevation and Song Complexity	32
2.5	The Contribution of Vegetation Microstructure and Macrostructure to the Sonic Environment	34
2.6	Reverberation and Attenuation in Broadleaf and Pine Forests	35
2.7	Vibrations and Leaves	36
2.8	Sound Propagation at Forest Edges	37
2.9	The Jungle Soundscape	38
2.10	The Sound of Fire	39
	References	40
3	Bioacoustics Theories	43
3.1	Introduction	44
3.2	The Morphological Adaptation Hypothesis (MAH)	44
3.3	The Acoustic Adaptation Hypothesis (AAH)	45
3.4	The Acoustic Niche Hypothesis (ANH)	54
3.5	The Species Recognition Hypothesis (SRH)	58
	References	59
4	Communication Theories	63
4.1	Introduction	64
4.2	The Communication Theory	65
4.3	Eavesdropping and Interspecific Communication	67
4.4	Echolocation: A Special Case of Communication	70
4.5	Heterospecific and Conspecific Attraction	70
4.6	Male–Female Song Recognition	72
4.7	Sound Degradation and Ranging Hypothesis	72
4.7.1	Amplitude Fluctuation and Reverberation and Ranging Efficiency	79
4.7.2	Blurring, Attenuation, and Signal-to-Noise Ratio and Ranging Efficiency	81
4.7.3	Some Caveats on Playback Methodology	82
4.8	Distress Calls	82
4.9	Soundscape Orientation and Spatial Source Segregation	83
4.10	Ecological Codes	84
4.11	How to Improve Signaling	87
4.12	The Honesty of Acoustical Signals	88
4.13	Dialects as a Divergent Communication	91
4.14	Acoustic Partitioning in Birds and Frogs	92
4.15	Communication on Steep Soils	93
4.16	Signaling Systems and Climatic Proxies	94

4.17	Song and Reproductive Timing	95
4.18	Acoustic Cues and Antipredatory Performance	97
4.19	Soft Song	98
4.20	Bioacoustics Interactions Between Plants and Insects	98
	References	102
5	Human Dimension of the Soundscape:	
	From Individuals to Society	107
5.1	Introduction	108
5.2	Psychological Approach to Soundscape Interpretation	110
5.3	Noise Sensitivity	111
5.4	Noise Annoyance: Definition and Evaluation Procedures	113
5.5	A Soundscape Semantic	115
5.6	Elements of Psychoacoustics	117
5.7	Noise Pollution: A Growing Problem for Human Societies	122
5.8	Consequences of Noise for Human Physiology and Health	123
5.9	The Characters of the Urban Soundscape	126
5.10	The Sonic Environment of Urban Parks	127
5.11	Pleasant Sounds, Sound Pressure Level, and Acoustic Comfort	129
5.12	The Value of Soundmarks in the Urban Landscape	130
5.13	The Interactions Between Visual and Acoustic Stimuli	130
5.14	Quiet Areas as Solution to Decrease People's Annoyance	135
5.15	The Aesthetic Component of Soundscape Interpretation	135
5.16	Conclusions	137
	References	140
6	Sonic Patterns I: The Noise	143
6.1	Introduction	143
6.2	A Definition of Noise	143
6.3	Characteristics of Anthropogenic Noise	145
6.4	Active Space and Noise	145
6.5	The Noise Context	146
6.6	Noise in Patchy Sonotopes	147
6.7	Noise Pattern as a Source of Environmental Pollution	148
6.8	The Effects of Noise on Vocal Animals	149
6.9	Masking Effect on Animal Life	150
6.10	Underwater Sound Sources	155
6.11	Marine Sound Signature	157
6.12	Acoustic Masking in Freshwater Ecosystems	160
6.13	Acoustic Masking in Marine Ecosystems	160
6.14	Ship and Boat Traffic Impacts on Marine Wildlife	161
6.15	Effect of Traffic Noise on Wildlife	162
6.16	Noise as a Signal in Marine Environments	166
6.17	Noise from a Multi-source Environment	170
6.18	Oil Spills, Noise, and Effects on Animals	170

6.19	Wind Turbines and Noise	172
6.20	Military Noise	174
6.21	A Psychoacoustic Approach to Noise	174
6.22	Noise from Urban Soundscapes	175
6.23	A Historical Perspective of Urban Noise	176
6.24	The Cognitive Component in Noise Evaluation	177
6.25	Effect of Noise on Humans and Society Health	178
6.26	Urban Soundscape Design for Biodiversity	182
6.27	Perspectives in Noise Research	185
	References	188
7	Sonic Patterns II: The Animal Choruses	193
7.1	Introduction	194
7.2	The Chorus Hypotheses	195
7.3	Choruses in Amphibians	199
7.4	Cooperative Versus Competitive Hypothesis in Amphibian Choruses	200
7.5	Choruses in Birds	201
7.5.1	The Energetic Hypothesis	201
7.5.2	The Behavioral Hypothesis	202
7.6	Reproduction Mechanisms and Choruses	203
	References	206
8	Sonic Patterns III: Sounds and Vibrations from Soils	209
8.1	Introduction	209
8.2	Seismic Signals from Reptiles	210
8.3	Seismic Signals from Mammals	212
8.4	Seismic Signals from Arthropods	213
8.5	Soil Pests, Sound Detection, and Biodiversity Assessment	217
	References	219
9	Methods	221
9.1	Introduction	221
9.2	Basic Elements of Acoustics	222
9.2.1	The Sound	222
9.2.2	The Decibel	229
9.3	Digital Representation of Sound	232
9.4	Time Domain and Frequency Domain of Sound	234
9.5	The Spectrogram	235
9.6	Field Recording Procedures	236
9.7	Metrics in Soundscape Ecology	239
9.7.1	Sound Pressure Measurements	240
9.7.2	Spectral Analysis	242
9.8	Pattern Recognition of Vocalizations	247
9.9	Functional Diversity Indices	249

9.10	Software Tools for Soundscape Analysis	250
9.11	Browsing the Audio Database	250
9.12	Methods to Evaluate/Rate the Quality of the Sonic Ambient	251
9.13	Method of Soundwalking	255
9.14	Soundscape Customer Satisfaction	256
9.15	The Assessment of the Human-Perceived Soundscape	257
	References	260
10	Applications	263
10.1	Introduction	263
10.2	Threats to Animal Communication	263
10.3	Acoustic Monitoring	267
10.4	A Sonic Observatory	269
10.5	Mapping Quiet Areas	269
10.6	Valuing Noises in Recreation Areas	270
10.6.1	External Nonrecreational Noise Intrusions	271
10.6.2	External Recreational Noise Intrusions	272
10.6.3	Onsite Interactivity Noise Intrusion	272
10.6.4	Onsite Intra-activity Noise Intrusions	272
10.7	Managing Sonic Context in Natural Areas	273
10.8	Soundscape Protection in National Parks	274
10.9	Perceived Crowding in Natural Parks	275
10.10	Snowmobile Noise in National Parks	278
10.11	Aircraft Noise in National Parks	280
10.12	Valuing Sonic Heritage	283
10.13	Some Characteristics of the Urban Sonic Environment	285
10.14	Urban Noise Management	285
10.15	Traffic Noise Mitigation Procedures and Urban Spaces	286
10.16	Design the Soundscape of Urban Spaces and Parks	288
10.17	Sonification	289
	References	294
Index		297