

Contents

<i>About the Authors</i>	xviii
<i>Foreword</i>	xx
<i>Acknowledgements</i>	xxii
<i>List of Acronyms, Units, Prefixes and Symbols</i>	xxiii
<i>Preface</i>	xxxiii
Chapter 1 Introduction	1
1.1 General Overview	1
1.2 Marine Mammal Classification	2
1.2.1 Cetaceans	3
1.2.2 Pinnipeds	3
1.2.3 Sirenians	4
1.2.4 Marine mustelids	4
1.2.5 Polar bear	5
1.3 Marine Mammal Distribution	5
1.4 Effects of Anthropogenic Sound on Marine Mammals	17
1.4.1 Temporary Threshold Shift and Permanent Threshold Shift	17
1.4.2 Behavioural alterations	18
1.4.3 Stress	19
1.4.4 Masking	19
1.4.5 Strandings	20
1.4.6 Indirect effects	21
1.5 Marine Mammal Hearing	21
1.5.1 Audiograms	21
1.5.2 Hearing ranges	23
1.5.3 Sound exposure criteria	29
Chapter 2 Mitigation Measures	33
2.1 Introduction	33
2.2 Protective Legislation	34

2.3 Marine Protected Areas	35
2.4 Project Planning	36
2.5 Control of Operational Procedures	36
2.6 Noise Reduction Methods	37
2.7 Acoustic Mitigation Devices	37
2.8 Active SONAR	37
2.9 Visual and Acoustic Watches	38
2.10 MMO and PAM Operator Requirements	43
2.11 Species for which Mitigation Applies	43
2.12 Exclusion Zones	43
2.13 Pre-Watch	43
2.14 Soft-Starts	44
2.15 Sound Source Testing	44
2.16 Operation Issues and Breaks in Sound Production	44
2.17 Delays and Shut-Downs	44
2.18 Night-Time and Low Visibility Working	45
2.19 Report Writing	45

Chapter 3 Sources of Anthropogenic Noise 46

3.1 Introduction	46
3.2 Shipping	47
3.3 Offshore Wind Farms	48
3.4 Tidal Turbines	49
3.5 Dredging	49
3.6 Drilling and Production	51
3.7 Floating Production Storage Offloading	54
3.8 Acoustic Mitigation Devices	54
3.9 Seismic	55
3.10 Pile Driving	57
3.11 SONAR	58
3.12 Whale Finders	59
3.13 Explosions	60
3.14 Electromagnetic	60

Chapter 4 Training 62

4.1 Introduction	62
4.2 Background Reading and Scientific Organisations	62
4.3 Becoming a Certified MMO or PAM Operator	64
4.3.1 MMO training	65

4.3.2 PAM Operator	65
4.4 Courses	66
4.4.1 UK and Ireland	66
4.4.2 USA (GoM)	66
4.4.3 Greenland	66
4.4.4 New Zealand	67
4.4.5 Offshore sea survival	67
4.4.5.1 BOSIET	68
4.4.5.2 Minimum Industry Safety Training	68
4.4.5.3 Safe Gulf safety training	69
4.4.6 Offshore medicals	69
4.4.6.1 Netherlands, Norway and UK	70
4.4.6.2 Seafarers' medicals	70
4.5 Insurance	70
4.6 Curriculum Vitae	71
4.7 Gaining Offshore Experience	71
Chapter 5 Offshore Life	72
5.1 Introduction	72
5.2 Contract Award	73
5.3 Pay	75
5.4 Documentation	75
5.5 Vantage Cards	76
5.6 Packing	76
5.7 Personal Protective Equipment	78
5.8 Pre-Project Research	79
5.9 Discretion	79
5.10 Mobilisation	79
5.11 Helicopters	80
5.12 Arrival	81
5.13 Offshore Personnel	82
5.14 Personal Conduct	83
5.15 Phone and Internet	84
5.16 Drugs and Alcohol	85
5.17 Safety Management Systems	85
5.18 T-Card System	87
5.19 Safety Drills	87
5.20 Demobilisation	88
5.21 Vessels	88
5.21.1 Kick-off meeting	88
5.21.2 Dealing with seasickness	88

5.21.3 Baseline surveys	89
5.21.4 Dredging	90
5.21.5 Hydrographical surveys	91
5.21.6 Seismic surveys	92
5.21.7 Piling	97
5.21.8 Military SONAR	98
5.22 Offshore Installations	99
5.22.1 Arrival	99
5.22.2 Layout	99
5.22.3 Kick-off, shift, and rotation meetings	101
5.22.4 Personnel	101
5.22.5 Operational activities	102
5.22.6 Weather	104
5.22.7 General hazards	104
5.22.8 Rig tow	105
5.22.9 Drilling rig and production platform complexes	106
5.22.10 VSP	107
5.22.11 Conductor hammering	107
Chapter 6 MMO Theory and Practice	109
6.1 Introduction	109
6.2 Equipment	110
6.2.1 Fold-over clipboard	110
6.2.2 Stationery	111
6.2.3 Digital watch	111
6.2.4 Marine radio	111
6.2.5 Binoculars	111
6.2.6 GPS	112
6.2.7 Cameras	112
6.2.8 Lenses	115
6.2.9 Plumb-bob	116
6.2.10 Field guides	116
6.3 Conducting an MMO Watch	117
6.4 Observation Platform	117
6.5 Recording Position	118
6.5.1 Ranging software	120
6.6 Recording Vessel Movements	120
6.7 Marine Mammal Identification	120
6.7.1 Cetacean identification	121
6.7.2 Pinniped identification	122
6.8 Range Estimation	122
6.9 Bearing Estimation	127
6.10 Photographing Marine Mammals	128
6.11 Data Collection	128
6.11.1 Cover page	129

8.5.2 Kogiidae	191
8.5.2.1 Pygmy sperm whale	191
8.5.3 Ziphiidae	191
8.5.3.1 Cuvier's beaked whale	191
8.5.3.2 Arnoux's beaked whale	191
8.5.3.3 Baird's beaked whale	192
8.5.3.4 Longman's beaked whale	192
8.5.3.5 Northern bottlenose whale	192
8.5.3.6 Gervais' beaked whale	193
8.5.3.7 Sowerby's beaked whale	193
8.5.3.8 Hubb's beaked whale	193
8.5.3.9 Stejneger's beaked whale	194
8.5.3.10 Blainville's beaked whale	194
8.5.3.11 Deraniyagala's beaked whale	195
8.5.4 Pontoporiidae	195
8.5.4.1 Franciscana/La Plata dolphin	195
8.5.5 Monodontidae	195
8.5.5.1 Narwhal	195
8.5.5.2 Beluga	196
8.5.6 Delphinidae	197
8.5.6.1 Commerson's or Kerguelen Islands dolphin	197
8.5.6.2 Chilean dolphin	198
8.5.6.3 Heaviside's dolphin	198
8.5.6.4 South Island or Maui's dolphin/North Island Hector's dolphin	198
8.5.6.5 Rough-toothed dolphin	198
8.5.6.6 Atlantic humpback dolphin	199
8.5.6.7 Pacific humpback dolphin	199
8.5.6.8 Guiana dolphin	199
8.5.6.9 Common or Black Sea bottlenose dolphin	200
8.5.6.10 Indo-Pacific bottlenose dolphin	201
8.5.6.11 Offshore or coastal pantropical spotted dolphin	201
8.5.6.12 Atlantic spotted dolphin	202
8.5.6.13 Gray's, eastern, Central American or dwarf spinner dolphin	203
8.5.6.14 Clymene dolphin	203
8.5.6.15 Striped dolphin	204
8.5.6.16 Short-beaked or Black Sea common dolphin	204
8.5.6.17 Long-beaked or Indo-Pacific common dolphin	205
8.5.6.18 Fraser's dolphin	205
8.5.6.19 White-beaked dolphin	206
8.5.6.20 Atlantic white-sided dolphin	206
8.5.6.21 Pacific white-sided dolphin	207
8.5.6.22 African, Fitzroy's, Peruvian/Chilean or New Zealand dusky dolphin	207
8.5.6.23 Peale's dolphin	208
8.5.6.24 Hourglass dolphin	208
8.5.6.25 Northern right whale dolphin	208
8.5.6.26 Risso's dolphin	208
8.5.6.27 Melon-headed whale	210
8.5.6.28 Pygmy killer whale	210

8.5.6.29 False killer whale	210
8.5.6.30 Resident or transient killer whale/orca	211
8.5.6.31 North Atlantic, southern or North Pacific long-finned pilot whale	212
8.5.6.32 Short-finned pilot whale	213
8.5.6.33 Irrawaddy dolphin	213
8.5.6.34 Australian snubfin dolphin	214
8.5.7 Phocoenidae	214
8.5.7.1 Indo-Pacific finless porpoise	214
8.5.7.2 East Asian narrow-ridged finless porpoise	214
8.5.7.3 Atlantic, eastern Pacific, Black Sea or western Pacific harbour/common porpoise	214
8.5.7.4 Vaquita	215
8.5.7.5 Dall's-type or Truei-type Dall's porpoise	216
Chapter 9 PAM Practice	217
9.1 Introduction	217
9.2 Existing PAM Technologies	218
9.3 PAM Equipment	219
9.3.1 Tow cable	219
9.3.2 Hydrophones	220
9.3.3 Depth sensor	221
9.3.4 Deck cable	222
9.3.5 Data Acquisition Unit	223
9.3.6 Sound cards	224
9.3.7 Computers	225
9.3.8 Filters and gain	225
9.3.9 GPS	226
9.3.10 Serial-to-USB converter	226
9.3.11 Gender changer	226
9.3.12 Headphones	227
9.3.13 Connectors	227
9.3.14 Oscilloscope	228
9.3.15 Tool kit	229
9.3.16 Tape	229
9.4 PAM Mobilisation	230
9.4.1 Unpacking	230
9.5 Deck Cable Run	232
9.6 PAM Monitoring Station Configuration	234
9.6.1 Data Acquisition Unit	235
9.6.2 DAU connectors	236
9.6.3 Sound cards	237
9.6.4 Computers	239
9.6.5 GPS or NMEA feed	240
9.6.6 Headphones	241
9.7 PAMGuard	241
9.7.1 Starting PAMGuard	241

9.7.2 Configuring PAMGuard: Part I	242
9.7.2.1 <i>Maps and mapping</i>	244
9.7.2.2 <i>Sound processing</i>	244
9.7.2.3 <i>Displays</i>	245
9.7.2.4 <i>Detectors</i>	246
9.7.2.5 <i>Utilities</i>	246
9.7.3 Hydrophone specifications and sampling rate	248
9.7.3.1 <i>Hydrophone frequency range</i>	248
9.7.3.2 <i>Hydrophone sensitivity</i>	248
9.7.3.3 <i>Sampling rate</i>	248
9.7.4 Configuring PAMGuard: Part II	250
9.7.4.1 <i>Maps and mapping</i>	250
9.7.4.2 <i>Sound processing</i>	251
9.7.4.3 <i>Display</i>	254
9.7.4.4 <i>Detectors</i>	255
9.7.4.5 <i>Utilities</i>	256
9.7.4.6 <i>Hydrophone settings</i>	256
9.7.4.7 <i>Filters</i>	258
9.7.5 PAMGuard troubleshooting	260
9.7.5.1 <i>Freezing and/or restarting</i>	261
9.7.5.2 <i>Position fix error</i>	261
9.7.5.3 <i>Erratic cursor</i>	263
9.7.5.4 <i>Spectrogram</i>	264
9.8 Tap (Noise) Test	264
9.9 Earthing	265
9.10 Depth Sensor Calibration	266
9.11 Tow Cable Deployment	268
9.11.1 <i>General deployment</i>	269
9.11.2 <i>Seismic survey vessels</i>	273
9.11.3 <i>Offshore support vessels</i>	276
9.11.4 <i>Vertical deployment</i>	276
9.12 PAM Monitoring	277
9.12.1 <i>Shifts</i>	277
9.12.2 <i>Monitoring methods</i>	278
9.12.3 <i>Data collection</i>	279
9.12.4 <i>Detection metrics</i>	280
9.12.5 <i>Sound playback</i>	281
9.13 PAM Detections During Industrial Operations	281
9.13.1 <i>Localising animals</i>	282
9.13.2 <i>Zero marine mammal detections: possible explanations</i>	284
9.13.3 <i>Non-target noise</i>	286
9.14 Equipment Responsibilities: Routine Housekeeping	289
9.14.1 <i>Retrieval in bad weather</i>	290
9.14.2 <i>Loss of propulsion</i>	290
9.14.3 <i>Wiring, soldering and potting</i>	290
9.15 PAM Demobilisation	291

9.15.1 Handover notes	291
9.15.2 Tow cable	291
9.15.3 Connectors, hydrophones and depth sensors	292
9.15.4 Deck cable removal	294
9.15.5 Cable reels and drums	294
9.15.6 PAM monitoring station	295
9.15.7 Pallet preparation	295
9.15.8 Documentation	296
Chapter 10 Report Writing	297
10.1 Introduction	297
10.2 Content	298
10.3 Summary	298
10.4 Introduction	298
10.5 Methodology	299
10.6 Results	300
10.6.1 Sightings	301
10.6.2 Delays or shut-downs	301
10.6.3 Weather	301
10.7 Discussion and Conclusion	302
10.8 Recommendations	302
10.9 Acknowledgements, References and Data Submission	302
<i>Glossary of Terms</i>	303
<i>References</i>	326
<i>Index</i>	371