

Draft environmental management plan

Significant species management plan

Y-H

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Go back to contents ▶

Santos GLNG Upstream

Significant Species Management Plan

Table of Contents

1.0	Introduction.....	1
1.1	Purpose and Scope of the SSMP	1
1.1.1	Purpose	1
1.1.2	Scope	2
2.0	Roles and Responsibilities.....	4
3.0	Legal and Other Requirements	5
3.1	Legal Requirements	5
3.2	Santos Environment, Health and Safety Management System.....	7
3.2.1	Environmental Protocol for Constraints Planning and Field Development	8
3.2.2	Fauna Management Plan	9
3.2.3	Species Management Program.....	9
3.2.4	Rehabilitation Management Plan	9
3.2.5	Environmental Offsets Strategy	9
4.0	Significant Species in the Santos GLNG Upstream Project Area	10
4.1	Overview	10
4.2	Significant Flora	10
4.3	Significant Fauna	15
4.3.1	Fauna Habitat.....	24
4.4	Threatened Ecological Communities	24
5.0	Threats to Significant Species and Threatened Ecological Communities	26
6.0	Management of Significant Species and TECs	29
6.1	Management Hierarchy	29
6.1.1	Avoid and Minimise	29
6.1.2	Mitigate	30
6.1.3	Rehabilitate	30
6.1.4	Offset.....	31
6.2	Mitigation Measures	31
6.2.1	Significant Flora Species.....	31
6.2.2	Significant Invertebrates.....	34
6.2.3	Significant Threatened Birds	36
6.2.4	Significant Reptiles.....	39
6.2.5	Significant Mammal Species	42
6.2.6	Aquatic Fauna	46
6.2.7	Significant Migratory Birds	49
6.2.8	Threatened Ecological Communities	52

7.0	Recording and Reporting Requirements	55
7.1.1	Recording and Tracking Disturbances to MNES	55
7.1.2	Data Collection and Storage	55
7.1.3	Reporting	55
7.2	Incident Investigation and Corrective Actions	55
7.2.1	Incident Investigation and Corrective Actions	55
7.3	Training	57
8.0	Evaluation and Review	58
8.1	Evaluation.....	58
8.2	Review.....	58
9.0	Species and Community Profiles	60
9.1	<i>Acacia curranii</i>	60
9.1.1	Status	60
9.1.2	Biology and ecology	60
9.1.3	Anticipated threats and potential impacts from the Project.....	62
9.1.4	Unavoidable impact from the Project	62
9.1.5	Management practices and methods	62
9.2	<i>Acacia grandifolia</i>	63
9.2.1	Status	63
9.2.2	Biology and ecology	63
9.2.3	Anticipated threats and potential impacts from the Project.....	65
9.2.4	Unavoidable impact from the Project	65
9.2.5	Management practices and methods	65
9.3	<i>Aristida annua</i>	66
9.3.1	Status	66
9.3.2	Biology and ecology	66
9.3.3	Anticipated threats and potential impacts from the Project.....	67
9.3.4	Unavoidable impact from the Project	67
9.3.5	Management practices and methods	67
9.4	<i>Arthraxon hispidus</i>	68
9.4.1	Status	68
9.4.2	Biology and ecology	68
9.4.3	Anticipated threats and potential impacts from the Project.....	69
9.4.4	Unavoidable impact from the Project	70
9.4.5	Management practices and methods	70
9.5	<i>Bertya opposens</i>	71

Santos

GLNG Project

9.5.1	Status	71
9.5.2	Biology and ecology	71
9.5.3	Anticipated threats and potential impacts from the Project.....	73
9.5.4	Unavoidable impact from the Project	73
9.5.5	Management practices and methods	73
9.6	<i>Cadellia pentastylis</i>	74
9.6.1	Status	74
9.6.2	Biology and ecology	74
9.6.3	Anticipated threats and potential impacts from the Project.....	75
9.6.4	Anticipated impact from the Project	75
9.6.5	Management practices and methods	76
9.7	<i>Calytrix gurulmundensis</i>	77
9.7.1	Status	77
9.7.2	Biology and ecology	77
9.7.3	Anticipated threats and potential impacts from the Project.....	78
9.7.4	Unavoidable impact from the Project	78
9.7.5	Management practices and methods	79
9.8	<i>Daviesia discolor</i>	80
9.8.1	Status	80
9.8.2	Biology and ecology	80
9.8.3	Anticipated threats and potential impacts from the Project.....	81
9.8.4	Unavoidable impact from the Project	82
9.8.5	Management practices and methods	82
9.9	<i>Dichanthium queenslandicum</i>	83
9.9.1	Status	83
9.9.2	Biology and ecology	83
9.9.3	Anticipated threats and potential impacts from the Project.....	84
9.9.4	Unavoidable impact from the Project	85
9.9.5	Management practices and methods	85
9.10	<i>Dichanthium setosum</i>	86
9.10.1	Status	86
9.10.2	Biology and ecology	86
9.10.3	Anticipated threats and potential impacts from the Project.....	87
9.10.4	Unavoidable impact from the Project	87
9.10.5	Management practices and methods	87
9.11	<i>Eucalyptus beaniana</i>	88

Santos

GLNG Project

9.11.1	Status	88
9.11.2	Biology and ecology	88
9.11.3	Anticipated threats and potential impacts from the Project.....	89
9.11.4	Unavoidable impact from the Project	90
9.11.5	Management practices and methods	90
9.12	<i>Homopholis belsonii</i>	91
9.12.1	Status	91
9.12.2	Biology and ecology	91
9.12.3	Anticipated threats and potential impacts from the Project.....	92
9.12.4	Unavoidable impact from the Project	93
9.12.5	Management practices and methods	93
9.13	<i>Homoranthus decumbens</i>	94
9.13.1	Status	94
9.13.2	Biology and ecology	94
9.13.3	Anticipated threats and potential impacts from the Project.....	95
9.13.4	Unavoidable impact from the Project	95
9.13.5	Management practices and methods	95
9.14	<i>Macrozamia platyrhachis</i>	96
9.14.1	Status	96
9.14.2	Biology and ecology	96
9.14.3	Anticipated threats and potential impacts from the Project.....	97
9.14.4	Unavoidable impact from the Project	98
9.14.5	Management practices and methods	98
9.15	<i>Phaius australis</i>	99
9.15.1	Status	99
9.15.2	Biology and ecology	99
9.15.3	Anticipated threats and potential impacts from the Project.....	101
9.15.4	Unavoidable impact from the Project	101
9.15.5	Management practices and methods	101
9.16	<i>Swainsona murrayana</i>	102
9.16.1	Status	102
9.16.2	Biology and ecology	102
9.16.3	Anticipated threats and potential impacts from the Project.....	103
9.16.4	Unavoidable impact from the Project	103
9.16.5	Management practices and methods	103
9.17	<i>Thesium australe</i>	104

Santos

GLNG Project

9.17.1	Status	104
9.17.2	Biology and ecology	104
9.17.3	Anticipated threats and potential impacts from the Project.....	105
9.17.4	Unavoidable impact from the Project	106
9.17.5	Management practices and methods	106
9.18	<i>Tylophora linearis</i>	107
9.18.1	Status	107
9.18.2	Biology and ecology	107
9.18.3	Anticipated threats and potential impacts from the Project.....	108
9.18.4	Unavoidable impact from the Project	108
9.18.5	Management practices and methods	109
9.19	<i>Westringia parvifolia</i>	110
9.19.1	Status	110
9.19.2	Biology and ecology	110
9.19.3	Anticipated threats and potential impacts from the Project.....	111
9.19.4	Unavoidable impact from the Project	111
9.19.5	Management practices and methods	111
9.20	<i>Xerothamnella herbacea</i>	112
9.20.1	Status	112
9.20.2	Biology and ecology	112
9.20.3	Anticipated threats and potential impacts from the Project.....	114
9.20.4	Unavoidable impact from the Project	114
9.20.5	Management practices and methods	114
9.21	<i>Eriocaulon carsonii</i>	115
9.21.1	Status	115
9.21.2	Biology and ecology	115
9.21.3	Anticipated threats and potential impacts from the Project.....	116
9.21.4	Unavoidable impact from the Project	116
9.21.5	Management measures and methods.....	117
9.22	Boggomoss snail	118
9.22.1	Status	118
9.22.2	Biology and ecology	118
9.22.3	Habitat	119
9.22.4	Habitat assessment.....	119
9.22.5	Anticipated threats and potential impacts from the Project.....	120
9.22.6	Unavoidable impact from the Project	120

9.22.7	Management practices and methods	121
9.23	Australasian bittern	122
9.23.1	Status	122
9.23.2	Biology and ecology	122
9.23.3	Habitat	124
9.23.4	Habitat assessment.....	124
9.23.5	Anticipated threats and potential impacts from the Project.....	125
9.23.6	Unavoidable impact from the Project	125
9.23.7	Management practices and methods	125
9.24	Red goshawk	126
9.24.1	Status	126
9.24.2	Biology and ecology	126
9.24.3	Habitat	128
9.24.4	Habitat assessment.....	129
9.24.5	Anticipated threats and potential impacts from the Project.....	130
9.24.6	Unavoidable impacts from the Project	130
9.24.7	Management practices and methods	131
9.25	Squatter pigeon – southern subspecies.....	132
9.25.1	Status	132
9.25.2	Biology and ecology	132
9.25.3	Habitat	134
9.25.4	Habitat assessment.....	135
9.25.5	Anticipated threats and potential impacts from the Project.....	136
9.25.6	Unavoidable impact from the Project	136
9.25.7	Management practices and methods	136
9.26	Swift parrot	137
9.26.1	Status	137
9.26.2	Biology and ecology	137
9.26.3	Habitat	139
9.26.4	Habitat assessment.....	139
9.26.5	Anticipated threats and potential impacts from the Project.....	140
9.26.6	Unavoidable impact from the Project	140
9.26.7	Management practices and methods	140
9.27	Star finch	141
9.27.1	Status	141
9.27.2	Biology and ecology	141

Santos

GLNG Project

9.27.3	Habitat	143
9.27.4	Habitat assessment.....	144
9.27.5	Anticipated threats and potential impacts from the Project.....	145
9.27.6	Unavoidable impact from the Project	145
9.27.7	Management practices and methods	145
9.28	Plains-wanderer	146
9.28.1	Status	146
9.28.2	Biology and ecology	146
9.28.3	Habitat	148
9.28.4	Habitat assessment.....	148
9.28.5	Anticipated threats and potential impacts from the Project.....	149
9.28.6	Unavoidable impact from the Project	149
9.28.7	Management practices and methods	150
9.29	Superb parrot	151
9.29.1	Status	151
9.29.2	Biology and ecology	151
9.29.3	Habitat	153
9.29.4	Habitat assessment.....	153
9.29.5	Anticipated threats and potential impacts from the Project.....	154
9.29.6	Unavoidable impact from the Project	154
9.29.7	Management practices and methods	154
9.30	Black-throated finch	155
9.30.1	Status	155
9.30.2	Biology and ecology	155
9.30.3	Habitat	157
9.30.4	Habitat assessment.....	158
9.30.5	Anticipated threats and potential impacts from the Project.....	159
9.30.6	Unavoidable impact from the Project	159
9.30.7	Management practices and methods	159
9.31	Australian painted snipe	160
9.31.1	Status	160
9.31.2	Biology and ecology	160
9.31.3	Habitat	162
9.31.4	Habitat assessment.....	162
9.31.5	Anticipated threats and potential impacts from the Project.....	163
9.31.6	Unavoidable impact from the Project	163

9.31.7	Management practices and methods	163
9.32	Black-breasted button-quail	164
9.32.1	Status	164
9.32.2	Biology and ecology	164
9.32.3	Habitat	166
9.32.4	Habitat assessment.....	167
9.32.5	Anticipated threats and potential impacts from the Project.....	168
9.32.6	Unavoidable impact from the Project	168
9.32.7	Management practices and methods	168
9.33	Five-clawed worm-skink.....	169
9.33.1	Status	169
9.33.2	Biology and ecology	169
9.33.3	Habitat	170
9.33.4	Habitat assessment.....	171
9.33.5	Anticipated threats and potential impacts from the Project.....	172
9.33.6	Unavoidable impact from the Project	172
9.33.7	Management practices and methods	172
9.34	Dunmall's snake	173
9.34.1	Status	173
9.34.2	Biology and ecology	173
9.34.3	Habitat	174
9.34.4	Habitat assessment.....	175
9.34.5	Anticipated threats and potential impacts from the Project.....	176
9.34.6	Unavoidable impact from the Project	176
9.34.7	Management practices and methods	176
9.35	Ornamental snake	177
9.35.1	Status	177
9.35.2	Biology and ecology	177
9.35.3	Habitat	178
9.35.4	Habitat assessment.....	179
9.35.5	Anticipated threats and potential impacts from the Project.....	180
9.35.6	Unavoidable impact from the Project	180
9.35.7	Management practices and methods	180
9.36	Collared delma	181
9.36.1	Status	181
9.36.2	Biology and ecology	181

Santos

GLNG Project

9.36.3	Habitat	182
9.36.4	Habitat assessment.....	182
9.36.5	Anticipated threats and potential impacts from the Project.....	183
9.36.6	Unavoidable impact from the Project	183
9.36.7	Management practices and methods	184
9.37	Yakka skink	185
9.37.1	Status	185
9.37.2	Biology and ecology	185
9.37.3	Habitat	186
9.37.4	Habitat assessment.....	187
9.37.5	Anticipated threats and potential impacts from the Project.....	188
9.37.6	Unavoidable impact from the Project	188
9.37.7	Management practices and methods	188
9.38	Large-eared pied bat.....	189
9.38.1	Status	189
9.38.2	Biology and ecology	189
9.38.3	Habitat	191
9.38.4	Habitat assessment.....	191
9.38.5	Anticipated threats and potential impacts from the Project.....	192
9.38.6	Unavoidable impact from the Project	193
9.38.7	Management practices and methods	193
9.39	South-eastern long-eared bat	194
9.39.1	Status	194
9.39.2	Biology and ecology	194
9.39.3	Habitat	195
9.39.4	Habitat assessment.....	196
9.39.5	Anticipated threats and potential impacts from the Project.....	197
9.39.6	Unavoidable impact from the Project	197
9.39.7	Management practices and methods	197
9.40	Northern quoll.....	198
9.40.1	Status	198
9.40.2	Biology and ecology	198
9.40.3	Habitat	200
9.40.4	Habitat assessment.....	200
9.40.5	Anticipated threats and potential impacts from the Project.....	201
9.40.6	Unavoidable impact from the Project	201

9.40.7	Management practices and methods	201
9.41	Bridled nail-tail wallaby.....	202
9.41.1	Status	202
9.41.2	Biology and ecology	202
9.41.3	Habitat	203
9.41.4	Habitat assessment.....	204
9.41.5	Anticipated threats and potential impacts from the Project.....	205
9.41.6	Unavoidable impact from the Project	205
9.41.7	Management practices and methods	205
9.42	Brush-tailed rock-wallaby	206
9.42.1	Status	206
9.42.2	Biology and ecology	206
9.42.3	Habitat	208
9.42.4	Habitat assessment.....	208
9.42.5	Anticipated threats and potential impacts from the Project.....	209
9.42.6	Unavoidable impact from the Project	210
9.42.7	Management practices and methods	210
9.43	Grey-headed flying-fox.....	211
9.43.1	Status	211
9.43.2	Biology and ecology	211
9.43.3	Known species populations and their relationship within the CSG fields	212
9.43.4	Habitat	213
9.43.5	Habitat assessment.....	213
9.43.6	Anticipated threats and potential impacts from the Project.....	214
9.43.7	Unavoidable impact from the Project	214
9.43.8	Management practices and methods	214
9.44	Koala	215
9.44.1	Status	215
9.44.2	Biology and ecology	215
9.44.3	Habitat	216
9.44.4	Habitat assessment.....	217
9.44.5	Anticipated threats and potential impacts from the Project.....	218
9.44.6	Unavoidable impact from the Project	218
9.44.7	Management practices and methods	218
9.45	Murray cod	219
9.45.1	Status	219

9.45.2	Biology and ecology	219
9.45.3	Habitat	221
9.45.4	Habitat assessment.....	221
9.45.5	Anticipated threats and potential impacts from the Project.....	222
9.45.6	Unavoidable impact from the Project	222
9.45.7	Management practices and methods	222
9.46	Fitzroy river turtle	223
9.46.1	Status	223
9.46.2	Biology and ecology	223
9.46.3	Habitat	224
9.46.4	Anticipated threats and potential impacts from the Project.....	226
9.46.5	Unavoidable impact from the Project	226
9.46.6	Management practices and methods	226
9.47	Great egret	227
9.47.1	Status	227
9.47.2	Biology and ecology	227
9.47.3	Habitat	228
9.47.4	Habitat assessment.....	229
9.47.5	Anticipated threats and potential impacts from the Project.....	230
9.47.6	Unavoidable impact from the Project	230
9.47.7	Management practices and methods	230
9.48	Cattle egret.....	231
9.48.1	Status	231
9.48.2	Biology and ecology	231
9.48.3	Habitat	232
9.48.4	Habitat assessment.....	232
9.48.5	Anticipated threats and potential impacts from the Project.....	234
9.48.6	Unavoidable impact from the Project	234
9.48.7	Management practices and methods	234
9.49	Fork-tailed swift	235
9.49.1	Status	235
9.49.2	Biology and ecology	235
9.49.3	Habitat	236
9.49.4	Habitat assessment.....	237
9.49.5	Anticipated threats and potential impacts from the Project.....	238
9.49.6	Unavoidable impact from the Project	238

Santos

GLNG Project

9.49.7	Management practices and methods	238
9.50	Sharp-tailed sandpiper	239
9.50.1	EPBC Act legal status	239
9.50.2	Biology and ecology	239
9.50.3	Known species populations and their relationship within the CSG fields	240
9.50.4	Habitat	240
9.50.5	Habitat assessment.....	241
9.50.6	Anticipated threats and potential impacts from the Project.....	242
9.50.7	Unavoidable impact from the Project	242
9.50.8	Management Practices and Methods.....	242
9.51	Latham's snipe	243
9.51.1	Status	243
9.51.2	Biology and ecology	243
9.51.3	Habitat	244
9.51.4	Habitat assessment.....	245
9.51.5	Anticipated threats and potential impacts from the Project.....	246
9.51.6	Unavoidable impact from the Project	246
9.51.7	Management practices and methods	246
9.52	White-bellied sea-eagle.....	247
9.52.1	Status	247
9.52.2	Biology and ecology	247
9.52.3	Anticipated threats and potential impacts from the Project.....	250
9.52.4	Unavoidable impact from the Project	250
9.52.5	Management practices and methods	251
9.53	White-throated needletail	252
9.53.1	Status	252
9.53.2	Biology and ecology	252
9.53.3	Habitat	253
9.53.4	Habitat assessment.....	253
9.53.5	Anticipated threats and potential impacts from the Project.....	255
9.53.6	Unavoidable impact from the Project	255
9.53.7	Management practices and methods	255
9.54	Rainbow bee-eater.....	256
9.54.1	Status	256
9.54.2	Biology and ecology	256
9.54.3	Habitat	258

Santos

GLNG Project

9.54.4	Habitat assessment.....	258
9.54.5	Anticipated threats and potential impacts from the Project.....	259
9.54.6	Unavoidable impact from the Project	259
9.54.7	Management practices and methods	259
9.55	Black-faced monarch	260
9.55.1	Status	260
9.55.2	Biology and ecology	260
9.55.3	Habitat	261
9.55.4	Habitat assessment.....	262
9.55.5	Anticipated threats and potential impacts from the Project.....	263
9.55.6	Unavoidable impact from the Project	263
9.55.7	Management practices and methods	263
9.56	Spectacled monarch	264
9.56.1	Status	264
9.56.2	Biology and ecology	264
9.56.3	Habitat	265
9.56.4	Habitat assessment.....	265
9.56.5	Anticipated threats and potential impacts	266
9.56.6	Unavoidable impact from Project	267
9.56.7	Management practices and methods	267
9.57	Satin flycatcher	268
9.57.1	Status	268
9.57.2	Biology and ecology	268
9.57.3	Habitat	269
9.57.4	Habitat assessment.....	270
9.57.5	Anticipated threats and potential impacts	271
9.57.6	Unavoidable impact from the Project	271
9.57.7	Management practices and methods	271
9.58	Eastern osprey	272
9.58.1	EPBC Act legal status	272
9.58.2	Biology and ecology	272
9.58.3	Habitat	274
9.58.4	Habitat assessment.....	274
9.58.5	Anticipated threats and potential impacts from the Project.....	275
9.58.6	Unavoidable impact from the Project	275
9.58.7	Specific management requirements.....	276

Santos

GLNG Project

9.59	Glossy ibis	277
9.59.1	EPBC Act legal status	277
9.59.2	Biology and ecology	277
9.59.3	Habitat	278
9.59.4	Habitat assessment.....	279
9.59.5	Anticipated threats and potential impacts from the Project.....	280
9.59.6	Unavoidable impact from the Project	280
9.59.7	Specific management requirements.....	280
9.60	Cotton pygmy-goose	281
9.60.1	EPBC Act legal status	281
9.60.2	Biology and ecology	281
9.60.3	Habitat	282
9.60.4	Habitat assessment.....	283
9.60.5	Anticipated threats and potential impacts from the Project.....	284
9.60.6	Unavoidable impact from the Project	284
9.60.7	Specific management requirements.....	284
9.61	Common greenshank.....	285
9.61.1	EPBC Act legal status	285
9.61.2	Biology and ecology	285
9.61.3	Habitat	286
9.61.4	Habitat assessment.....	287
9.61.5	Anticipated threats and potential impacts from the Project.....	288
9.61.6	Unavoidable impact from the Project	288
9.61.7	Specific management requirements.....	288
9.62	Marsh sandpiper	289
9.62.1	EPBC Act legal status	289
9.62.2	Biology and ecology	289
9.62.3	Habitat	290
9.62.4	Habitat assessment.....	290
9.62.5	Anticipated threats and potential impacts from the Project.....	292
9.62.6	Unavoidable impact from the Project	292
9.62.7	Management Practices and Methods.....	292
9.63	Pacific golden plover	293
9.63.1	EPBC Act legal status	293
9.63.2	Biology and ecology	293
9.63.3	Habitat	295

Santos

GLNG Project

9.63.4	Habitat assessment.....	295
9.63.5	Anticipated threats and potential impacts from the Project.....	296
9.63.6	Unavoidable impact from the Project	296
9.63.7	Management Practices and Methods.....	296
9.64	Wood sandpiper	297
9.64.1	EPBC Act legal status	297
9.64.2	Biology and ecology	297
9.64.3	Habitat	298
9.64.4	Habitat assessment.....	299
9.64.5	Anticipated threats and potential impacts from the Project.....	300
9.64.6	Unavoidable impact from the Project	300
9.64.7	Management Practices and Methods.....	300
9.65	Caspian tern.....	301
9.65.1	EPBC Act legal status	301
9.65.2	Biology and ecology	301
9.65.3	Habitat	302
9.65.4	Habitat assessment.....	303
9.65.5	Anticipated threats and potential impacts from the Project.....	304
9.65.6	Unavoidable impact from the Project	304
9.65.7	Management Practices and Methods.....	304
9.66	Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin 305	
9.66.1	Status	305
9.66.2	Ecology.....	305
9.66.3	Known TEC populations and their relationship with the CSG Fields	307
9.66.4	Anticipated threats and potential impacts as a result of the Project	307
9.66.5	Unavoidable impact from the Project	307
9.66.6	Management practices and methods	307
9.67	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant).....	308
9.67.1	Status	308
9.67.2	Ecology.....	308
9.67.3	Known TEC populations and their relationship with the CSG Fields	310
9.67.4	Anticipated threats and potential impacts as a result of the Project	310
9.67.5	Unavoidable impact from the Project	310
9.67.6	Management practices and methods	310
9.68	Semi-evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions.....	311

Santos

GLNG Project

9.68.1	Status	311
9.68.2	Ecology.....	311
9.68.3	Known TEC populations and their relationship with the CSG Fields	313
9.68.4	Anticipated threats and potential impacts as a result of the Project	313
9.68.5	Unavoidable impact from the Project	313
9.68.6	Management practices and methods	313
9.69	The Community of Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin	314
9.69.1	Status	314
9.69.2	Ecology.....	314
9.69.3	Known TEC populations and their relationship with the CSG Fields	315
9.69.4	Anticipated threats and potential impacts as a result of the Project	316
9.69.5	Unavoidable impact from the Project	316
9.69.6	Management practices and methods	316
9.70	Weeping Myall Woodlands.....	317
9.70.1	Status	317
9.70.2	Ecology.....	317
9.70.3	Known TEC populations and their relationship with the CSG Fields	318
9.70.4	Anticipated threats and potential impacts as a result of the Project	318
9.70.5	Unavoidable impact from the Project	318
9.70.6	Management practices and methods	318
9.71	Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	319
9.71.1	Status	319
9.71.2	Ecology.....	319
9.71.3	Known TEC populations and their relationship with the CSG Fields	322
9.71.4	Anticipated threats and potential impacts as a result of the Project	322
9.71.5	Unavoidable impact from the Project	322
9.71.6	Management practices and methods	322
10.0	References	323

Tables

Table 1: Summary of Applicable Legislation	5
Table 2: Summary of Applicable Standards and Guidelines	6
Table 3: Significant Flora Species within the Santos GLNG Upstream Project Area	11
Table 4: Significant Fauna and Migratory Bird Species within the Santos GLNG Upstream Project Area	16

Table 5: Fauna Habitat Categories.....	24
Table 6: Threatened Ecological Communities (TEC) within the Santos GLNG Upstream Project Area	25
Table 7: Potential Impacts to Significant Species and Threatened Communities.....	26
Table 8: Management Measures for Significant Flora Species.....	31
Table 9: Management Measures for Significant Invertebrate Species.....	34
Table 10: Management Measures for Significant Threatened Bird Species.....	36
Table 11: Management Measures for Significant Reptile Species.....	39
Table 12: Management Measures for Significant Mammal Species.....	42
Table 13: Management Measures of Significant Species of Aquatic Fauna.....	46
Table 14: Management Measures for Significant Species of Migratory Birds.....	49
Table 15: Management Measures for TECs	52
Table 16: Methods to Assess Legal and Procedural Effectiveness	58
Table 17: Migration period to Australia (Pizzey & Knight 2007)	236
Table 18: Breeding period (Orange indicates breeding period) (Pizzey & Knight 2003)	249
Table 19: Breeding periods (Orange indicates breeding period) (Pizzey & Knight 2003).....	258
Table 20: REs analogous with Natural Grasslands TECs in Queensland	306
Table 21: REs analogous with Brigalow TECs in Queensland from DSEWPaC (2011ao).....	309
Table 22: REs analogous with SEVT TECs in Queensland from DSEWPaC (2011ap)	312
Table 23: REs analogous with SEVT TECs in Queensland from DSEWPaC (2011aq)	315
Table 24: REs analogous with Weeping myall woodland TECs in Queensland from DSEWPaC (2011ar)	317
Table 25: REs analogous with Coolibah – Black box woodlands TEC in Queensland (TSSC 2011c)	321

Figures

Figure 1: The Santos GLNG Upstream Project Area	3
Figure 2: The Santos Approach to Environmental Management	7
Figure 3: Santos GLNG Document Tree for the Management of Significant Species and TECs.....	8
Figure 4: Mapped distribution range of <i>Acacia curranii</i> (Source: DOTE 2014c)	61
Figure 5: Mapped distribution range of <i>Acacia grandifolia</i> (Source: DOTE 2014d)	64
Figure 6: Mapped distribution range of <i>Aristida annua</i> (Source: DOTE 2014e)	67
Figure 7: Mapped distribution range of <i>Arthraxon hispidus</i> (Source: DOTE 2014f).....	69
Figure 8: Mapped distribution range of <i>Bertya opposens</i> (Source: DSEWPaC 2011b)	72
Figure 9: Mapped distribution range of <i>Cadellia pentastylis</i> (Source: DSEWPaC 2011c).....	75
Figure 10: Mapped distribution range of <i>Calytrix gurlmundensis</i> (Source: DOTE 2014g)	78
Figure 11: Mapped distribution range of <i>Daviesia discolor</i> (Source: DOTE 2014h)	81
Figure 12: Mapped distribution range of <i>Dichanthium queenslandicum</i> (Source: DSEWPaC 2011e) .	84

Figure 13: Mapped distribution range of <i>Dichanthium setosum</i> (Source: DSEWPac 2011f)	86
Figure 14: Mapped distribution range of <i>Eucalyptus beaniana</i> (Source: DOTE 2014i)	89
Figure 15: Mapped distribution range of <i>Homopholis belsonii</i> (Source: DSEWPac 2011h)	92
Figure 16: Mapped distribution range of <i>Homoranthus decumbens</i> (Source: DOTE 2014j)	95
Figure 17: Mapped distribution range of <i>Macrozamia platyrhachis</i> (Source: DOTE 2014l)	97
Figure 18: Mapped distribution range of <i>Phaius australis</i> (Source: DOTE 2014m)	100
Figure 19: Mapped distribution range of <i>Swainsona murrayana</i> (Source: DSEWPac 2011j)	103
Figure 20: Mapped distribution range of <i>Thesium australe</i> (Source: DOTE 2014n)	105
Figure 21: Mapped distribution range of <i>Tylophora linearis</i> (Source: DOTE 2014o)	108
Figure 22: Mapped distribution range of <i>Westringia parvifolia</i> (Source: DOTE 2014p)	110
Figure 23: Mapped distribution range of <i>Xerothamnella herbacea</i> (Source: Atlas of Living Australia 2012)	113
Figure 24: Mapped distribution range of <i>Eriocaulon carsonii</i> (Source: DSEWPac 2011k)	116
Figure 25: Mapped distribution range of Boggomoss snail (Source: DSEWPac 2011l)	119
Figure 26: Mapped distribution range of Australasian bittern (Source: DOTE 2014r)	123
Figure 27: Mapped distribution range of Red goshawk (Source: DSEWPac 2011m)	127
Figure 28: Mapped distribution range of Squatter pigeon (southern) (Source: DSEWPac 2011n)	133
Figure 29: Mapped distribution range of Swift parrot (Source: DOTE 2014s)	138
Figure 30: Mapped distribution range of Star finch (Source: DOTE 2014t)	142
Figure 31: Mapped distribution range of Plains-wanderer (Source: DOTE 2014u)	147
Figure 32: Mapped distribution range of the Supurb parrot (Source: Atlas of Living Australia 2014) .	152
Figure 33: Mapped distribution range of the Black-throated finch (Source: DOTE 2014w)	156
Figure 34: Mapped distribution range of Australian painted snipe (Source: DSEWPac 2011o)	161
Figure 35: Mapped distribution range of Black-breasted button-quail (Source: DSEWPac 2011p) ...	165
Figure 36: Mapped distribution range of the Five-clawed worm-skink (Source: DOTE 2014x)	170
Figure 37: Mapped distribution range of Dunmall's snake (Source: DSEWPac 2011q)	174
Figure 38: Mapped distribution range of Ornamental snake (Source: DSEWPac 2011r)	178
Figure 39: Mapped distribution range of Collared delma (Source: DSEWPac 2011s)	182
Figure 40: Mapped distribution range of Yakka skink (Source: DSEWPac 2011t)	186
Figure 41: Mapped distribution range of Large-eared pied bat (Source: DSEWPac 2011v)	190
Figure 42: Mapped distribution range of South-eastern long-eared bat (Source: DSEWPac 2011w) ..	195
Figure 43: Mapped distribution range of Northern quoll (Source: DSEWPac 2011x)	199
Figure 44: Mapped distribution range of the Bridled nail-tail wallaby (Source: DOTE 2014y)	203
Figure 45: Mapped distribution range of the Bridled nail-tail wallaby (Source: DOTE 2014z)	207
Figure 46: Mapped distribution range of the Grey-headed flying-fox (Source: DOTE 2014aa)	212
Figure 47: Mapped distribution range of Koala (Source: DOTE 2014a)	216
Figure 48: Mapped distribution range of Murray cod (Source: DSEWPac 2011y)	220

Figure 49: Mapped distribution range of Fitzroy river turtle (Source: DSEWPac 2011aa)	224
Figure 50: Mapped distribution range of Great egret (Source: DSEWPac 2011ab)	228
Figure 51: Mapped distribution range of Cattle egret (Source: DSEWPac 2011ac)	232
Figure 52: Mapped distribution range of the Fork-tailed swift (Source: DOTE 2014ac)	236
Figure 53: Distribution range of the Sharp-tailed sandpiper (Source: DOTE 2014ab).....	240
Figure 54: Mapped distribution range of Latham's snipe (Source: DSEWPac 2011ad)	244
Figure 55: Mapped distribution range of White-bellied sea-eagle (Source: DSEWPac 2011ae)	248
Figure 56: Mapped distribution range of White-throated needletail (Source: DSEWPac 2011ah)	253
Figure 57: Mapped distribution range of Rainbow bee-eater (Source: DSEWPac 2011ag)	257
Figure 58: Mapped distribution range of Black-faced monarch (Source: DSEWPac 2011ai)	261
Figure 59: Mapped distribution range of Spectacled monarch (Source: DSEWPac 2011aj)	265
Figure 60: Mapped distribution range of Satin flycatcher (Source: DSEWPac 2011ak)	269
Figure 61: Distribution range of the Glossy ibis (Source: BirdLife International 2014c).....	278
Figure 62: Distribution range of the Cotton pygmy-goose (Source: BirdLife International 2014d).....	282
Figure 63: Distribution range of the Common greenshank (Source: Atlas of Living Australia 2014) ..	286
Figure 64: Distribution range of the Marsh sandpiper (Source: DOTE 2014af)	290
Figure 65: Distribution range of the Pacific golden plover (Source: DOTE 2014ag)	294
Figure 66: Distribution range of the Wood sandpiper (Source: DOTE 2014ah)	298
Figure 67: Distribution range of the Caspian tern (Source: DOTE 2014ai)	302

Plates

Plate 1: <i>Acacia curranii</i> (Source: Fagg n.d).....	60
Plate 2: <i>Acacia grandifolia</i> (Source: Fagg n.d)	63
Plate 3: <i>Aristida annua</i> (Source: Ausgrass2 n.d)	66
Plate 4: <i>Arthraxon hispidus</i> (Source: Ausgrass2 n.d).....	68
Plate 5: <i>Bertya opposens</i> (Source: Wain 2011)	71
Plate 6: <i>Cadellia pentastylis</i> (Source: Stark 2014)	74
Plate 7: <i>Calytrix gurlmundensis</i> (Source: Clarke n.d).....	77
Plate 8: <i>Daviesia discolor</i> (Source: Hotchkiss n.d).....	80
Plate 9: <i>Dichanthium queenslandicum</i> (Source: Queensland Herbarium 2002).....	83
Plate 10: <i>Dichanthium setosum</i> (Source: Queensland Herbarium 2002)	86
Plate 11: <i>Eucalyptus beaniana</i> (Source: Brooker & Kleinig n.d)	88
Plate 12: <i>Homopholis belsonii</i> (Source: Tropical Grassland Society of Australia Inc 1996)	91
Plate 13: <i>Homoranthus decumbens</i> (Source: © plant.nerd 2010)	94
Plate 14: <i>Macrozamia platyrhachis</i> (Source: Dowling n.d.).....	96

Plate 15: <i>Phaius australis</i> (Source: Woodard 2010)	99
Plate 16: <i>Swainsona murrayana</i> (Source: Knight 2005)	102
Plate 17: <i>Thesium australe</i> (Source: Office of Environment and Heritage n.d.)	104
Plate 18: <i>Tylophora linearis</i> (Source: © Carr n.d.)	107
Plate 19: <i>Xerothermella herbacea</i> (Source: Queensland Herbarium 2007)	112
Plate 20: <i>Eriocaulon carsonii</i> (Source: DEHP n.d.)	115
Plate 21: Boggomoss snail (<i>Adclarkia dawsonensis</i>) (Source: White 2006)	118
Plate 22: Australasian bittern (<i>Botaurus poiciloptilus</i>) (Source: Turner 2008)	122
Plate 23: Red goshawk (Source: Baker-Gabb 2008)	126
Plate 24: Squatter pigeon (southern) (Source: Dreis 2010)	132
Plate 25: Habitat examples for Squatter pigeon (Source: Wain 2012)	135
Plate 26: Swift parrot (<i>Lathamus discolor</i>) (Source: Harrison 2010)	137
Plate 27: Star finch (<i>Neochmia ruficauda ruficauda</i>) (Source: Harrison n.d.)	141
Plate 28: Plains-wanderer (<i>Pedionomus torquatus</i>) (Source: Bishop n.d.)	146
Plate 29: Superb parrot (<i>Polytelis swainsonii</i>) (Source: Palmer 2012)	151
Plate 30: Black-throated finch (<i>Poephila cincta cincta</i>) (Source: Williamson 2009)	155
Plate 31: Australian painted snipe (Source: Aviceda 2002a)	160
Plate 32: Black-breasted button-quail (Source: Hogan 1996)	164
Plate 33: Five-clawed worm-skink (<i>Anomalopus mackayi</i>) (Source: Dolley n.d.)	169
Plate 34: Dunmall's snake (Source: Wilson 2009)	173
Plate 35: Ornamental snake (Source: Wilson 2008)	177
Plate 36: Photo of habitat example (Source: Aurecon 2013)	179
Plate 37: Collared delma (Source: Peck 2006)	181
Plate 38: Yakka skink (Source: DSEWPaC 2011t)	185
Plate 39: Large-eared pied bat (Source: Pennay 2006)	189
Plate 40: South-eastern long-eared bat (Source: Murphy 2005)	194
Plate 41: Northern quoll (Source: Ward 2010)	198
Plate 42: Bridled nail-tail wallaby (<i>Onychogalea fraenata</i>) (Source: Reardon n.d.)	202
Plate 43: Brush-tailed rock-wallaby (<i>Petrogale penicillata</i>) (Source: Fergus 2004)	206
Plate 44: Grey-headed flying fox (<i>Pteropus poliocephalus</i>) (Source: Welbergen 2009)	211
Plate 45: Koala (Source: Monkhouse 2005)	215
Plate 46: Murray cod (Source: Schmida 2003)	219
Plate 47: Fitzroy river turtle (Source: DERM 2007b)	223
Plate 48: Great egret (Source: Folini 2006)	227
Plate 49 Cattle egret (Source: Garg 2008a; Vaidyanathan 2007)	231
Plate 50: Fork-tailed swift (Source: Francksan n.d.)	235

Plate 51: Sharp-tailed sandpiper (Source: Alnus 2007)	239
Plate 52: Latham's snipe (Source: Birds in Backyards 2010)	243
Plate 53: White-bellied sea-eagle (Source: Issadeen 2009)	247
Plate 54: White-throated needletail (Source: Bridger 2010).....	252
Plate 55: Rainbow bee-eater (Source: Aviceda 2007)	257
Plate 56: Black-faced monarch (Source: Armbrust 1998)	260
Plate 57: Spectacled monarch (Source: Armbrust 1998)	264
Plate 58: Satin flycatcher female (left) and male (right) (Source: Birds Australia 2010)	268
Plate 59: Eastern osprey (Source: Psylexic 2007)	272
Plate 60: Glossy ibis (Source: Karatay 2007)	277
Plate 61: Cotton pygmy-goose (Source: Fergus 2006)	281
Plate 62: Eastern osprey (Source: Aviceda 2009)	285
Plate 63: Marsh sandpiper (Source: Psylexic 2007)	289
Plate 64: Pacific golden plover (Source: Harrison 2013).....	293
Plate 65: Wood sandpiper (Source: Harrison 2011).....	297
Plate 66: Caspian tern (Source: Mdf 2007)	301
Plate 67: Natural grasslands community (Source: DSEWPac 2012a)	305
Plate 68: Brigalow TEC community (Source: DEHP 2013).....	308
Plate 69: SEVT TEC community (Source: EPA 2007)	311
Plate 70: Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin TEC community (Source: EPA 2005)	314
Plate 71: Weeping Myall Woodlands TEC community (Source: NSW Catchment Management Authority 2013)	317
Plate 72: Coolibah – Black Box Woodlands TEC community (Source: Ausecology 2012).....	319

Abbreviations and Units

Acronym	Description
CAMBA	China-Australia Migratory Bird Agreement
cm	Centimetre
CSG	Coal Seam Gas
E	Endangered
EA	Environmental Authority
EHSMS	Santos Environment, Health, Safety & Management System
EP Act	<i>Environmental Protection Act 1994</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
GIS	Geographical Information System
GLNG	Gladstone Liquefied Natural Gas
ha	Hectares
HERBRECS	Queensland Herbarium database
JAMBA	Japan-Australia Migratory Bird Agreement
LNG	Liquefied Natural Gas
LZ	Land Zone
m	Metres
Mi	Migratory
Mm	Millimetres
MNES	Matters of National Significance
MSES	Matters of State Significance
NC Act	<i>Nature Conservation Act 1992</i>
NT	Near Threatened
QLD	Queensland
RE	Regional Ecosystem
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROW	Right of Way
SEQ	South East Queensland
SEVT	Semi-evergreen Vine Thicket
SSMP	Significant Species Management Plan
TEC	Threatened Ecological Communities
V	Vulnerable

1.0 Introduction

Santos GLNG is developing Coal Seam Gas (CSG) resources in the Surat and Bowen Basins in Queensland. Santos GLNG currently has approval to develop 2,650 production wells and associated infrastructure across a number of tenements within the Santos GLNG gas fields of Roma, Fairview and Arcadia. The Santos GLNG Gas Field Development Project (the GFD Project) is an expansion of the existing approved Santos GLNG Project and will involve the construction, operation, decommissioning and rehabilitation of additional production wells, and associated supporting infrastructure that will provide additional gas over a project life exceeding 30 years.

The GFD Project will expand the Santos GLNG Project's gas fields from 6,887 km² to 10,676 km² and develop an additional 6,100 production wells beyond the currently authorised 2,650 production wells; resulting in a maximum of 8,750 wells. Starting in 2016, the GFD Project will progressively develop wells and associated supporting infrastructure across 35 Santos GLNG petroleum tenements, which includes the current existing project area and surrounding tenures located in the Arcadia, Fairview, Roma and Scotia gas fields. These areas combined are referred to as the Santos GLNG Upstream Project Area.

A number of significant species (comprised of both threatened flora and fauna and migratory fauna species) and Threatened Ecological Communities (TECs) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are known to, or have the potential to, occur within the Santos GLNG Upstream Project Area. During the course of conducting gas field activities, it is expected that Santos GLNG will encounter significant species. Given the iterative nature of the planning and development for upstream infrastructure, Santos GLNG has prepared and implemented a Significant Species Management Plan (SSMP) to enable the considered management of significant species and TECs. The SSMP in conjunction with the Environmental Protocol for Constraints Planning and Field Development (the Protocol) provides Santos GLNG with the tools to systematically identify significant species and implement management measures to avoid and minimise or mitigate the risk of potential adverse impacts to identified species resulting from activities in the Santos GLNG Upstream Project Area.

1.1 Purpose and Scope of the SSMP

1.1.1 Purpose

Santos GLNG has both a legal and social responsibility to minimise Project related impacts to significant species and TECs listed under the EPBC Act. This SSMP has been prepared to satisfy these obligations and to complement the overarching Santos Environment, Health and Safety Management System (EHSMS).

The objectives of the SSMP are to:

- Facilitate compliance with Commonwealth and State legislation, regulations and approvals;
- Support the Santos *Environmental Hazard Standard 01 – Biodiversity and Land Disturbance* (EHS01); and
- Provide a framework for Santos GLNG to:
 - Identify significant species and TECs present within the Santos GLNG Upstream Project Area; and

- Appropriately manage / mitigate adverse impacts to significant species and TECs throughout the Project lifecycle.

1.1.2 Scope

This SSMP is designed to manage impacts from activities that have been planned (in consideration of ecological constraints) and approved for construction and will have an identified impact on a significant species (EPBC listed) or its habitat or a TEC. All planning-related considerations including measures to avoid ecological constraints are addressed in the *Environmental Protocol for Constraints Planning and Field Development*.

This SSMP provides an overview of the strategy, methods and controls implemented by Santos GLNG to manage adverse impacts to significant species and TECs. Specifically, this SSMP:

- Identifies significant species and TECs that are present, or may occur, within the Santos GLNG Upstream Project Area;
- Provides detailed profiles for each of the significant species and TECs identified within the Santos GLNG Upstream Project Area;
- Identifies key threats to significant species and TECs caused by activities within the Santos GLNG Upstream Project Area; and
- Outlines general mitigation measures to be implemented by Santos GLNG to minimise the impact of key threats to significant species and TECs caused by Project-related activities.

The SSMP is to be implemented by all Santos GLNG Project personnel responsible for conducting activities that have the potential to impact significant species and/or TECs throughout the exploration, construction, production, decommissioning and rehabilitation phases of the Project.

This SSMP applies to activities carried out within the Santos GLNG Upstream Project Area. The Santos GLNG Upstream Project Area consists of Santos GLNG petroleum tenements comprising the Arcadia, Fairview, Roma and Scotia gas fields and as illustrated in Figure 1.

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GLNG Project

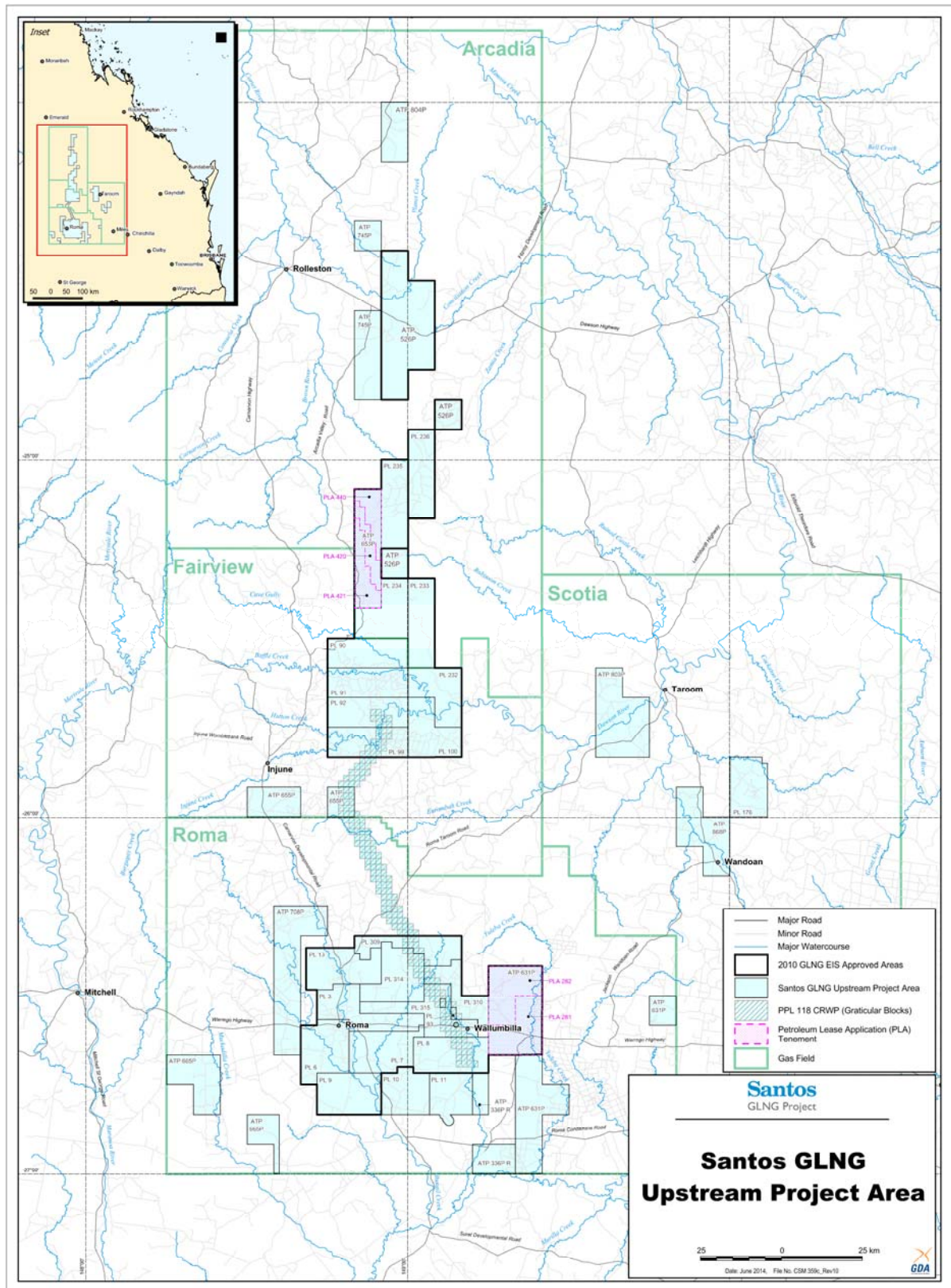


Figure 1: The Santos GLNG Upstream Project Area

2.0 Roles and Responsibilities

Santos GLNG Project personnel are responsible for the environmental performance of their activities, for complying with relevant approval / permit requirements and for ensuring that all environmental objectives associated with the work are achieved. Santos GLNG Project personnel must also be mindful of the General Environmental Duty (GED) as outlined in the *Environmental Protection Act 1994* (Qld) (EP Act). Section 319(1) of the EP Act states that “*a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practical measures to prevent or minimise the harm.*”

Roles, responsibilities and accountability under the SSMP will be assigned in accordance with the *Santos EHSMS05 – Responsibility and Accountability*.

3.0 Legal and Other Requirements

3.1 Legal Requirements

Santos GLNG must comply with all relevant Commonwealth and Queensland legislation and approvals. A summary of primary legislation in relation to the management of significant species and TECs relevant to the development of the SSMP is presented in Table 1.

Table 1: Summary of Applicable Legislation

Act or Strategy	Summary of Act or Strategy
<i>Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	The EPBC Act is the Commonwealth Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important fauna species and ecological communities. The EPBC Act focuses Commonwealth Government interests on the protection of Matters of National Environmental Significance (MNES), with the states and territories having responsibility for matters of state and local significance. MNES includes listed migratory species as well as threatened species and communities.
<i>Environmental Protection Act 1994 (EP Act)</i> <i>Environmental Protection Regulation 2008 (EP Reg)</i>	The EP Act provides for environmental management practices and environmental safeguards. The EP Act is applicable to the GFD Project in regards to Environmental Authorities (EAs). Each stage of the development of a natural gas lease requires an EA before the issue of a license. The EP Act details the process of environmental assessment for the granting of EAs. The EP Act also requires Santos GLNG to take all reasonable and practicable measures to prevent or minimise environmental harm.
<i>State Development and Public Works Organisation Act 1971(SDPWOA)</i>	Under Section 35 of SDPWOA the Coordinator-General must prepare the Coordinator-General's report for an Environmental Impact Statement. In evaluating the Environmental Impact Statement, the Coordinator-General may state conditions and make recommendations. Conditions relevant to the management of significant species in the Santos GLNG gas fields will be provided in the Coordinator-General's evaluation report for the GFD Project EIS.
<i>Nature Conservation Act 1992 (NC Act)</i> <i>Nature Conservation (Wildlife Management) Regulation 2006 (Qld) (NC Regulation)</i>	The primary purpose of the NC Act is to conserve biodiversity by protecting wildlife and its habitat. Permits are required for the taking and/or relocation of protected flora and fauna under this act. Section 88 of the <i>Nature Conservation Act 1992 (Qld)(NC Act)</i> and Section 332 of the <i>Nature Conservation (Wildlife Management) Regulation 2006 (Qld) (NC Regulation)</i> require the development of a Species Management Program (SMP) in relation to the tampering with animal breeding places for 'least concern' and 'special least concern' species listed under the NC Act.

The SSMP was further developed in consideration of the advice contained within the standards and guidelines provided in Table 2.

Table 2: Summary of Applicable Standards and Guidelines

Standards and Guidelines	
Title	Author
BONN Convention (1983)	CMS 2012
China-Australia Migratory Bird Agreement (CAMBA) (1988)	Government of Australia 1988
Collecting and preserving plant specimens, a manual: Queensland Herbarium	Queensland Herbarium 2013
Draft Koala Referral Guidelines for the Vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)	DOTE 2013
Draft Queensland Brigalow Belt Reptile Recovery Plan 2008-2012	Richardson 2008
(Draft) National Recovery Plan for the South-Eastern Long-Eared Bat (<i>Nyctophilus corbeni</i>)	Schulz & Lumsden 2010
Draft Survey Guidelines for Australia's Threatened Orchids	DOTE 2013
Guidelines for the Translocation of Threatened Species in Australia	Vallee <i>et al</i> 2004
Japan-Australia Migratory Bird Agreement (JAMBA) (1981)	Government of Australia 1981
National Multi-Species Recovery Plan for the Cycads, <i>Cycas Megacarpa</i> , <i>Cycas Ophiolitica</i> , <i>Macrozamia Cranei</i> , <i>Macrozamia Lomandroides</i> , <i>Macrozamia Pauli-Guilielmi</i> and <i>Macrozamia Platyrachis</i>	Queensland Herbarium 2007
National Recovery Plan for the Black-Breasted Button-Quail (<i>Turnix Melanogaster</i>)	Mathieson & Smith 2009
The Action Plan for Australian Bats	Environment Australia 1999
National Recovery Plan for the <i>Bertya</i> sp. (Cobar-Coolabah) (This Recovery Plan Encompasses <i>Bertya opposens</i>)	NPWS 2002a
Recovery Plan for the Brigalow (<i>Acacia harpophylla</i>) Dominant and Co-Dominant Endangered Ecological Community	Butler 2007b
National Recovery Plan for the Red Goshawk (<i>Erythrotriorchis Radiatus</i>)	DERM 2009
National Recovery Plan for The "Semi-Evergreen Vine Thickets of the Brigalow Belt (North And South) And Nandewar Bioregions" Ecological Community	Mcdonald 2010
The Action Plan for Australian Birds	Garnett <i>et al</i> 2010
Republic of Korea- Australia Migratory Bird Agreement (ROKAMBA) (2007)	Government of Australia 2007
Survey Guidelines for Australia's Threatened Bats	DEWHA 2010a
Survey Guidelines for Australia's Threatened Birds	DEWHA 2010b
Survey Guidelines for Australia's Threatened Mammals	DEWHA 2011a
Survey Guidelines for Australia's Threatened Reptiles	DEWHA 2011b
Recovery Plan for the Community of Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin	Fensham <i>et al</i> 2010

3.2 Santos Environment, Health and Safety Management System

The Santos EHSMS provides a framework for environmental and safety practices across Santos operations worldwide. The framework is consistent with *AS 4801:2000 Occupational Health and Safety Management Systems* and *AS/NZS ISO 14001:2004 Environmental Management Systems*.

This SSMP complements the requirements of the EHSMS, in particular, the Santos Environmental Hazard Standard *EHS01 Biodiversity and Land Disturbance*. This standard defines the requirements to minimise environmental impacts associated with disturbance to biodiversity and/or land during oil and gas exploration, production, processing and rehabilitation activities. An additional relevant EHSMS standard is *EHS06 – Environmental Impact Assessment and Approvals*. This standard discusses both external and internal approval requirements necessary prior to conducting disturbances to land.

This SSMP specifically addresses unique features and requirements relating to the Santos GLNG Project. GLNG specific documentation is based on identified environmental and reputational risks and accounts for Santos GLNG's legal and other obligations, commitments made by the Santos GLNG Project and Santos GLNG's Social Licence to Operate.

In this context, the SSMP also provides additional guidance for the management of environmental issues and support the development of asset / activity / department-based guidelines and work instructions, in order to secure compliance with legal requirements as well as deliver on company environmental standards.

The Santos approach to environmental management is illustrated in Figure 2.



Figure 2: The Santos Approach to Environmental Management

There are a number of Santos GLNG documents relevant to the management of significant species and TECs within the Santos GLNG Upstream Project Area. Individual documents typically reflect the steps in management of ecological constraints during the different phases of the Project, namely Planning, Construction, Operation and Decommissioning and Rehabilitation, as well as the principles for ecological constraints management, namely Avoid, Minimise, Mitigate, Rehabilitate and Offset.

The relationship between these documents is illustrated in Figure 3. Key documents related to the management of MNES are discussed further below. The application of each of the documents in the overall management of impacts to significant species and TECs is discussed further in Section 7.0.

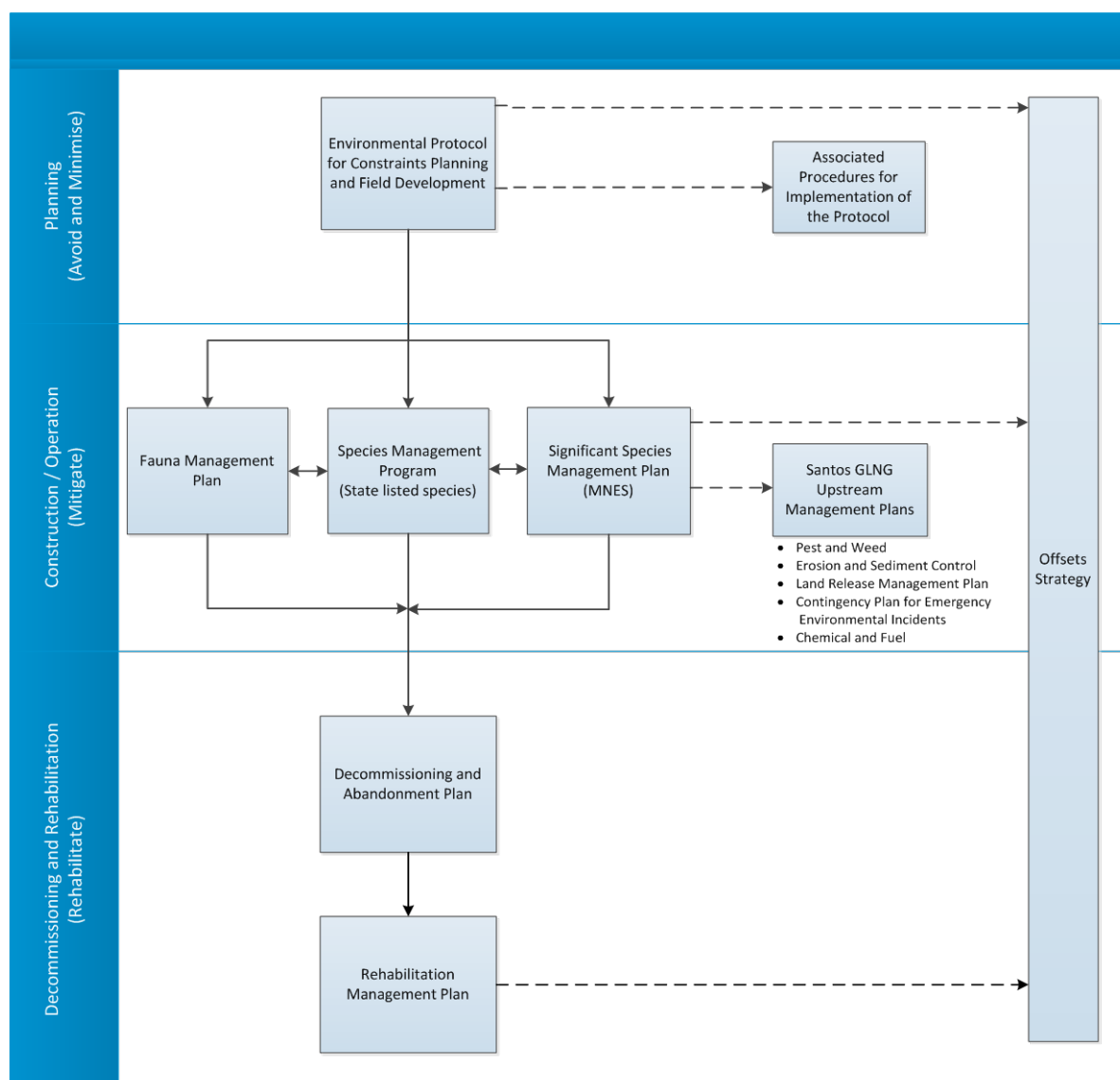


Figure 3: Santos GLNG Document Tree for the Management of Significant Species and TECs

3.2.1 Environmental Protocol for Constraints Planning and Field Development

The Santos GLNG *Environmental Protocol for Constraints Planning and Field Development* (the Protocol) outlines the approach taken by Santos GLNG to identify, assess, avoid or minimise potential impacts to MNES and State related matters, when seeking to locate project infrastructure or undertake Project activities in the Santos GLNG Upstream Project Area. The Protocol provides details on the types of development proposed to be undertaken within, or in proximity to, specific environmental values (including significant species and TECs) and outlines the internal processes to be undertaken in order to identify such environmental values (i.e. ecological surveys, desktop assessments, internal environmental approvals etc.). The Protocol aligns closely with the 'Avoid' and 'Minimise' principles for ecological constraints management.

3.2.2 Fauna Management Plan

The *Santos GLNG Upstream Fauna Management Plan* provides a series of mitigation measures / considerations for the appropriate management of fauna on construction and operational sites. This plan deals with all fauna irrespective of their conservation status and consequently overlaps significantly with the management approach to significant species described in this SSMP. The Fauna Management Plan aligns most closely with the 'Mitigate' principle for ecological constraints management.

3.2.3 Species Management Program

The *Santos GLNG Species Management Program* outlines the approach to the management of fauna and their breeding places listed under the NC Act. Aspects of this plan, most notably commitments made around animal breeding places, will apply to EPBC listed species that are also listed under the NC Act. The Species Management Plan aligns most closely with the 'Minimise' and 'Mitigate' principles for ecological constraints management.

3.2.4 Rehabilitation Management Plan

Where a direct or indirect impact has occurred to a significant species or TEC, Santos GLNG will apply rehabilitation measures as appropriate for the impacted species or TEC, to minimise cumulative impacts throughout the life of the Project. The Rehabilitation Management Plan aligns most closely with the 'Rehabilitate' principle for ecological constraints management.

3.2.5 Environmental Offsets Strategy

The *Santos GFD Project Environmental Offsets Strategy* is an approach to provide environmental benefits to counterbalance the impacts that remain after avoidance, minimisation, mitigation and remediation and rehabilitation measures. Where required, Santos GLNG will provide suitable offsets for activities that result in an unavoidable significant residual adverse impact to MNES and Matters of State Environmental Significance (MSES). The *Santos GFD Project Environmental Offsets Strategy* aligns most closely with the 'Offset' principle for ecological constraints management.

4.0 Significant Species in the Santos GLNG Upstream Project Area

4.1 Overview

Species of significant flora, fauna and TECs are known either to occur, or have the potential to occur within the Santos GLNG Upstream Project Area. The likelihood of each species occurring within the Project area was determined through the detailed review of multiple resources including State and Commonwealth databases and GIS data, peer-reviewed literature and previous studies, results of field assessments, current (known) distribution range and the presence and condition of suitable habitat in each GFD Project tenement.

Species considered to have a **low likelihood of occurrence** include species that fit one or more of the following criteria:

- Have not been recorded previously in the study area and locality and for which the study area is beyond the current distributional limits;
- Use specific habitat types or resources that are not present in the study area; and
- Are considered locally extinct.

Species considered to have a **moderate likelihood of occurrence** include species that fit one or more of the following criteria:

- Have infrequently been recorded previously in the study area and locality;
- Use habitat types or resources that are present in the study area, although generally in a poor or modified condition; and
- Are unlikely to maintain sedentary populations, however may seasonally utilise resources within the study area opportunistically during variable seasons or migration.

A '**high likelihood of occurrence**' category has not been included in this assessment as this cannot be predicted with sufficient certainty in the absence of a development footprint and therefore, specific areas of vegetation clearing and habitat disturbance cannot be determined. This understanding of occurrence in proposed disturbance areas will be established as part of detailed field investigations.

Species recorded during field assessments or included as specimen-backed records in the HERBRECS, Wildlife online, Atlas of Living Australia, Queensland Museum and/or Birds Australia databases (regardless of currency of records) are marked as **known to occur**.

The following Sections provide an overview of the significant species and TECs and their likelihood of occurrence within the GFD Project Area. This SSMP provides detailed profiles for each of the species and TECs discussed respectively.

4.2 Significant Flora

Significant flora species known or likely to occur within the Santos GLNG Upstream Project Area are presented in Table 3. The conservation status of each species under both the Commonwealth EPBC Act and the Queensland NC Act, as well as a general description of the habitat within which each species is expected to occur, is also provided in Table 3.

Table 3: Significant Flora Species within the Santos GLNG Upstream Project Area

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
Terrestrial Flora						
<i>Acacia curranii</i>	Curly-bark wattle	Known to occur	V	V	<i>Acacia curranii</i> grows most often on rocky outcrops of isolated hills and ranges. Soils are variable between the different centres of distribution (Pickard 1995).	Section 10.1
<i>Acacia grandifolia</i>	-	Known to occur	V	C	The species grows on hilly terrain of varying aspects and slope, on hillcrests, in gullies on plains (Qld CRA/RFA Steering Committee 1998). It occurs in ironbark gum and spotted gum forests and woodlands (QDNR 2000). The most frequently recorded associated tree species are <i>Eucalyptus crebra</i> , <i>Corymbia citriodora</i> , <i>Corymbia trachyphloia</i> and <i>Eucalyptus exserta</i> (Qld CRA/RFA Steering Committee 1998).	Section 10.2
<i>Aristida annua</i>	-	Known to occur	V	V	<i>Aristida annua</i> occurs in eucalypt woodland. It is restricted to black clay soils, basalt soils and possibly disturbed sites (DOTE 2014e).	Section 10.3
<i>Arthraxon hispidus</i>	Hairy-joint grass	Known to occur	V	V	<i>Arthraxon hispidus</i> is found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps, as well as woodland (TSSC 2008n). In south-east Queensland, <i>Arthraxon hispidus</i> has also been recorded growing around freshwater springs on coastal foreshore dunes, in shaded small gullies, on creek banks and on sandy alluvium in creek beds in open forests and also with bog mosses in mound springs (TSSC 2008n).	Section 10.4
<i>Bertya opposens</i>	Coolabah bertya	Known to occur	V	-	In Queensland, the species has been identified on sandstone ridges and amongst sandstone boulders in a dense thicket in association with <i>Alstonia constricta</i> , <i>Alphitonia excelsa</i> , <i>Erythroxylum</i> sp., <i>Jasminum simplicifolium</i> and <i>Bursaria spinosa</i> with scattered <i>Callitris glaucophylla</i> , <i>Callitris endlicheri</i> and <i>Eucalyptus crebra</i> on sandy loam (Atlas of Living Australia 2014). The species has also been identified in open woodland such as <i>Acacia shirleyi</i> woodland associated with scattered <i>Eucalyptus decorticans</i> with a grassy ground layer dominated by <i>Cleistochloa</i> sp. and in heavy shade (Atlas of Living Australia 2014).	Section 10.5

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
<i>Cadellia pentastylis</i>	Ooline	Known to occur	V	V	Ooline occurs in a range of vegetation types, and often associates with <i>Acacia harpophylla</i> (Brigalow), <i>Casuarina cristata</i> (Belah), <i>Acacia catenulata</i> (Bendee) and <i>Lysiphyllum carronii</i> (Red bauhinia) species in dry rainforest, semi-evergreen vine thicket and sclerophyll communities (TSSC 2008b).	Section 10.6
<i>Calytrix gurlmundensis</i>		Known to occur	V	V	The species is recorded as occurring in open shrubland with sparse, stunted <i>Eucalyptus</i> , <i>Casuarina</i> and <i>Acacia</i> spp. and in <i>Triodia</i> hummock grassland with scattered shrubs (Craven 1987; QDNR 2000).	Section 10.7
<i>Daviesia discolor</i>	-	Known to occur	V	V	On the Blackdown Tableland, <i>Daviesia discolor</i> occurs on sandy soil derived from sandstone and on lateritic clay, at altitudes of 600 to 900 m, in open eucalypt forest dominated by species such as Blackdown stringybark (<i>Eucalyptus sphaerocarpa</i>) and Black stringybark (<i>Eucalyptus nigra</i>) (Crisp 1991). In the Mount Walsh area, <i>Daviesia discolor</i> grows in very tall open forests of Bloodwood (<i>Corymbia trachyphloia</i>) and White mahogany (<i>Eucalyptus acmenoides</i>) on hillcrests and slopes at 500 to 580 m altitude on well-drained, shallow sandy loam to sandy clays (Halford 1998). The population in Carnarvon National Park occurs on brown sandy loam of creek banks, in mixed shrubland with scattered <i>Triodia</i> sp. hummocks and <i>Angophora</i> sp. trees (TSSC 2008o).	Section 10.8
<i>Dichanthium queenslandicum</i>	King bluegrass	Known to occur	E	V	<i>Dichanthium queenslandicum</i> occurs on black cracking clay in tussock grasslands mainly in association with other species of blue grasses (<i>Dichanthium</i> spp. and <i>Bothriochloa</i> spp.) but also with other grasses restricted to this soil type (Fletcher 2001, Simon 1982).	Section 10.9
<i>Dichanthium setosum</i>	Bluegrass	Known to occur-	V	NT	<i>Dichanthium setosum</i> is associated with heavy basaltic black soils and stony red-brown loam with clay subsoil and has been observed in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pastures (TSSC 2008d).	Section 10.10
<i>Eucalyptus beaniana</i>	Bean's ironbark	Known to occur	V	V	<i>Eucalyptus beaniana</i> grows in woodland with numerous other eucalypt species, on quartzose sandstone ridges. Soils are shallow and sandy (Queensland Herbarium 2008c).	Section 10.11

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
<i>Homopholis belsonii</i>	Belson's panic	Known to occur	V	E	<i>Homopholis belsonii</i> is usually found in dry woodland habitats at elevations ranging from 200 to 520 m altitude including rocky hills supporting White box (<i>Eucalyptus albens</i>) and in Wilga (<i>Geijera parviflora</i>) woodland; flat to gently undulating alluvial areas supporting Belah (<i>Casuarina cristata</i>) forest; soils and plant communities of Poplar box (<i>Eucalyptus populnea</i>) woodlands and shadier areas of Brigalow (<i>Acacia harpophylla</i>), Yarran (<i>Acacia melvillei</i>), and Weeping myall (<i>Acacia pendula</i>) communities; in Mountain coolibah (<i>Eucalyptus orgadophila</i>) communities; and on roadsides (TSSC 2008f).	Section 10.12
<i>Homoranthus decumbens</i>	A Shrub	Known to occur	E	V	The species is found in tall shrubland or heath up to 800 m in altitude. It occurs on the edges of sandstone cliffs or in shallow sandy soil containing lateritic pebbles, and is often associated with species such as <i>Goodenia racemosa</i> , <i>Petrophile</i> spp. (Cone bush), <i>Xanthorrhoea</i> spp. (Grasstree) and <i>Banksia oblongifolia</i> (Dwarf banksia) (Wang 1995).	Section 10.13
<i>Macrozamia platyrhachis</i>	-	Known to occur	E	E	Populations of <i>Macrozamia platyrhachis</i> are found in eucalypt woodland or open forest. Dominants include <i>Angophora leiocarpa</i> , <i>Corymbia bunites</i> , <i>Corymbia citriodora</i> subsp. <i>citriodora</i> , <i>Corymbia hendersonii</i> , <i>Corymbia watsoniana</i> , <i>Eucalyptus baileyana</i> , <i>E. cloeziana</i> , <i>E. crebra</i> , <i>E. melanoleuca</i> , <i>E. suffulgens</i> , <i>Lophostemon suaveolens</i> and <i>Lysicarpus angustifolius</i> on deep sandy soils derived from sandstone at altitudes between 300 and 780 m (Queensland Herbarium 2007).	Section 10.14
<i>Phaius australis</i>	Lesser-swamp Orchid	Known to occur	E	E	<i>Phaius australis</i> is commonly associated with coastal wet heath/sedgeland wetlands (Barry 2005), swampy grassland or swampy forest and often where Broad-leaved paperbark or Swamp mahogany are found (NH NSW 2006; Sparshott & Bostock 1993). Typically, <i>Phaius australis</i> is restricted to the swamp-forest margins, where it occurs in swamp sclerophyll forest (Broad-leaved paperbark/Swamp mahogany/Swamp box (<i>Lophostemon suaveolens</i>)), swampy rainforest (often with sclerophyll emergents), or fringing open forest. It is often associated with rainforest elements such as Bangalow palm (<i>Archontophoenix cunninghamiana</i>) or Cabbage tree palm (<i>Livistona australis</i>) (Benwell 1994; Bishop 1996; Weston in Harden 1993).	Section 10.15
<i>Swainsona murrayana</i>	Slender darling-pea	Moderate likelihood	V	V	<i>Swainsona murrayana</i> is found in grassland, herbland, and open Black-box woodland, often in depressions. This species grows in heavy grey or brown clay, loam, or red cracking clays. It is often associated with low Chenopod shrubs (<i>Maireana</i> spp.), Wallaby-	Section 10.16

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
					grass (<i>Austrodanthonia</i> spp), and Spear grass (<i>Austrostipa</i> spp). The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (TSSC 2008h).	
<i>Thesium australe</i>	Austral toadflax	Known to occur	V	V	<i>Thesium australe</i> is semi-parasitic on roots of a range of grass species, notably Kangaroo grass (<i>Themeda triandra</i>) (Scarlett <i>et al</i> 1994). It occurs in subtropical, temperate and subalpine climates over a wide range of altitudes. It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils including black clay loams to yellow podzolics and peaty loams (Leigh & Briggs 1984; Hunter <i>et al</i> 1999; Cohn 2004).	Section 10.17
<i>Tylophora linearis</i>	-	Moderate likelihood	E	E	<i>Tylophora linearis</i> grows in dry scrub, open forest and woodlands associated with <i>Melaleuca uncinata</i> , <i>Eucalyptus fibrosa</i> , <i>Eucalyptus sideroxylon</i> , <i>Eucalyptus albens</i> , <i>Callitris endlicheri</i> , <i>Callitris glaucophylla</i> , <i>Allocasuarina luehmannii</i> , <i>Acacia hakeoides</i> , <i>Acacia lineata</i> , <i>Myoporum</i> spp. and <i>Casuarina</i> spp. (NSW OEH 2014; Forster <i>et al</i> 2004).	Section 10.18
<i>Westringia parvifolia</i>	-	Moderate likelihood	V	V	<i>Westringia parvifolia</i> grows with Baker's mallee (<i>Eucalyptus bakeri</i>) and Green mallee (<i>Eucalyptus viridis</i>) and between clumps of Spinifex (<i>Triodia</i> sp.) on sandy and stony soils (BRI n.d.; White & Francis 1921).	Section 10.19
<i>Xerothamnella herbacea</i>	-	Known to occur	E	E	<i>Xerothamnella herbacea</i> occurs in Brigalow (<i>Acacia harpophylla</i>) dominated communities in shaded situations, often in leaf litter and is associated with gilgais (shallow ground depressions). Soils are heavy, grey to dark brown clays (Queensland Herbarium 2008a).	Section 10.20
Aquatic Flora						
<i>Eriocaulon carsonii</i>	Salt pipewort	Known to occur	E	E	<i>Eriocaulon carsonii</i> is entirely restricted to flowing mound springs. Such springs occur on all margins of the Great Artesian Basin (Ponder 1986). The species appears to prefer areas of shallow standing water with slow flow (Fatchen & Fatchen 1993). Populations are generally found at the tail of the spring or above the vent of slow flowing springs (National Parks and Wildlife Services 2002b).	Section 10.21

Table notes: EPBC Act = Environmental Protection and Biodiversity Conservation Act 1999; NC Act = Nature Conservation Act 1992

E = Endangered, V = Vulnerable, NT = Near Threatened, LC = Least Concern

4.3 Significant Fauna

Significant fauna species (including migratory species) likely to occur within the Santos GLNG Upstream Project Area are presented in Table 4. The conservation status of each species under both the EPBC Act and the NC Act is also provided.

Table 4 also presents a general description of the habitat in which each species is expected to occupy / utilise for their survival. Section 5.3.1 further discusses fauna habitat.

Table 4: Significant Fauna and Migratory Bird Species within the Santos GLNG Upstream Project Area

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
Invertebrates						
<i>Adclarkia dawsonensis</i>	Boggomoss snail, Dawson valley snail	Known to occur adjacent to the project area	CE	LC	<ul style="list-style-type: none">Intact drainage lines- low flowIntact drainage lines with intact overstorey vegetationFallen logs, well developed leaf litter later maintaining moist microclimateCarnarvon fan palmBoggomoss springsDense vegetation on ground up to 0.5m trunk	Section 10.22
Aves						
<i>Botaurus poiciloptilus</i>	Australasian bittern	Moderate likelihood	E	LC	The Australasian bittern is associated with freshwater, and occasionally estuarine, wetlands. The species prefers wetlands with dense vegetation, for example thick shrubbery, reedbeds, sedges etc (Morcombe 2003).	Section 10.23
<i>Erythrotriorchis radiatus</i>	Red goshawk	Moderate likelihood	V	E	This species can be found in open forests and woodlands, especially near rivers, wetlands and rainforest fringes (Pizzey & Knight 2007).	Section 10.24
<i>Geophaps scripta scripta</i>	Squatter pigeon	Known to occur	V	V	Prefers areas of sandy soil dissected by low gravelly ridges, which have the shortest cover of grasses in woodlands/grasslands. Nearly always found near permanent water (Australian Government 2013c).	Section 10.25
<i>Lathamus discolor</i>	Swift parrot	Moderate likelihood	E	E	Swift parrots are found in dry sclerophyll forests and woodlands, suburban parks and gardens and flowering fruit trees. The species breeds in Tasmania during spring and summer, dispersing widely across south-eastern Australia during winter. They roost communally, often in the same tree each night. They are almost always occur in trees, only coming to ground to drink (Birdlife Australia 2013).	Section 10.26

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
<i>Neochmia ruficauda ruficauda</i>	Star finch	Moderate likelihood	E	E	The Star finch (eastern subspecies) inhabits tall grass and reed beds associated with swamps and watercourses. It may also be found in grassy woodlands, open forests and mangroves. The condition of this habitat varies according to season, grazing pressure and fire. Parts of its range occur within conservation reserves (Queensland Government 2012).	Section 10.27
<i>Pedionomus torquatus</i>	Plains-wanderer	Moderate likelihood	V	V	The Plains-wanderer inhabits sparse, treeless, lowland native grasslands with approximately 50% bare ground, most vegetation less than 5 cm in height, with some widely-spaced plants up to 30 cm high (SPRAT 2013).	Section 10.28
<i>Polytelis swainsonii</i>	Superb parrot	Moderate likelihood	V	LC	The Superb parrot is found along timbered waterways and nearby well-watered woodlands, especially in River Red Gums forests and woodlands or box woodlands. The species is usually seen in family parties or small flocks. They roost communally in trees (Birdlife Australia 2013).	Section 10.29
<i>Poephila cincta cincta</i>	Black-throated finch	Moderate likelihood	E	E	Found in grassy scrublands, woodlands, dune woodlands and pandanus near water (Pizzey & Knight 2007).	Section 10.30
<i>Rostratula australis</i>	Australian painted snipe	Known to occur	E/M	V	Found in freshwater (occasionally brackish) wetlands of south-east Australia. Possibly part-migratory moving north into Queensland in summer (Garnett & Crowley 2000).	Section 10.31
<i>Turnix melanogaster</i>	Black-breasted button-quail	Moderate likelihood	V	V	A Black-breasted button-quail is found in low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. Has also been recorded within the dry forest of the Brigalow Belt (SPRAT 2013).	Section 10.32
Reptiles						
<i>Anomalopus mackayi</i>	Five-clawed worm-skink	Moderate likelihood	V	E	The Five-clawed worm-skink is known to occur in both remnant and non-remnant woodlands and grasslands. In areas modified by agriculture and other human activities, the species has been found sheltering under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales (SPRAT 2013).	Section 10.33

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
<i>Furina dunmalli</i>	Dunmall's snake	Known to occur	V	V	Forests and woodlands on black alluvial cracking clay and clay loams dominated by Brigalow, other Wattles (<i>Acacia burowii</i> , <i>Acacia deanii</i> , <i>Acacia leiocalyx</i>), native Cypress (<i>Callitris</i> spp.) or Bull-oak (<i>Allocasuarina luehmannii</i>). Also <i>Corymbia citriodora</i> , <i>Eucalyptus crebra</i> and <i>Eucalyptus melanophloia</i> , <i>Callitris glaucophylla</i> and Bullock open forest and woodland associations on sandstone derived soils (SPRAT 2013).	Section 10.34
<i>Denisonia maculata</i>	Ornamental snake	Known to occur	V	V	Preferred habitat is within, or close to, habitat that is favoured by its prey - frogs. The species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai mounds and depressions in Queensland RE land zone 4, but also lake margins and wetlands. Gilgai formations are found where deep-cracking alluvial soils with high clay contents occur (SPRAT 2013).	Section 10.35
<i>Delma torquata</i>	Collared delma	Known to occur	V	V	Typically associated with westerly facing ridgelines supporting dry open eucalyptus/acacia woodlands with an open midstorey and a ground layer consisting of native grasses, thick leaf litter with an abundance of loose surface rocks. Populations have been recorded from highly disturbed areas, which maintain an established native canopy cover. Important retaining feature is the retention of surface rocks (Curtis <i>et al</i> 2012).	Section 10.36
<i>Egernia rugosa</i>	Yakka skink	Known to occur	V	V	Usually found in open woodland in dense ground vegetation, hollow logs and cavities in root systems below the ground (Wilson & Knowles 1988; Cogger 2000).	Section 10.37
Mammals						
<i>Chalinolobus dwyeri</i>	Large-eared pied bat	Known to occur	V	V	Variety of habitats including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves (Churchill 2008).	Section 10.38
<i>Nyctophilus corbeni</i>	South-eastern long-eared bat	Known to occur	V	V	In Queensland its preferred habitat is eucalypt woodland, although it has also been recorded from rainforest with hoop pines in the Bunya Mountains, and in semi evergreen vine thickets on the banks of the Dawson River. It is	Section 10.39

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
					most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer. The eastern long-eared bat is thought to roost solitarily under the loose bark, and in the crevices and hollows of trees (Queensland Government 2013).	
<i>Dasyurus hallucatus</i>	Northern quoll	Moderate likelihood	E	LC	The Northern quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. Recent surveys throughout Queensland have suggested Northern Quolls are more likely to be present in high relief areas that have shallower soils, greater cover of boulders, less fire impact and were closer to permanent water (SPRAT 2013).	Section 10.40
<i>Onychogalea fraenata</i>	Bridled nail-tail wallaby	Known to occur	E	E	The Bridled nail-tail wallaby occurs in woodland, particularly in Brigalow scrub, preferring areas with the most fertile soil. (SPRAT 2013).	Section 10.41
<i>Petrogale penicillata</i>	Brush-tailed rock-wallaby	Known to occur	V	V	This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks (SPRAT 2013).	Section 10.42
<i>Pteropus poliocephalus</i>	Grey-headed flying-fox	Known to occur	V	LC	Roost sites are typically formed in areas with a dense canopy, close to water, often in gullies. Daily foraging generally occurs within 15 km of roost site in areas consisting of rainforest trees (figs and palms) and eucalypts, angophoras, tea-trees and banksias (Strahan 1995).	Section 10.43
<i>Phascolarctos cinereus</i>	Koala	Known to occur	V	LC, V(SEQ)	Koala habitat can be broadly defined as any environment containing koala food trees species (<i>Eucalyptus</i> spp., <i>Corymbia</i> spp., <i>Angophora</i> spp. and <i>Lophostemon</i> spp.) or shelter trees, which may be used by Koalas for roosting, sheltering or breeding, and which is sufficiently connected. Preferred food and shelter trees are naturally abundant on fertile clayey soils (SPRAT 2013).	Section 10.44
Aquatic Fauna						

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
<i>Maccullochella peelii</i>	Murray cod	Moderate likelihood	V	LC	The Murray cod has the ability to live in a diverse range of habitats, including clear rocky streams, to slow flowing, turbid rivers and billabongs. Within the large range of habitats, the Murray cod is usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures. The Murray cod is considered a main channel specialist as it is frequently found in the main river channel and larger tributaries (National Murray Cod Recovery Team 2009).	Section 10.45
<i>Rheodytes leukops</i>	Fitzroy river turtle	Known to occur	V	V	The Fitzroy river turtle is found in rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (Cogger <i>et al</i> 1993).	Section 10.46
Migratory Birds						
<i>Ardea alba</i> (<i>Ardea modesta</i>)	Great egret	Known to occur	M	SLC	Reported in a wide range of wetland habitats, including inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial (Australian Government 2013).	Section 10.47
<i>Ardea ibis</i>	Cattle egret	Known to occur	M	SLC	Freshwater wetlands and adjoining pasture areas. Nests colonially in <i>Melaleuca</i> forests (Morcombe 2003).	Section 10.48
<i>Apus pacificus</i>	Fork-tailed swift	Known to occur	M	SLC	Aerial over coasts, urban areas and arid areas (Morcombe 2003).	Section 10.49
<i>Calidris acuminata</i>	Sharp-tailed sandpiper	Known to occur	M	SLC	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves (Higgins and Davies 1996).	Section 10.50

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
<i>Gallinago hardwickii</i>	Latham's snipe, Japanese snipe	Known to occur	M	SLC	Typical habitat for the species includes low vegetation around wetlands and in shallows, sedges, reeds, heath, salt marsh and irrigated crops. Although it doesn't breed in Australia, it is a regular summer migrant with its stronghold in south-east Queensland to southern South Australia (Morcombe 2003).	Section 10.51
<i>Haliaeetus leucogaster</i>	White-bellied sea eagle	Known to occur	M	SLC	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey and Knight 2007).	Section 10.52
<i>Hirundapus caudacutus</i>	White-throated needletail	Known to occur	M	SLC	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey and Knight 2007).	Section 10.53
<i>Merops ornatus</i>	Rainbow bee-eater	Known to occur	M	SLC	An aerial species found over coastal woodlands, open forests and mangroves. Nests in burrows in sandy banks and ground (Morcombe 2003).	Section 10.54
<i>Monarcha melanopsis</i>	Black-faced monarch	Known to occur	M	SLC	Mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical rainforest, subtropical rainforest, mesophyll thicket/shrubland, warm temperate rainforest, dry rainforest and (occasionally) cool temperate rainforest (Australian Government 2013).	Section 10.55
<i>Monarcha trivirgatus</i>	Spectacled monarch	Known to occur	M	SLC	The Spectacled monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves (Birdlife Australia 2013).	Section 10.56
<i>Myiagra cyanoleuca</i>	Satin flycatcher	Known to occur	M	SLC	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey and Knight 2007).	Section 10.57
<i>Pandion haliaetus</i>	Eastern osprey	Moderate	M	SLC	Coastal waters and estuaries. Follows major rivers and wetlands far inland from the coast to large river pools, including to arid regions where large	Section 10.58

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
		likelihood			pools occur in gorges (Morcombe 2003).	
<i>Plegadis falcinellus</i>	Glossy ibis	Known to occur	M	SLC	Preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. Occasionally found in coastal locations such as estuaries, deltas, saltmarshes and coastal lagoons (Australian Government 2013).	Section 10.59
<i>Nettapus coromandelianus</i>	Cotton-pygmy goose	Known to occur	M	NT	Deep freshwater swamps, lagoons and dams with waterlilies and other semi-emergent water plants (Pizzey & Knight 2007).	Section 10.60
<i>Tringa nebularia</i>	Common greenshank	Known to occur	M	-	Common greenshanks are found both on the coast and inland, in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms and flooded crops (Birdlife Australia 2013).	Section 10.61
<i>Tringa stagnatilis</i>	Marsh sandpiper	Known to occur	M	SLC	Permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, salt pans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. Recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes; and avoid, or rarely occur in, tidal habitats, and rarely occur on beaches (Australian Government 2013).	Section 10.62
<i>Pluvialis fulva</i>	Pacific golden plover	Known to occur	M	SLC	The Pacific golden plover is found on muddy, rocky and sandy wetlands, shores, paddocks, saltmarsh, coastal golf courses, estuaries and lagoons (Birdlife Australia 2013)	Section 10.63
<i>Tringa glareola</i>	Wood sandpiper	Known to occur	M	SLC	Well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes (Higgins & Davies 1996)	Section 10.64
<i>Hydroprogne caspia</i>	Caspian tern	Known to occur	M	SLC	Mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. Also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. Also use artificial wetlands,	Section 10.65

Santos

GLNG Project

Species	Common Name	Likelihood of Occurrence	Status		Summary of Habitat	Species Profile
			EPBC Act	NC Act		
					including reservoirs, sewage ponds and saltworks. In offshore areas the species prefers sheltered situations, particularly near islands, and is rarely seen beyond reefs (Higgins & Davies 1996)	

Table notes: EPBC Act = *Environmental Protection and Biodiversity Conservation Act 1999*; NC Act = (*Nature Conservation Act 1992*)

E = Endangered, V = Vulnerable, NT = Near Threatened, M = Migratory, LC = Least Concern, SLC = Special Least Concern

4.3.1 Fauna Habitat

Significant fauna species are dependent on suitable habitat for survival. Given that habitat can be difficult to define for individual species, for the purpose of this SSMP, fauna habitat has been segregated into four distinct categories (refer Table 5) based on pre-clearance surveys, available scientific information, and expert advice contained within the Biodiversity Planning Assessment (BPA) (EPA 2006).

These habitat classifications can be used to assess direct disturbance impacts to the significant fauna species habitat assessed within this SSMP. A specific set of habitat assumptions regarding each of the species contained within this SSMP have been developed to categorise habitat into these categories. The species-specific habitat assumptions are outlined within Part 2 of this SSMP.

General / indicative habitat descriptions for significant fauna likely to be present within the Santos GLNG Upstream Project Area is provided in Table 4.

Table 5: Fauna Habitat Categories

Habitat Type	Description
Core	Core habitat consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.
Essential	Essential habitat is an area containing resources considered essential for the maintenance of populations of the species (e.g. potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).
General	General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.
Unlikely	Unlikely habitat areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

4.4 Threatened Ecological Communities

The spatial extent of TECs has been estimated using vegetation community data in Santos' GIS. This data utilises the Regional Ecosystems (RE) mapping as a base layer and is updated and refined following ecological field surveys.

Six EPBC listed TECs are known to occur, or are likely to occur, within the Santos GLNG Upstream Project Area as listed in Table 6. Detailed profiles of these TECs are provided in Part 3 of this SSMP.

Table 6: Threatened Ecological Communities (TEC) within the Santos GLNG Upstream Project Area

Threatened Ecological Community	Likelihood of Occurrence	EPBC Status	Species Profile
Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Not identified but has the potential to occur	Endangered	Section 10.66
Brigalow (<i>Acacia harpophylla</i> dominant and sub-dominant)	Known to occur	Endangered	Section 10.67
Semi-evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions	Known to occur	Endangered	Section 10.68
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Known to occur	Endangered	Section 10.69
Weeping Myall Woodlands	Known to occur	Endangered	Section 10.70
Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Known to occur	Endangered	Section 10.71

5.0 Threats to Significant Species and Threatened Ecological Communities

The development of the Santos GLNG Upstream Project Area will see a diversity of activities occurring concurrently throughout the CSG fields. The activities required for the development of the CSG fields pose a potential threat to significant flora, fauna and TECs. Potential threats to significant species posed by the development and operation of the Santos GLNG Project are summarised in Table 7.

Table 7: Potential Impacts to Significant Species and Threatened Communities

Potential Impact	Description
Habitat Loss	<p>The clearing of vegetation for the construction of project infrastructure has the potential to result in a direct loss of significant species habitats. Clearing also has the potential to degrade the quality of existing habitat where the construction of infrastructure has resulted in fragmentation and the creation of edge effects.</p> <p>Clearing will predominantly occur during the construction phases and is to be limited to the extent essential to allow for safe construction and operations (e.g. trees may be lopped and not felled to allow construction vehicle access).</p>
Fragmentation	<p>Clearing required for the construction of infrastructure within the GFD Project Area has the potential to result in fragmentation of habitat and contiguous vegetation communities. This can interrupt species movements and result in the formation of 'islands' and thereby population fragmentation.</p> <p>Much of the Santos GLNG Upstream Project Area is already highly fragmented due to clearing associated with historic grazing practices, however intact stands of contiguous vegetation remain. Project related clearing will predominantly occur during the construction phases and is to be limited to the extent essential to allow for safe construction and operations (e.g. trees may be lopped and not felled to allow construction vehicle access).</p>
Injury / Mortality / Entrapment	<p>The development of track and road networks during the construction phase and their continued use throughout operation phase has the potential to result in injury / mortality of fauna. On the track and road network injury and mortality is likely to be limited to smaller, less mobile fauna such as reptiles, amphibians and mammals, and some bird species such as Squatter pigeon. In addition, other infrastructure, including markers and fencing, pipeline trenches and fluid containment structures, has the potential to cause injury and/or mortality for some more active fauna species.</p>
Introduction of pests and weeds	<p>Pests and weeds can be spread very easily across a landscape either intentionally or unintentionally via both man-made and natural mechanisms. Activities conducted throughout the Santos GLNG Upstream Project Area have the potential to inadvertently introduce and spread pest and weed species across the region, primarily through poor weed hygiene practices and the movement of Project vehicles between 'clean' and 'dirty' regions.</p> <p>There is also some potential for increased movement of pest fauna which are already present in the CSG fields through the changing to habitat modification, allowing the species to survive more readily, and potentially at the expense of native species.</p>
Disturbance of behaviour / movement	<p>Construction and operations have the potential to disturb the behaviour and movements of some fauna. Disturbances may include some disruption of breeding activities. On its own, some disturbance of fauna movement and behaviour is likely to have minimal impact on populations. However, when combined with the loss of habitat, changes in behaviour may increase the risk of predation and the sustainability of populations. Most Project related disturbances are expected to be short-term and occur predominantly during construction.</p>

Potential Impact	Description
Dust	<p>Prolonged deposition of dust on foliage can impact on a plant's ability to photosynthesise, thereby inducing stress in the plant and the potential for death. Potential impacts associated with dust are most likely to occur during the construction phase where there is significant vehicle movement and earth-breaking activities. Construction and clearing activities have the potential to create small areas of relatively high but localised airborne dust loads with implications for the surrounding flora and fauna. Dust from operational activities is envisaged to be minimal.</p> <p>Areas impacted by dust will predominantly be small (i.e. areas directly bordering construction and clearing activities or track or road verge) and impacts will be short term. Impacts as a result of dust are likely to be limited to sensitive flora species, TEC located close to dust sources and fauna with minimal mobility (e.g. aquatic fauna, amphibians and small reptiles).</p>
Noise, Lighting, Vibration	<p>Excessive noise, bright lighting and vibration have the potential to disturb fauna inhabiting the immediate vicinity of construction activity, particularly whilst breeding or preparing to breed. Potential impacts of noise, lighting and vibration will be more prevalent during the construction phase and will therefore be relatively short-term. Sensitive fauna are likely to temporarily leave impacted areas, but some acclimation may occur. Fauna are likely return to impacted areas on cessation of the disturbance activities.</p>
Sediment Transport	<p>Clearing and construction activities have the potential to result in localised erosion and thereby sediment transport, particularly where activity occurs on slopes or in the vicinity of landform features such as gullies, outcrops and drainage lines. Following significant rain events, run-off from disturbed areas may result in the build-up of sediment in watercourses and waterholes. Sediment deposition to land or waterways has the potential to have an impact on flora, with some potential impact on aquatic fauna possible.</p> <p>Many surface waterways in the region have naturally high turbidity after significant rain events and under normal flow conditions, due to the nature of the soils and the existing disturbed nature of landscapes. Therefore, significant impacts are not anticipated.</p>
Fire	<p>Fire can result in the potential loss (either temporary or permanent) of vegetative cover or microhabitat, thereby impacting on terrestrial flora, fauna and TECs. Altered fire regimes (i.e. increased frequency) caused by Project activities may over time also result in vegetation changes, further equating to the loss of habitat.</p> <p>The risk of fire associated with Project activities is considered unlikely.</p>
Soil Contamination	<p>Soil contamination has the potential to occur during the construction and operational Project phases as result of spillage of hydrocarbons from construction machinery, particularly during refuelling, or from fuel or chemical storage tanks. Flora and fauna can be adversely affected by soil contamination.</p>
Surface Water Degradation	<p>Construction and operations near waterways and in particular the construction of linear infrastructure in the vicinity of waterways may result in alteration of flows and increased sedimentation and turbidity. This has the potential to adversely impact aquatic fauna and flora. Contamination of waterways resulting from the spillage of hydrocarbons is unlikely, although some flow into waterways may occur following a large spill. Contamination of waterways will also pose a risk to aquatic flora and fauna.</p> <p>Impacts to waterways are most likely to occur during the construction phase and is anticipated that direct impacts would be small and localised .</p>
Groundwater Degradation	<p>Contamination of shallow groundwater has the potential to occur during the construction phase as result of prolonged spillage of hydrocarbons (fuels, hydraulic oils and lubricants) from construction activities, however this is considered to localised and limited).</p>

Santos

GLNG Project

Potential Impact	Description
	<p>CSG water is a by-product of the extraction of CSG and may pose a threat to flora and fauna by:</p> <ul style="list-style-type: none"> • Seeping into GAB aquifers from a loss of containment from storage ponds / turkey nests • Impacts on GAB recharge springs or related groundwater dependent ecosystems (GDE), including impacts on springs supplied by rainfall water which has infiltrated the soil and underlying shallow aquifer (rather than GAB aquifers) and is then locally discharged into creeks and springs • Impacts on species and threatened ecological communities listed in the EPBC Act 1999 – potential for impacts on the distribution, health or life cycle of listed flora and fauna.

6.0 Management of Significant Species and TECs

6.1 Management Hierarchy

Due to the iterative nature of gas field development, all gas field planning and management around ecological values is constraints based. Planning and management of disturbances are assessed and in consideration of a set of hierarchical management principles that are designed to avoid, minimise, mitigate impacts to known environmental values (including significant species and TECs). These management principles are to be applied using the following hierarchy:

1. Avoidance – Avoiding direct and indirect adverse environmental impacts where reasonable and practicably possible;
2. Minimise – Minimise direct and indirect adverse environmental impacts where impacts cannot be avoided;
3. Mitigate – Implement mitigation and management measures to minimise direct, indirect and cumulative adverse environmental impacts;
4. Remediation and Rehabilitation – Actively remediate and rehabilitate impacted areas to promote and maintain long-term recovery; and
5. Provide Offsets – Where required, Santos GLNG will provide suitable offsets for activities that result in an unavoidable significant residual adverse impact to MNES and MSES. The offsets will be submitted for approval in accordance with both Queensland and Commonwealth Government requirements.

This hierarchy is implemented through the use of a number of the Santos EHSMS and the combination of plans illustrated in Figure 3. These plans have the common goal of firstly avoiding and then managing potential impacts to significant species, TECs and other environmental values.

Each of these principles in relation to significant species and TECs are discussed further in the following sections.

6.1.1 Avoid and Minimise

6.1.1.1 Constraints Based Management of Ecological Impacts

Santos GLNG has developed the *Environmental Protocol for Constraints Planning and Field Development* (the Protocol), which outlines the approach Santos GLNG uses to identify, assess and then avoid or minimise potential impacts to MNES where practicable, including significant species and TECs, as well other State related matters. Ecological constraints are grouped based on the nature of development that can occur within each of the ecological constraints and immediately adjacent to the constraint (i.e. buffer zones).

Similarly, the Protocol outlines the internal steps necessary to gain an environmental approval to authorise the disturbance to land. These steps include:

- Desktop assessments that assess the location of proposed infrastructure against the development constraints using GIS datasets of TECs and significant species locations and habitat;
- Ecological surveys (where required) to identify the location of TEC and significant species and habitats in proposed disturbance areas; and

- Assessment of the on-the-ground values and development of appropriate conditions highlighting mitigation measures including any zones of restriction or exclusion to adequately protect the identified environmental values.

As part of any assessment, the Environmental Advisor will work through the management hierarchy described in Section 7.0 above – firstly seeking to avoid the constraint where practicable before undertaking steps to mitigate impacts to that constraint.

6.1.2 Mitigate

This step in the hierarchy primarily involves the application of the SSMP as well as the other related Santos GLNG management plans shown in Figure 3. The implementation of the SSMP is only necessary once a decision has been made (in accordance with the Protocol) to progress with a disturbance to land that will have a potential adverse impact on a significant species and/or a TEC.

The SSMP and other related management plans outline high level strategies and practical mitigation measures to be implemented on the ground to mitigate and manage the risk of adverse impacts to significant species, their habitat and TECs. It is acknowledged that in addition to the management measures provided, the input of a suitably qualified ecologist or environmental advisor will be required in most instances to ensure the appropriate mitigation is used for individual circumstances and that additional measures are not required to manage the risk of adverse impacts at any one location.

Management measures specific to significant species and TECs are discussed further in Section 7.2.

6.1.3 Rehabilitate

Where a direct or indirect impact has occurred to a significant species or TEC, Santos GLNG will apply rehabilitation measures as appropriate for the impacted species / area, to minimise cumulative impacts throughout the life of the Project. Three (3) forms of rehabilitation typically occur as part of the current Santos GLNG Project and these will be the rehabilitation strategies adopted for the GFD Project:

1. Stabilisation of exposed construction disturbances – this occurs during the construction phase and is designed to minimise the area of disturbance exposed, thereby minimising the potential for soil loss, erosion and sedimentation of the surrounding areas. This may involve some revegetation but is predominantly about contouring and stabilisation.
2. Reduction of the construction footprint – at the cessation of construction, there is often scope for the construction footprint to be reduced to an operational footprint. This can either involve further stabilisation as described above, designed to prevent adverse impacts such as erosion and to protect the asset or in some cases may be the commencement of rehabilitation of vegetation with the view to reach final rehabilitation objectives (i.e. progressive rehabilitation)
3. Final rehabilitation – this most commonly occurs at the end of an operational assets life and coincides with the activities undertaken as part of decommissioning and abandonment (as per the DAMP). Final rehabilitation is completed in accordance with the Rehabilitation Plan with the view of achieving pre-determined and agreed rehabilitation objectives and standards. It is important to note that where an offset has been provided for a disturbance to a significant species or TEC, the objectives for final rehabilitation may be reduced to account for the provision of offsets. Instead, the area will be stabilised and soil profiles reinstated, thereby providing the foundations for the pre-clearance vegetation and community to return through natural successional processes.

6.1.4 Offset

Where impacts are significant residual residual and adverse resulting in a permanent loss of an environmental value, Santos GLNG will provide environmental offsets in accordance with both Queensland and Commonwealth government requirements and the Santos GLNG Environmental Offsets Strategy (refer Section 4.2.5).

6.2 Mitigation Measures

As discussed in Section 7.1.2, this SSMP outlines a series of management measures designed to minimise and/or mitigate potential impacts to the significant species and TECs by ameliorating known threats to these values and as identified in Section 0.

Management measures have been grouped into the following categories:

- Flora – Section 7.2.1;
- Invertebrates – Section 0;
- Birds – Section 7.2.3;
- Reptiles and Amphibians – Section 7.2.4;
- Mammals – Section 7.2.5;
- Aquatic Fauna – Section 7.2.6;
- Migratory Birds – Section 7.2.7; and
- TECs – Section 7.2.8.

Management measures within each of the above categories have been further grouped by Project phase. This is because common works typically occur within each phase regardless of the construction activity, allowing for the transparent application of measures at the appropriate time. The Project phases are as follows:

- Planning
- Assessment
- Construction
- Operation; and
- Decommissioning, including abandonment.

6.2.1 Significant Flora Species

Table 8: Management Measures for Significant Flora Species

Activity	Mitigation Measure
Planning Phase	
Infrastructure Planning / Siting	An evaluation of the presence of threatened flora will be undertaken using data obtained from desktop and ground truthing studies, as per the <i>Environmental Protocol for Constraints Planning and Field Development</i> .
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified threatened flora wherever practicable.
	Where impacts to threatened flora cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning</i>

Santos

GLNG Project

Activity	Mitigation Measure
	<i>and Field Development</i> will be complied with.
Assessment Phase	
Rehabilitation / Offsets Planning	Where a significant residual adverse impact is to occur to threatened flora, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted in proximity to threatened flora.
Site Preparation	The extent of disturbance within the vicinity of threatened flora will be demarcated using flagging tape, barricade webbing or similar.
	Any exclusion zones surrounding individual plants and or patches of multiple plants in areas immediately adjacent to the disturbance will also be appropriately marked out.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
	Where threatened flora is present in areas adjacent to the disturbance, exclusion zones are to be established around identified individual plants and or patches of multiple plants.
	Known threatened flora in areas adjacent to disturbances will be regularly checked to ensure no disturbances.
Clearing	All vegetation clearing within identified threatened flora must comply with clearing related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities within and adjacent to threatened flora will be supervised by an Environmental Representative.
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition and the smothering of threatened flora.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened flora will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	To minimise erosion and restore natural functions as far as possible, areas where threatened flora habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened flora habitat where required by the Santos GLNG Upstream, <i>Rehabilitation Management Plan</i> .
Operational Phase	
Access	Access is to occur along designated access tracks only
	Areas of exclusion will remain appropriately marked for the duration of the activity.
Fire management	A buffer will be maintained around ignition sources.

Santos

GLNG Project

Activity	Mitigation Measure
	Fire management and response will be conducted in accordance with the relevant Santos GLNG Bushfire Management Plan, the Contingency Plan for Emergency Environmental Incidents, and in consultation with local regulatory authorities.
Dust management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition and the smothering of threatened flora.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened flora will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Erosion and Sediment Control	Erosion and sediment control for Project disturbances will be implemented in accordance with the Santos GLNG Upstream <i>Erosion and Sediment Control Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened flora habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the Santos GLNG Upstream <i>Decommissioning and Abandonment Management Plan</i> (DAMP).
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Monitoring	
<ul style="list-style-type: none"> In areas where mitigation measures have been implemented to minimise impacts to threatened flora species occurring adjacent to the disturbance, monitoring will be conducted during the construction and operational phases to ensure mitigation is effective and where necessary, apply corrective actions. The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required. 	
Performance Criteria	
<ul style="list-style-type: none"> No unauthorised disturbance of threatened flora species are to occur as a result of construction and operation activities. Sightings of individuals are appropriately documented, submitted to relevant authorities and recorded within the Santos Constraints Database. Rehabilitation of areas associated with threatened flora has been completed in accordance with the Rehabilitation Plan. Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1. 	

6.2.2 Significant Invertebrates

Table 9: Management Measures for Significant Invertebrate Species

Activity	Mitigation Measure
Planning Phase	
Infrastructure Planning / Siting	An evaluation of the presence of threatened fauna and threatened fauna habitat will be undertaken using data obtained from desktop and ground truthing studies, as per the <i>Environmental Protocol for Constraints Planning and Field Development</i> .
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified threatened fauna and threatened fauna habitat wherever practicable.
	Where impacts to threatened fauna cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning and Field Development</i> will be complied with.
Assessment Phase	
Rehabilitation / Offsets Planning	Where a significant residual adverse impact is to occur to threatened fauna or threatened fauna habitat, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted within, or in proximity to, threatened fauna or threatened fauna habitat.
Site Preparation	Threatened fauna habitat features or any associated buffer in proximity to the disturbance is to be demarcated using flagging tape, barricade webbing or similar.
	Any exclusion zones associated with fauna habitat or breeding places that are to be avoided adjacent to the disturbance area will also be appropriately marked out.
	A licensed spotter-catcher qualified to handle all types of wildlife will survey the area to be disturbed for the presence of fauna species, immediately prior to the commencement of disturbance and relocate the fauna to an undisturbed location.
	Where practicable, microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
	Known populations in areas adjacent to disturbances will be regularly checked to ensure that impacts to populations are minimal
Clearing	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.

Santos

GLNG Project

Activity	Mitigation Measure
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna / habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	<p>To minimise erosion and restore natural functions as far as possible, areas where threatened fauna habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.</p> <p>With the exception of areas subject to operational and maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat, where required by the Santos GLNG Upstream, <i>Rehabilitation Management Plan</i>.</p>
Operational Phase	
Access	<p>Access is to occur along designated access tracks only</p> <p>Designated speed limits are to be adhered to.</p>
Fire management	<p>A buffer will be maintained around ignition sources.</p> <p>Fire management and response will be conducted in accordance with the relevant Santos GLNG Bushfire Management Plan, the Contingency Plan for Emergency Environmental Incidents, and in consultation with local regulatory authorities.</p>
Dust management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact fauna species / habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational and maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat, where required by the Santos GLNG Upstream, <i>Rehabilitation Management Plan</i> .
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the Santos GLNG Upstream <i>Decommissioning and Abandonment Management Plan</i> (DAMP).
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Monitoring	
<ul style="list-style-type: none"> In areas where mitigation measures have been implemented to minimise impacts to threatened fauna species or their habitat, occurring adjacent to the disturbance, monitoring will be conducted during the construction and operational phases to ensure mitigation is effective and where necessary, apply corrective actions. The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required. 	

Performance Criteria

- No injury or fatalities of threatened fauna species are to occur as a result of construction and operation activities.
- Sightings of individuals / active breeding places are appropriately documented, submitted to relevant authorities and recorded within the Santos Constraints Database.
- Significant habitat features are not destroyed as a result of construction and operation activities (e.g. construction clearing, pedestrian, vehicle and machinery movements).
- Rehabilitation of associated threatened fauna habitat areas has been completed.
- Active breeding places are not destroyed as a result of construction and operation activities (e.g. construction clearing, pedestrian, vehicle and machinery movements).
- Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1.

6.2.3 Significant Threatened Birds

Table 10: Management Measures for Significant Threatened Bird Species

Activity	Mitigation Measure
Planning Phase	
Infrastructure Planning / Siting	An evaluation of the presence of threatened fauna and threatened fauna habitat will be undertaken using data obtained from desktop and ground truthing studies, as per the <i>Environmental Protocol for Constraints Planning and Field Development</i> .
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified threatened fauna and threatened fauna habitat wherever practicable.
	Where impacts to threatened fauna or threatened fauna habitat cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning and Field Development</i> will be complied with.
	Clearing in and around wetlands will be avoided, where possible.
	100 metre exclusion zones are to be created around identified active breeding places.
	Active breeding places are to be monitored by a suitably qualified person to ensure the breeding site has been vacated prior to the buffer being removed.
	Where practicable, construction works should be timed so as to avoid breeding periods.
Assessment Phase	
Rehabilitation / Offsets Planning	Where a significant residual adverse impact is to occur to threatened fauna or threatened fauna habitat, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted within, or in proximity to, threatened fauna or threatened fauna habitat.
Site Preparation	Threatened fauna habitat features or any associated buffer in proximity to the disturbance is to be demarcated using flagging tape, barricade webbing or similar.
	Where clearing within vegetated fauna habitat, all efforts to retain mature trees will be taken.
	Any exclusion zones such as breeding places will also be appropriately marked out.

Activity	Mitigation Measure
	A licensed spotter-catcher qualified to handle all types of wildlife will survey the area to be disturbed for the presence of fauna species, immediately prior to the commencement of disturbance.
	Where practicable, microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
	The use of barb wire will be avoided where possible when erecting Project related fencing. Where barb wire fencing is unavoidable, the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs or the top strand will be made visible to fauna through the use of tagging.
	Restricted zones of 50 m are to be established around breeding places / nests that have become active after construction has commenced.
	In restricted zones, vehicles must reduce speed and thoroughfare is to be limited to critical site specific construction activities. Alternative routes are to be sought and utilised for all other Project traffic.
	Night works within restricted zones are to be avoided. Where they are required to occur, activities will be restricted to critical site specific construction activities
Clearing	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities within and adjacent to threatened fauna habitat will be supervised by an Environmental Representative.
	Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the clearing activities and into adjacent natural areas.
	A licensed spotter-catcher qualified to handle all types of wildlife will monitor all clearing works in habitat. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	Where habitat trees need to be removed the following measures will be implemented: <ul style="list-style-type: none"> • Non-hollow bearing trees will be removed before hollow-bearing (or potential habitat) trees, allowing fauna an opportunity to self-relocate from the potential habitat trees. This applies in the instance when the fauna cannot be relocated, and it is evident that an animal exists within the trees; • Habitat trees will be left overnight from the time of the felling of the non-habitat trees nearby; • Habitat trees will be inspected by a qualified spotter / catcher after at least one night has passed from the time that the surrounding vegetation has been cleared, to determine occupancy; • In Where possible, a spotter / catcher will encourage the fauna to leave by reasonable means or capture and relocate it in the local environment prior to felling and trimming; • Habitat trees will be felled gently or lowered to the ground and trees will be left for a short period of time on the ground to give any fauna trapped in the trees an opportunity to escape before further processing of the trees. After this time the spotter catcher will thoroughly check the tree to ensure there are no injured animals; • Displaced fauna will then be relocated (within their hollows) to a suitable, previously identified recipient site provided the animal did not sustain any injuries. Any injured

Santos

GLNG Project

Activity	Mitigation Measure
	animals (native or introduced) are to be taken to receive veterinary attention immediately. Once recovered, animals will be relocated to an area of similar habitat in proximity to the disturbance area
Blasting	Blasting should be avoided, where practicable, around areas with congregations of birds, such as wetlands.
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	<p>To minimise erosion and restore natural functions as far as possible, areas where threatened fauna habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.</p> <p>With the exception of areas subject to operational and maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat, where required by the Santos GLNG Upstream, <i>Rehabilitation Management Plan</i>.</p>
Operational Phase	
Access	<p>Access is to occur along designated access tracks only</p> <p>Designated speed limits are to be adhered to.</p>
Fire management	<p>A buffer will be maintained around ignition sources.</p> <p>Fire management and response will be conducted in accordance with the relevant Santos GLNG Bushfire Management Plan, the Contingency Plan for Emergency Environmental Incidents, and in consultation with local regulatory authorities.</p>
Dust management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Emissions management	<p>Lighting disturbances will be reduced / minimised especially near threatened habitat areas and active breeding places. Where practicable, lighting will be directed away from sensitive areas or engineering solutions will be used to limit light spillage.</p> <p>To reduce noise and vibration, equipment will be regularly maintained and is in good working order.</p>
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational and maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat, where required by the Santos GLNG Upstream, <i>Rehabilitation Management Plan</i> .

Activity	Mitigation Measure
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the <i>Santos GLNG Upstream Decommissioning and Abandonment Management Plan (DAMP)</i> .
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .

Monitoring

- In areas where mitigation measures have been implemented to minimise impacts to threatened fauna species or their habitat, occurring adjacent to the disturbance, monitoring will be conducted during the construction and operational phases to ensure mitigation is effective and where necessary, apply corrective actions.
- The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required.

Performance Criteria

- No injury or fatalities of threatened fauna species are to occur as a result of construction and operation activities.
- Sightings of individuals / active breeding places or roosts are appropriately documented, submitted to relevant authorities and recorded within the Santos Constraints Database.
- Significant habitat features are not destroyed as a result of construction and operation activities (e.g. construction clearing, pedestrian, vehicle and machinery movements).
- Rehabilitation of associated threatened fauna habitat areas has been completed.
- Active breeding places are not destroyed as a result of construction and operation activities (eg construction clearing, pedestrian, vehicle and machinery movements).
- Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1.

6.2.4 Significant Reptiles

Table 11: Management Measures for Significant Reptile Species

Activity	Mitigation Measure
Planning Phase	
Infrastructure Planning / Siting	An evaluation of the presence of threatened fauna and threatened fauna habitat will be undertaken using data obtained from desktop and ground truthing studies, as per the <i>Environmental Protocol for Constraints Planning and Field Development</i> .
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified threatened fauna and threatened fauna habitat wherever practicable.
	Where impacts to threatened fauna or threatened fauna habitat cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning and Field Development</i> will be complied with.
	Land disturbance of areas containing large amounts of coarse woody debris microhabitats will be avoided, where possible.
	100 metre exclusion zones are to be created around identified active breeding places.
	Active breeding places are to be monitored by a suitably qualified person to ensure the breeding site has been vacated prior to the buffer being removed.
Assessment Phase	

Santos

GLNG Project

Activity	Mitigation Measure
Rehabilitation / Offsets Planning	Where a significant residual adverse impact is to occur to threatened fauna or threatened fauna habitat, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
	Where clearing within fauna habitat, all efforts to retain microhabitat such as logs and rocks will be taken and moved to an adjacent undisturbed area.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted within, or in proximity to, threatened fauna or threatened fauna habitat.
Site Preparation	Threatened fauna habitat features or any associated buffer in proximity to the disturbance is to be demarcated using flagging tape, barricade webbing or similar.
	Any exclusion zones such as breeding places will also be appropriately marked out.
	A licensed spotter-catcher qualified to handle all types of wildlife will survey the area to be disturbed for the presence of fauna species, immediately prior to the commencement of disturbance.
	Where practicable, microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
	Restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced.
	The status of known populations in areas adjacent to disturbances will be regularly checked in a way that does not risk abandonment by individuals
	In restricted zones, vehicles must reduce speed and thoroughfare is to be limited to critical site specific construction activities. Alternative routes are to be sought and utilised for all other Project traffic.
	Night works within restricted zones are to be avoided. Where they are required to occur, activities will be restricted to critical site specific construction activities
Clearing	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities within and adjacent to threatened fauna habitat will be supervised by an Environmental Representative.
	Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the clearing activities and into adjacent natural areas.
	A licensed spotter-catcher qualified to handle all types of wildlife will monitor all clearing works in habitat.
	Where microhabitat features are removed they will be utilised in areas adjacent the clearing activities.
	Displaced fauna will be relocated to a suitable, previously identified recipient site provided that animal did not sustain any injuries. Any injured animals are to be taken to receive veterinary attention immediately. Once recovered, animals will be relocated to an area of similar habitat in proximity to the disturbance area.

Activity	Mitigation Measure
	Cleared vegetation and construction equipment and pipes shall be stockpiled in a manner that does not significantly impede fauna movements.
Blasting	Blasting should be avoided where practicable, around sandstone ridges containing many microhabitat features such as caves and overhangs.
Pipeline Construction	The period of time that trenches and other excavations are open, will be minimised, particularly in known or significant fauna habitat areas.
	Pipe string ends will be capped nightly to prevent access to threatened fauna.
	Where feasible, temporary exclusion fencing to exclude fauna from trenches will be utilised.
	Open trenches will be checked for trapped fauna twice daily each day, regardless of whether fencing has been used.
	Measures, such as trench ramps, sticks, ropes and the use of moist hessian sacks at regular intervals (or similar) will be utilised to help trapped fauna escape and/or survive until removed by fauna spotters.
	Prior to backfilling, trenches are to be checked for fauna.
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Operational Phase	
Access	Access is to occur along designated access tracks only
	Designated speed limits are to be adhered to.
	Where practicable, travel during dusk, dawn and at night when fauna is most active, will be avoided
Fire management	A buffer will be maintained around ignition sources.
	Fire management and response will be conducted in accordance with the relevant Santos GLNG Bushfire Management Plan, the Contingency Plan for Emergency Environmental Incidents, and in consultation with local regulatory authorities.
Dust management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Emissions management	Lighting disturbances will be reduced especially near threatened habitat areas and active breeding places. Where practicable, lighting will be directed away from sensitive areas or engineering solutions will be used to limit light spillage.
	To reduce noise and vibration, equipment will be regularly maintained and is in good working order.

Activity	Mitigation Measure
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	<p>To minimise erosion and restore natural functions as far as possible, areas where threatened flora habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.</p> <p>With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i>.</p>
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the Santos GLNG Upstream <i>Decommissioning and Abandonment Management Plan</i> (DAMP).
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .

Monitoring

- In areas where mitigation measures have been implemented to minimise impacts to threatened fauna species or their habitat, occurring adjacent to the disturbance, monitoring will be conducted during the construction and operational phases to ensure mitigation is effective and where necessary, apply corrective actions.
- The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required.

Performance Criteria

- No injury or fatalities of threatened fauna species are to occur as a result of construction and operation activities.
- Sightings of individuals, active breeding places or other observations such as latrine sites are appropriately documented, submitted to relevant authorities and recorded within the Santos Constraints Database.
- Significant microhabitat features such as logs, rocks and bark are not unnecessarily destroyed as a result of construction and operation activities (e.g. construction clearing, pedestrian, vehicle and machinery movements).
- Rehabilitation of associated threatened fauna habitat areas has been completed.
- Active breeding places are not destroyed as a result of construction and operation activities (e.g. construction clearing, pedestrian, vehicle and machinery movements).
- Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1.

6.2.5 Significant Mammal Species

Table 12: Management Measures for Significant Mammal Species

Activity	Mitigation Measure
Planning Phase	
Infrastructure	An evaluation of the presence of threatened fauna and threatened fauna habitat will be undertaken using data obtained from desktop and ground truthing studies, as per the

Santos

GLNG Project

Activity	Mitigation Measure
Planning / Siting	<i>Environmental Protocol for Constraints Planning and Field Development.</i>
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified threatened fauna and threatened fauna habitat wherever practicable.
	Where impacts to threatened fauna or threatened fauna habitat cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning and Field Development</i> will be complied with.
	Clearing in and around cave structures and rocky outcrops will be avoided, where possible.
	100 metre exclusion zones are to be created around identified active breeding places.
Assessment Phase	
Rehabilitation / Offsets Planning	Where a significant residual adverse impact is to occur to threatened fauna or threatened fauna habitat, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
	Where clearing within vegetated fauna habitat, all efforts to retain mature trees will be taken.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted within, or in proximity to, threatened fauna or threatened fauna habitat.
Site Preparation	Threatened fauna habitat features or any associated buffer in proximity to the disturbance is to be demarcated using flagging tape, barricade webbing or similar.
	Any exclusion zones such as breeding places will also be appropriately marked out.
	A licensed spotter-catcher qualified to handle all types of wildlife (including bats) will survey the area to be disturbed for the presence of fauna species, immediately prior to the commencement of disturbance.
	Where practicable, microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
	The use of barb wire will be avoided where possible when erecting Project related fencing. Where barb wire fencing is unavoidable, the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs or the top strand will be made visible to fauna through the use of tagging.
	Restricted zones of 50 m are to be established around breeding places that become active after construction has commenced.
	The status of known populations in areas adjacent to disturbances will be regularly checked in a way that does not risk abandonment by individuals.
	Night works within restricted zones are to be avoided. Where they are required to occur, activities will be restricted to critical site specific construction activities
	In restricted zones, vehicles must reduce speed and thoroughfare is to be limited to critical site specific construction activities. Alternative routes are to be sought and utilised for all other Project traffic.
Clearing	All vegetation clearing within identified threatened fauna habitat must comply with clearing

Activity	Mitigation Measure
	related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities within and adjacent to threatened fauna habitat will be supervised by an Environmental Representative.
	Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the clearing activities and into adjacent natural areas.
	A licensed spotter-catcher qualified to handle all types of wildlife (including bats) will monitor all clearing works in habitat.
	Where habitat trees need to be removed the following measures will be implemented: <ul style="list-style-type: none"> • Non-hollow bearing trees will be removed before hollow-bearing (or potential habitat) trees, allowing fauna an opportunity to self-relocate from the potential habitat trees. This applies in the instance when the fauna cannot be relocated, and it is evident that an animal exists within the trees; • Habitat trees will be left overnight from the time of the felling of the non-habitat trees nearby; • Habitat trees will be inspected by a qualified spotter / catcher after at least one night has passed from the time that the surrounding vegetation has been cleared, to determine occupancy; • In the case of the presence of bat species, the spotter / catcher will encourage the fauna to leave by reasonable means or capture and relocate it in the local environment prior to felling and trimming; • Hollows identified as containing fauna will be plugged with a suitable material such as a towel, the section removed from the tree and gently lowered to the ground using ropes; • Habitat trees will be felled gently or lowered to the ground and trees will be left for a short period of time on the ground to give any fauna trapped in the trees an opportunity to escape before further processing of the trees. After this time the spotter catcher will thoroughly check the tree to ensure there are no injured animals; • Displaced fauna will then be relocated (within their hollows) to a suitable, previously identified recipient site provided the animal did not sustain any injuries. Any injured animals (native or introduced) are to be taken to receive veterinary attention immediately. Once recovered, animals will be relocated to an area of similar habitat in proximity to the disturbance area.
	Cleared vegetation and construction equipment and pipes shall be stockpiled in a manner that does not significantly impede fauna movements.
Blasting	Blasting should be avoided, where possible, around sandstone ridges with caves, overhangs or old mine shafts.
Pipeline Construction	The period of time that trenches and other excavations are open, will be minimised, particularly in known or significant fauna habitat areas.
	Pipe string ends will be capped nightly to prevent access to threatened fauna.
	Where feasible, temporary exclusion fencing to exclude fauna from trenches will be utilised.
	Open trenches will be checked for trapped fauna twice daily each day, regardless of whether fencing has been used.
	Measures, such as trench ramps, sticks, ropes and the use of moist hessian sacks at regular intervals (or similar) will be utilised to help trapped fauna escape and/or survive until removed by fauna spotters.
	Prior to backfilling, trenches are to be checked for fauna.

Santos

GLNG Project

Activity	Mitigation Measure
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	<p>To minimise erosion and restore natural functions as far as possible, areas where threatened flora habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.</p> <p>With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i>.</p>
Operational Phase	
Access	Access is to occur along designated access tracks only
	Designated speed limits are to be adhered to.
	Where practicable, travel during dusk, dawn and at night when fauna is most active, will be avoided
Fire management	A buffer will be maintained around ignition sources.
	Fire management and response will be conducted in accordance with the relevant Santos GLNG Bushfire Management Plan, the Contingency Plan for Emergency Environmental Incidents, and in consultation with local regulatory authorities.
Dust management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat.
Emissions management	Lighting disturbances will be reduced especially near threatened habitat areas and active breeding places. Where practicable, lighting will be directed away from sensitive areas or engineering solutions will be used to limit light spillage.
	To reduce noise and vibration, equipment will be regularly maintained and is in good working order.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .

Activity	Mitigation Measure
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the Santos GLNG Upstream <i>Decommissioning and Abandonment Management Plan</i> (DAMP).
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .

Monitoring

- In areas where mitigation measures have been implemented to minimise impacts to threatened fauna species or their habitat, occurring adjacent to the disturbance, monitoring will be conducted during the construction and operational phases to ensure mitigation is effective and where necessary, apply corrective actions.
- The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required.

Performance Criteria

- No injury or fatalities of threatened fauna species are to occur as a result of construction and operation activities.
- Sightings of individuals / active breeding places or roosts are appropriately documented, submitted to relevant authorities and recorded within the Santos Constraints Database.
- Significant habitat features such as caves or overhangs are not destroyed as a result of construction and operation activities (eg construction clearing, pedestrian, vehicle and machinery movements).
- Rehabilitation of associated threatened fauna habitat areas has been completed.
- Active breeding places are not destroyed as a result of construction and operation activities (eg construction clearing, pedestrian, vehicle and machinery movements).
- Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1.

6.2.6 Aquatic Fauna

Table 13: Management Measures of Significant Species of Aquatic Fauna

Activity	Mitigation Measure
Planning Phase	
Infrastructure Planning / Siting	An evaluation of the presence of threatened fauna and threatened fauna habitat will be undertaken using data obtained from desktop and ground truthing studies, as per the <i>Environmental Protocol for Constraints Planning and Field Development</i> .
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified threatened fauna and threatened fauna habitat wherever practicable.
	Where impacts to threatened fauna or threatened fauna habitat cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning and Field Development</i> will be complied with.
	Where possible watercourse and wetland crossings will be selected to avoid areas containing deep pools and river sandbanks likely to be suitable for breeding places
	500 metre exclusion zones are to be created around Fitzroy River Turtle nests identified by an approved Ecologist during pre-clearance survey work.

Santos

GLNG Project

Activity	Mitigation Measure
Assessment Phase	
Rehabilitation / Offsets Planning	Where a significant residual adverse impact is to occur to threatened fauna or threatened fauna habitat, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
	Where land disturbances occur in aquatic fauna habitats, all efforts to retain mature trees and maintain water quality will be taken.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted within, or in proximity to, threatened fauna or threatened fauna habitat.
Site Preparation	Threatened fauna habitat features or any associated buffer in proximity to the disturbance is to be demarcated using flagging tape, barricade webbing or similar.
	Any exclusion zones surrounding Fitzroy River Turtle nests will be appropriately marked out.
	A licensed spotter-catcher qualified to handle all types of wildlife will survey the area to be disturbed for the presence of fauna species, immediately prior to the commencement of disturbance.
	Where possible, microhabitat such as semi-submerged logs and snags will be relocated to undisturbed areas prior to disturbance.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
	Exclusion zones of 10 m are to be established around Fitzroy River Turtle nests.
Clearing	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities within and adjacent to threatened fauna habitat will be supervised by an Environmental Representative.
Blasting	Blasting should be avoided, where possible, around watercourses.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Erosion and Sediment Control	All requirements within the Santos GLNG Upstream <i>Erosion and Sediment Control Plan</i> will be implemented to reduce sedimentation of watercourses, manage turbidity and maintain flow rates.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	To minimise erosion and restore natural functions as far as possible, areas where threatened flora habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .

Santos

GLNG Project

Activity	Mitigation Measure
Operational Phase	
Access	Access is to occur along designated access tracks only
	Designated speed limits are to be adhered to.
Emissions management	Lighting disturbances will be reduced especially near threatened habitat areas and active breeding places. Where practicable, lighting will be directed away from sensitive areas or engineering solutions will be used to limit light spillage.
	To reduce noise and vibration, equipment will be regularly maintained and is in good working order.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Erosion and Sediment Control	All requirements within the Santos GLNG Upstream <i>Erosion and Sediment Control Plan</i> will be implemented to reduce sedimentation of watercourses, manage turbidity and maintain flow rates.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened fauna or their habitat will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent threatened fauna habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the Santos GLNG Upstream <i>Decommissioning and Abandonment Management Plan</i> (DAMP).
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Monitoring	
<ul style="list-style-type: none"> In areas where mitigation measures have been implemented to minimise impacts to threatened fauna species or their habitat, occurring adjacent to the disturbance, monitoring will be conducted during the construction and operational phases to ensure mitigation is effective and where necessary, apply corrective actions. The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required. 	
Performance Criteria	
<ul style="list-style-type: none"> No injury or fatalities of threatened fauna species are to occur as a result of construction and operation activities. Sightings of individuals / active breeding places are appropriately documented, submitted to relevant authorities and recorded within the Santos Constraints Database. Significant habitat features are not destroyed as a result of construction and operation activities (eg construction clearing, pedestrian, vehicle and machinery movements). 	
Performance Criteria	
<ul style="list-style-type: none"> Rehabilitation of associated threatened fauna habitat areas has been completed. Active breeding places are not destroyed as a result of construction and operation activities (eg construction clearing, pedestrian, vehicle and machinery movements). 	

- Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1.

6.2.7 Significant Migratory Birds

Table 14: Management Measures for Significant Species of Migratory Birds

Activity	Mitigation Measure
Planning Phase	
Infrastructure Planning / Siting	An evaluation of the presence of migratory birds and migratory bird habitat will be undertaken using data obtained from desktop and ground truthing studies, as per the <i>Environmental Protocol for Constraints Planning and Field Development</i> .
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified migratory birds and migratory bird habitat wherever practicable.
	Where impacts to migratory birds or migratory bird habitat cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning and Field Development</i> will be complied with.
	Clearing around wetlands will be avoided, where possible.
	100 metre exclusion zones are to be created around identified active nests.
Assessment Phase	
Rehabilitation / Offsets Planning	Where a significant residual adverse impact is to occur to migratory birds or migratory bird habitat, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
	Where clearing within vegetated fauna habitat, all efforts to retain mature trees will be taken.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted within, or in proximity to, migratory birds or migratory birds habitat.
Site Preparation	Migratory bird habitat features or any associated buffer in proximity to the disturbance is to be demarcated using flagging tape, barricade webbing or similar.
	Any exclusion zones such as nests will also be appropriately marked out.
	A licensed spotter-catcher qualified to handle all types of wildlife will survey the area to be disturbed for the presence of fauna species, immediately prior to the commencement of disturbance.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
	The use of barb wire will be avoided where possible when erecting Project related fencing. Where barb wire fencing is unavoidable, the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs or the top strand will be made visible to fauna through the use of tagging.
	Restricted zones of 50 m are to be established around nests that have become active after construction has commenced.
	In restricted zones, vehicles must reduce speed and thoroughfare is to be limited to critical site specific construction activities. Alternative routes are to be sought and utilised for all other Project traffic.
	Night works within restricted zones are to be avoided. Where they are required to occur,

Activity	Mitigation Measure
Clearing	activities will be restricted to critical site specific construction activities.
	During migratory periods, known populations in areas adjacent to disturbances will be regularly checked in a way that does not risk abandonment by individuals.
	All vegetation clearing within identified migratory bird habitat must comply with clearing related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities within and adjacent to migratory bird habitat will be supervised by an Environmental Representative.
	Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the clearing activities and into adjacent natural areas.
	A licensed spotter-catcher qualified to handle all types of wildlife will monitor all clearing works in habitat.
	Where habitat trees need to be removed the following measures will be implemented: <ul style="list-style-type: none"> • Non-habitat trees will be removed before habitat (or potential habitat) trees, allowing fauna an opportunity to self-relocate from the potential habitat trees. This applies in the instance when the fauna cannot be relocated, and it is evident that an animal exists within the trees; • Habitat trees will be left overnight from the time of the felling of the non-habitat trees nearby; • Habitat trees will be inspected by a qualified spotter / catcher after at least one night has passed from the time that the surrounding vegetation has been cleared, to determine occupancy; • A spotter / catcher will encourage the fauna to leave by reasonable means or capture and relocate it in the local environment prior to felling and trimming; • Habitat trees will be felled gently or lowered to the ground and trees will be left for a short period of time on the ground to give fauna trapped an opportunity to escape before further processing of the trees. After this time the spotter catcher will thoroughly check the tree to ensure there are no injured animals; • Displaced fauna will then be relocated to a suitable, previously identified recipient site provided the animal did not sustain any injuries. Any injured animals (native or introduced) are to be taken to receive veterinary attention immediately. Once recovered, animals will be relocated to an area of similar habitat in proximity to the disturbance area.
	Trees containing nests will be inspected to ensure the nests are not active. Where a nest is active a 50 m restriction zone is to be established around identified active nest.
Blasting	Blasting should be avoided, where possible, around areas with large congregations of migratory birds such as wetlands.
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on migratory birds habitat.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact migratory birds will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	To minimise erosion and restore natural functions as far as possible, areas where migratory bird habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.

Santos

GLNG Project

Activity	Mitigation Measure
	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent migratory bird habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Operational Phase	
Access	Access is to occur along designated access tracks only
	Designated speed limits are to be adhered to.
Fire management	A buffer will be maintained around ignition sources.
	Fire management and response will be conducted in accordance with the relevant Santos GLNG Bushfire Management Plan, the Contingency Plan for Emergency Environmental Incidents, and in consultation with local regulatory authorities.
Dust management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on migratory bird habitat.
Emissions management	Lighting disturbances will be reduced especially near threatened habitat areas and active nests. Where practicable, lighting will be directed away from sensitive areas or engineering solutions will be used to limit light spillage.
	To reduce noise and vibration, equipment will be regularly maintained and is in good working order.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact migratory fauna will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent migratory bird habitat where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the Santos GLNG Upstream <i>Decommissioning and Abandonment Management Plan</i> (DAMP).
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Monitoring	
<ul style="list-style-type: none"> In areas where mitigation measures have been implemented to minimise impacts to migratory birds or their habitat, occurring adjacent to the disturbance, monitoring will be conducted during the construction and operational phases to ensure mitigation is effective and where necessary, apply corrective actions. The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required. 	
Performance Criteria	
<ul style="list-style-type: none"> No injury or fatalities of migratory bird species are to occur as a result of construction and operation activities. Sightings of individuals / active nests or roosts are appropriately documented, submitted to relevant authorities and recorded within the Santos Constraints Database. Rehabilitation of associated migratory bird habitat areas has been completed. 	

- Active nests are not destroyed as a result of construction and operation activities (e.g. construction clearing, pedestrian, vehicle and machinery movements).
- Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1.

6.2.8 Threatened Ecological Communities

Table 15: Management Measures for TECs

Activity	Management Measure
Planning Phase	
Infrastructure Planning / Siting	An evaluation of the presence of TECs will be undertaken using data obtained from desktop and ground truthing studies, as per the <i>Environmental Protocol for Constraints Planning and Field Development</i> .
	Infrastructure will be sited in accordance with the <i>Environmental Protocol for Constraints Planning and Field Development</i> , so as to avoid potential adverse impacts to identified TEC's wherever practicable.
	Where the TEC cannot be avoided, EPBC approval conditions and the internal approval processes outlined in the <i>Environmental Protocol for Constraints Planning and Field Development</i> will be complied with.
Assessment Phase	
Rehabilitation / Offsets Planning	Where deemed appropriate by a qualified ecologist, collection of local provenance seed from the TEC that is to be disturbed is to be undertaken prior to the commencement of site works.
	Where a significant residual adverse impact to the TEC is to occur, an appropriate offset must be considered in accordance with the Santos GLNG Offsets Strategy.
	Where clearing within a TEC is required, all efforts to retain mature vegetation will be taken.
Site Induction and Work Instruction	Prior to site entry, all relevant site personnel including contractors shall be appropriately trained and made aware of the sensitive environs in which they will be working and be advised of any specific limitations appropriate to the construction works being conducted within, or in proximity to, a TEC.
Site Preparation	The extent of disturbance within the TEC or any associated buffer will be demarcated using temporary fencing, flagging tape, barricade webbing or similar.
	In areas where TEC is known or likely to occur a suitably qualified ecologist will survey the area for the presence of a TEC.
Construction Phase	
Access	Access to and from Project locations is to occur along designated access tracks only.
Clearing	All vegetation clearing must comply with clearing related approval conditions (both statutory and internal approvals).
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities within and adjacent to TECs will be supervised by an Environmental Representative.
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on plants within the TEC.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.

Santos

GLNG Project

Activity	Management Measure
Hazardous Substances Management	Hazardous substances with the potential to impact TECs will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Progressive Rehabilitation / Stabilisation	<p>To minimise erosion and restore natural functions as far as possible, areas where TEC was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.</p> <p>With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent TEC where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i>.</p>
Operational Phase	
Access	<p>Access to and from Project locations is to occur along designated access tracks only.</p> <p>Areas of exclusion will remain adequately marked for the duration of the activity.</p>
Fire Management	<p>A buffer will be maintained around ignition sources.</p> <p>Fire management and response will be conducted in accordance with the relevant Santos GLNG Bushfire Management Plan, the Contingency Plan for Emergency Environmental Incidents, and in consultation with local regulatory authorities.</p>
Dust Management	Dust suppression strategies will be deployed to manage the risk of adverse impacts associated with excessive dust deposition on plants within the TEC.
Pest and Weed Management	All requirements within the Santos GLNG Upstream <i>Pest and Weed Management Plan</i> will be implemented to minimise the introduction and spread of pest and weed species associated with petroleum activities.
Hazardous Substances Management	Hazardous substances with the potential to impact TEC will be stored within contained areas and managed in accordance with the Santos GLNG Upstream <i>Waste Management Plan</i> and <i>Chemical and Fuel Management Plan</i> .
Erosion and Sediment Control	Erosion and sediment control for Project disturbances will be implemented in accordance with the Santos GLNG Upstream <i>Erosion and Sediment Control Plan</i> .
Progressive Rehabilitation / Stabilisation	With the exception of areas subject to operational or maintenance requirements, revegetation will commence to achieve consistency with the floristic composition of the adjacent TEC where required by the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Decommissioning Phase	
Decommissioning and Abandonment	All decommissioning and abandonment of Project infrastructure will be conducted as per the Santos GLNG Upstream <i>Decommissioning and Abandonment Management Plan</i> (DAMP).
Final Rehabilitation	Disturbed areas will be offset and/or rehabilitated in accordance with the Santos GLNG Upstream <i>Rehabilitation Management Plan</i> .
Monitoring	
<ul style="list-style-type: none"> Monitoring of activities during the time of disturbance will be conducted by an Environmental Representative. Monitoring of rehabilitation success will be conducted in accordance with the Rehabilitation Plan. The results and observations made throughout monitoring will be used to update the SSMP as part of the review process to ensure management processes and procedures are adapted as required. 	
Performance Criteria	
<ul style="list-style-type: none"> Authorised, unavoidable, adverse impacts to TECs resulting from exploration, construction and decommissioning of the CSG fields do not exceed imposed regulatory disturbance limits. 	

Santos

GLNG Project

- Significant Residual Adverse impacts to the TEC from Project activities is contained to within the demarcated area of disturbance.
 - Rehabilitation of TECs has been completed in accordance with the Santos GLNG Upstream Rehabilitation Plan.
 - Appropriate corrective actions are effectively implemented in accordance with Section 7.2.1.
-

7.0 Recording and Reporting Requirements

Consistent with the Protocol, the following information will be collected and maintained to demonstrate compliance with this SSMP.

7.1.1 Recording and Tracking Disturbances to MNES

For disturbances to significant species and TECs, the following details will be recorded:

- The location and extent of the disturbance and the type of infrastructure or activity responsible for the disturbance;
- The related pre-construction field scouting and ecological survey documents identifying the significant species and TECs;
- The reasons for the decision to disturb the significant species and/or TEC including justification for the action taken, description of the efforts taken to avoid impact, and an explanation why, given the coexisting environmental constraints, the decision was justified;
- The significant species and/or TEC disturbed; and
- The effect on any disturbance limits for the significant species and TECs as set out in the approval documents.

The information will be recorded and maintained so that it can be audited. Disturbances will be frequently updated in Santos GIS so that predicted disturbances can be analysed with actual disturbances and records updated to accurately reflect cumulative disturbance levels.

7.1.2 Data Collection and Storage

All data collected from field assessment will be entered into the Santos GIS system. Field collected data will be stored and managed in accordance with Santos GIS data management procedures.

The results of ecological assessments and documentation are to be documented and records maintained. A record of all documents required by the SSMP will be kept for the life of the Project.

7.1.3 Reporting

Santos GLNG will report on upstream activities as required by Commonwealth Government approvals. Details of any impact or presumed impact to a significant species or TECs along with a record of any assessments required will be kept, and submitted to the administering authority as required.

Where specific constraints possess a statutory disturbance limit, the total disturbance levels will be reported annually.

7.2 Incident Investigation and Corrective Actions

7.2.1 Incident Investigation and Corrective Actions

All incidents relating to significant species and TECs are to be reported in the Santos GLNG Incident Management System (IMS) and investigated according to Santos standard *EHSMS14 - Monitoring, Measurement and Reporting* and *EHSMS15 - Incident Investigation and Response*. Corrective actions are to be carried out based on the findings from incident investigations.

Detailed below are actions that will be taken should an incident occur relating directly to significant species and TECs.

7.2.1.1 Flora

If a significant flora species is unintentionally uprooted during clearing operations, the following actions will occur:

- The Environmental Advisor shall be notified and advice sought as to appropriate measures to ensure successful transplantation of the plant (dependant on the species type and size, plants can generally be replanted straight away in an area marked as a 'No Go' or rehabilitation zone);
- If the species can be replanted in its original location, monitoring and follow up management (including watering) of the species should occur over the duration of the construction period to increase the likelihood of successful re-establishment. Follow up monitoring management such as watering may also be required after the construction period;
- If the species cannot be replanted (e.g. is too damaged or habitat has been destroyed) a solution will be reached with the Australian Government;
- Current mitigation strategies outlined in this SSMP will be reviewed in conjunction with a suitably qualified ecologist; and
- The SSMP will be amended as required and changes communicated to the business for implementation.

7.2.1.2 Fauna

If a native animal is injured on site, an Environmental Advisor or Fauna Spotter-Catcher who holds the appropriate permits under the NC Act will be immediately notified to attend and handle the animal. The animal will be bundled in a dry warm blanket or jacket and taken to a vet or approved wildlife carer (do not attempt to handle snakes or platypus). If it is unsafe or not possible to bundle the animal then:

- The location of the injured animal will be identified / marked so it can be located again;
- The species of animal will be identified if possible and its approximate size determined;
- The type of injury sustained will be identified if possible (without handling or causing the animal further stress); and
- The Environmental Advisor shall immediately contact the QPWS Office or DEHP - 1300 130 372 and provide details of the last known location of the injured / dead animal or will arrange for its possible capture for transportation to a vet and/or wildlife carer.

Following the capture / recovery of the animal, an investigation into the cause of the event will be undertaken including an assessment of the effectiveness of corrective and preventative actions currently in place.

Any corrective and preventative actions identified will be implemented. The risk register, relevant procedures and documentation (including this plan) will be reviewed and revised as is necessary.

The SSMP will be reviewed in conjunction with a suitably qualified ecologist. New mitigation measures will be discussed with Commonwealth and State Governments prior to implementation and the SSMP will be updated accordingly for implementation.

7.2.1.3 Threatened Ecological Communities

If a TEC is unintentionally cleared (i.e. outside of the approved area) during construction or operations, the following actions will occur:

- A “stop work” order for works in the non-compliant area will be issued and will remain in place until the non-compliance has been rectified and measures implemented to prevent the breach re-occurring;
- If plants have been damaged, refer to Section 8.2.1.1 for actions;
- If fauna have been injured or killed, refer to the fauna Section 8.2.1.2 for actions;
- Current mitigation strategies outlined in this SSMP will be reviewed in conjunction with a suitably qualified ecologist; and
- The SSMP will be amended as required and changes communicated to the business for implementation.

7.3 Training

All relevant Santos GLNG personnel and visitors are required to undertake appropriate environmental training and induction programs prior to working within the Santos GLNG Upstream Project Area. These training and induction programs will incorporate the identification, management and reporting of significant species (as appropriate) on-site. Applicable training suited to the different roles and responsibilities (Section 0) is also to be undertaken in accordance with appropriate Santos Standards including *EHSMS06 Training and Competency* and *EHS01 Biodiversity and Land Disturbance*.

Regular toolbox meetings will also address significant species management. Topics addressed by these sessions include key SSMP management principles to maintain compliance with regulatory requirements and to reinforce solutions or increase awareness of any issues related to significant species that arise during the course of exploration, construction, operations, decommissioning and rehabilitation.

8.0 Evaluation and Review

8.1 Evaluation

The implementation and effectiveness of the SSMP and its associated procedures will be regularly assessed to ensure:

- Santos GLNG is demonstrating compliance with legal and landholder obligations;
- The overall management strategy remains relevant and up to date; and
- The plan and procedures adequately manage the environmental issue.

Effectiveness can be assessed by a number of methods as shown in Table 16.

Table 16: Methods to Assess Legal and Procedural Effectiveness

Assessment Tool	Description
Checklists – Santos GLNG Compliance Management System	<ul style="list-style-type: none"> • Checklists, developed to reflect legal and procedural requirements / outcomes will be used by individual Santos GLNG Departments to assess and manage compliance. The results of the checklists will be evaluated for trending non-compliances that may be resolved through procedural change or by implementing another measure or process.
Audits	<ul style="list-style-type: none"> • Conduct internal and third party audits to formally assess the level of compliance with both regulatory requirements and with Santos GLNG procedures. • Audit outcomes are used to develop corrective actions which may include changes to this plan and/or procedures.
Review of Incidents	<ul style="list-style-type: none"> • A review of internal incidents, near misses or hazards will be undertaken to identify recurrences of similar incident types. This may highlight a requirement for a change in the existing plan and/or procedure, require the development of a new procedure or by implementation of another measure or process to address the recurring issue.
Review of Data	<ul style="list-style-type: none"> • Analyse all relevant data collected for negative and/or undesirable trends that may be prevented by procedural changes or by implementing another measure or process.

8.2 Review

The SSMP is a living document and shall be reviewed at least every three years or sooner if any of the following occur:

- The plan is not adequately managing the issue - an unauthorised direct or indirect impact to significant species and/or TEC is identified as a result of activity in the Santos GLNG Upstream Project Area (as identified by steps outlined in Section 9.1);
- Legislative requirements change;
- The area of activity changes;
- A new listed species or community is identified within the Santos GLNG Upstream Project Area;
- The protection status of a listed species or ecological community changes;
- Details of specific recovery plans or action statements change;
- Conditions of approval relevant to significant species and communities management in the Santos GLNG Upstream Project Area are amended;

Santos

GLNG Project

- Planning for the commencement of a new stage of development in the Santos GLNG Upstream Project Area; and/or,
- A written request from the Minister for the SSMP to be reviewed is received by Santos GLNG.

Reviews shall be undertaken by a qualified ecologist approved by the Commonwealth Government (with other experts as appropriate). Updates will consider information made available by the Commonwealth and Queensland Government Departments, other CSG proponents and input from other independent reviews. All reviews and updates to the SSMP will be at the financial cost of Santos GLNG.

The revised SSMP will be submitted to the Commonwealth Government for approval. Approved revisions of the SSMP will be communicated to relevant Santos GLNG Project personnel for immediate implementation.

9.0 Species and Community Profiles

9.1 *Acacia curranii*

9.1.1 Status

Vulnerable – listed 16 July 2000

9.1.2 Biology and ecology

9.1.2.1 Characteristics

Acacia curranii (Curly-bark wattle) is an erect or spreading multi-stemmed shrub with distinctive red curling (minniritchi) bark. Its habit resembles that of broombush and it grows to a height of 3 to 4 m (Pedley 1978; Harden 1991; Cunningham *et al* 1992).



Plate 1: *Acacia curranii* (Source: Fagg n.d)

9.1.2.2 Known distribution

The species has a disjunct distribution in western New South Wales and south-eastern Queensland, occurring in three areas each separated by several hundred kilometres. In New South Wales it grows in the Lake Cargelligo area and on the Gunderbooka Range near Bourke. In Queensland it occurs in the Gurulmundi area, north of Miles (Pickard 1995). In the Gurulmundi area in the Darling Downs district of Queensland, plants occur in widely scattered thickets of about ten plants. This distribution centre is less than 20 km across (Pickard 1995).



Figure 4: Mapped distribution range of *Acacia curranii* (Source: DOTE 2014c)

9.1.2.3 Known species populations within the CSG fields

Acacia curranii is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.1.2.4 Habitat

Acacia curranii grows most often on rocky outcrops of isolated hills and ranges. Soils are variable between the different centres of distribution (Pickard 1995).

This species forms groves. In New South Wales typical accompanying species are *Acacia doratoxylon*, *Eucalyptus dwyeri* and *Callitris glaucophylla*. In Queensland, the plant occurs in patches in very species-rich heathy scrub (DOTE 2014c).

In Gurulmundi, the species occurs on deeply weathered sandstone forming red sandy soils. The soil is stony with patches of deep sand and little evidence of rock outcrop near the patches. The species occurs in widely scattered thickets in patches of diverse heath scrub with emergent trees (Pickard 1995).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions (TSSC 2008m)

9.1.2.5 Biology and reproduction

The flowerheads are ovoid-shaped spikes and are golden in colour and flowers are borne August to September (Orchard & Wilson 2001). Pods ripen in November (Lithgow 1997).

This species may well require fire before the seeds will germinate (Pickard 1995). Preliminary attempts to germinate seeds by seed scarification have been largely unsuccessful, though this may be due to insect damage or poor development rendering seeds unviable (Pickard 1995).

Anecdotes and field observations indicate that populations adjacent to Nombinnie National Park, at Shepherds Hill and at Gurulmundi are regenerating after disturbance and fire (Pickard 1995). In general, populations which have undergone disturbance (eg railway spur at Shepherds Hill and a burnt area on Mylone and Ambone) appear to have many small plants, while undisturbed populations are generally composed entirely of medium to large plants. It is uncertain whether the many small plants that seem to be a result of disturbance are seedlings or root suckers. No recruitment of juveniles was observed at Gundabooka National Park (NSW NPWS 2003).

The three main population regions are considered too isolated for gene flow (Pickard 1995).

9.1.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.1.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.1.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.2 *Acacia grandifolia*

9.2.1 Status

Vulnerable – listed 16 July 2000

9.2.2 Biology and ecology

9.2.2.1 Characteristics

Acacia grandifolia is a tree growing to about 8 m high with flowers in long golden spikes (Orchard & Wilson 2001).



Plate 2: *Acacia grandifolia* (Source: Fagg n.d)

9.2.2.2 Known distribution

This species is endemic to south-east Queensland and is restricted to a small area around Gayndah, Mundubbera, Coulston Lakes and Proston in the Burnett District (Qld CRA/RFA Steering Committee 1998; QDNR 2000).

The type specimen is from 54 km south of Mundubbera and another specimen is from 12 km east of Gayndah (Pedley 1987). The species occurs in State Forest 132 (Brovinia), State Forest 220 (Malmaison), State Forest 249 (Wigton), State Forest 255 (Woroon) and State Forest 1344 (Boompa) (QDNR 2000). This species also occurs in State Forest 210 and on Brian Pastures Research Station. It is also recorded from leasehold land and road verges in the area (Qld CRA/RFA Steering Committee 1998).

The literature does not specify how many populations exist, though its existence near three towns and in five state forests (QDNR 2000), suggests around eight populations. The species occurs as large colonies or as scattered individuals (QDNR 2000). It covers a range of approximately 100 km and encompasses an area of occurrence of approximately 4,200 km² (Qld CRA/RFA Steering Committee 1998).

There are no records of this species from a conservation reserve or a protected area (Briggs & Leigh 1996; Qld CRA/RFA Steering Committee 1998; QDNR 2000).

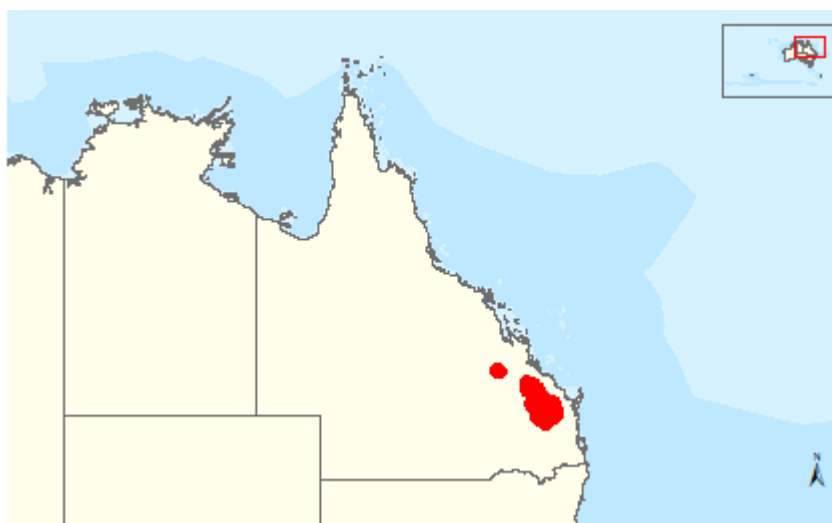


Figure 5: Mapped distribution range of *Acacia grandifolia* (Source: DOTE 2014d)

9.2.2.3 Known species populations within the CSG fields

Acacia grandifolia is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.2.2.4 Habitat

The species grows on hilly terrain of varying aspects and slope, on hillcrests, in gullies on plains (Qld CRA/RFA Steering Committee 1998). The species appears to flourish in disturbed ground and grows well on roadsides. At the type locality the species forms open stands on sand, among large sandstone boulders. It has also been recorded on shallow stony soils derived from basalt (Pedley 1978, 1987; Orchard & Wilson 2001).

It occurs in ironbark gum and spotted gum forests and woodlands (QDNR 2000). The most frequently recorded associated tree species are *Eucalyptus crebra*, *Corymbia citriodora*, *Corymbia trachyphloia* and *Eucalyptus exserta* (Qld CRA/RFA Steering Committee 1998).

9.2.2.5 Biology and reproduction

This species flowers from July to October and mature pods have been collected from October to November. Seeds are dormant when released from mature pods and accumulate as a persistent seed bank between fires. It is not known how long seeds remain viable in the soil (DOTE 2014d).

Although plants flowered profusely, no seed was produced at observed sites over two successive years. This may have been due to climatic conditions or to low genetic diversity. Although not confirmed, it is suspected that these plants usually seed irregularly (Leverington *et al* 2003).

Rare species occurring within a restricted geographical location typically exhibit low levels of genetic diversity; this is so for *A. grandifolia*. Its genetic profile suggests that it may have been geographically isolated from near relatives and has developed in isolation (Leverington *et al* 2003).

The plant appears to respond well to disturbance, with records of good regeneration in disturbed areas and by roadsides. It appears to be highly fire tolerant with populations expanding after fire (Leverington *et al* 2003).

9.2.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.2.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.2.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.3 *Aristida annua*

9.3.1 Status

Vulnerable – listed 16 July 2000

9.3.2 Biology and ecology

9.3.2.1 Characteristics

Aristida annua is an annual loosely tufted grass with a flowering stem growing to approximately 50 cm in height. It has smooth 25 to 50 cm long culms (stems) with culm-internodes that are distally glabrous. The species has sparse lateral branches and leaf-blades that have pubescent surfaces, are hairy adaxially and grow between 7 and 15 cm long and 1 to 1.5 mm wide. Panicle is open (10 to 20 cm long and 5 to 12 cm wide), elliptic and effuse. Spikelets are solitary (Simon 1992).



Plate 3: *Aristida annua* (Source: Ausgrass2 n.d)

9.3.2.2 Known distribution

Aristida annua is restricted to central Queensland in Emerald and Springsure districts. The species is very poorly understood and there appears to be no survey data (DOTE 2014e).

There is no information on the population size of *Aristida annua* and the species has not been researched (DOTE 2014e).



Figure 6: Mapped distribution range of *Aristida annua* (Source: DOTE 2014e)

9.3.2.3 Known species populations within the CSG fields

Aristida annua is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.3.2.4 Habitat

Aristida annua occurs in eucalypt woodland. It is restricted to black clay soils, basalt soils and possibly disturbed sites (DOTE 2014e). The species occurs in the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin ecological community, which is listed as Endangered under the EPBC Act (QLD DERM 2011b).

9.3.2.5 Biology and reproduction

The species flowers between March and June (BRI collection records n.d).

9.3.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.3.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.3.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.4 *Arthraxon hispidus*

9.4.1 Status

Vulnerable – listed 16 July 2000

9.4.2 Biology and ecology

9.4.2.1 Characteristics

Arthraxon hispidus, Family Poaceae, also known as Hairy-joint grass, is a slender tufted creeping grass that roots at the nodes, with erect to semi-erect stems (Leigh *et al* 1984; DECC NSW 2005). The leaves are reddish to purplish with long white hairs around the edge, broad at the base and tapering abruptly to a sharp point (DECC NSW 2005).

The fruit is a caryopsis (simple, dry single seeded fruit, with seed fused to the wall of the fruit and remaining closed at maturity) (Leigh *et al* 1984). The seed-heads are held above the plant on a long fine stalk (DECC NSW 2005).



Plate 4: *Arthraxon hispidus* (Source: Ausgrass2 n.d)

9.4.2.2 Known distribution

In Australia, the species has been recorded from scattered locations throughout Queensland and on the northern tablelands and north coast of New South Wales (DECC NSW 2005; Bostock & Holland 2007). In Queensland this species occurs north to Port Douglas and west to disjunct occurrences around mound springs in Carnarvon National Park; however, most occurrences are from Noosa southwards (TSSC 2008n).

This species occurs within the Border River–Gwydir, Northern Rivers (NSW), Fitzroy, Border Rivers–Maranoa Balonne, Condamine, South East, Burnett Mary and Wet Tropics (Queensland) Natural Resource Management Regions (TSSC 2008n).

Arthraxon hispidus is known to be reserved in Carnarvon Cooloola National Park, Noosa National Park, Carnarvon National Park and Daintree National Park (TSSC 2008n).



Figure 7: Mapped distribution range of *Arthraxon hispidus* (Source: DOTE 2014f)

9.4.2.3 Known species populations within the CSG fields

Arthraxon hispidus is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.4.2.4 Habitat

In NSW and Queensland, *Arthraxon hispidus* is found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps, as well as woodland (TSSC 2008n). In south-east Queensland, *Arthraxon hispidus* has also been recorded growing around freshwater springs on coastal foreshore dunes, in shaded small gullies, on creek banks and on sandy alluvium in creek beds in open forests and also with bog mosses in mound springs (TSSC 2008n).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (TSSC 2008n)

9.4.2.5 Biology and reproduction

Flowers appear in March to July (Harden 1993) and summer to autumn (Jacobs & Wall 2007).

This species was once considered an annual, but is now thought to be a perennial that tends to die down in winter (TSSC 2008n).

9.4.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.4.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.4.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.5 *Bertya opposens*

9.5.1 Status

Vulnerable – listed 16 July 2000

9.5.2 Biology and ecology

9.5.2.1 Characteristics

Bertya opposens (Coolabah bertya) is a slender shrub or small tree to 4 m high and consists of either slender, multiple stems or a single trunk. The branches and stems are covered with whitish to brown, dense, intertwined hairs. The upper surface is dark-green and hairless and the under-surface is velvety-woolly (NPWS 2002a).

Flowers lack stalks and have one to three female and male flowers clustered together and surrounded by four thick, yellowish to golden brown, hairy bracts. Flowering is thought to primarily occur between July and August however, this may be dependent on the individual site characteristics (NPWS 2002a).

The fruit capsule is ovoid to globose, 8 to 9 mm long with dense, long weak hairs and contains two to three seeds (NPWS 2002a).



Plate 5: *Bertya opposens* (Source: Wain 2011)

9.5.2.2 Distribution

In Queensland, *Bertya opposens* distribution generally extends from Toowoomba to Charleville, north to Emerald and then towards the coast, south of Gladstone. The species is known to occur at Chesterton Range National Park, Palmgrove National Park and Thomby Range. The species has also been identified on Lonesome Holding, Kentucky Holding and during pre-clearance surveys at Baffle Creek (Atlas of Living Australia 2014).

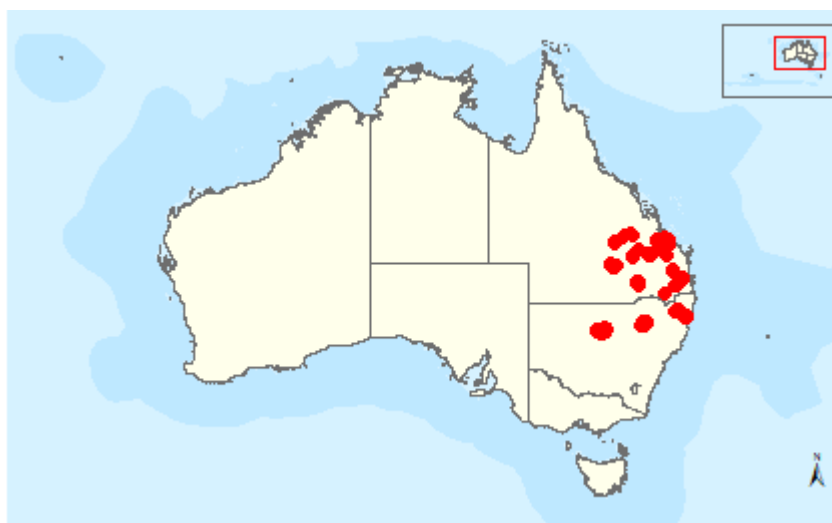


Figure 8: Mapped distribution range of *Bertya opponens* (Source: DSEWPaC 2011b)

9.5.2.3 Known species populations within the CSG fields

Bertya opponens is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.5.2.4 Habitat

The known populations of *Bertya opponens* within New South Wales occur in a number of different habitats, ranging from stony mallee ridges and cypress pine forests of the inland, to cliff edges in the high rainfall eastern fall areas of the Great Dividing Range (NPWS 2002a). The wide variation in habitat type between the populations makes the identification of critical habitat very difficult (NPWS 2002a). In Queensland, the species has been identified on the crest of a sandstone massif in a dense thicket (circa 4 m high) in association with *Alstonia constricta*, *Alphitonia excelsa*, *Erythroxylum* sp., *Jasminum simplicifolium* and *Bursaria spinosa* with scattered *Callitris glaucophylla*, *Callitris endlicheri* and *Eucalyptus crebra* on sandy loam (Atlas of Living Australia 2014).

The species has also been identified in *Acacia shirleyi* woodland on a steep sandstone ridge with sandy substrate associated with scattered *Eucalyptus decorticans* with a grassy ground layer dominated by *Cleistochloa* sp. (Atlas of Living Australia 2014).

At Baffle Creek, the species was identified in open woodland amongst sandstone boulders between the base of the cliffline and the north side of creek in heavy shade (Atlas of Living Australia 2014).

9.5.2.5 Biology and reproduction

The primary mechanism for pollen dispersal in *Bertya opponens* is probably wind given that the flowers lack chemical and colour attractants and the styles and anthers are exposed. However, European honeybees have been observed visiting *Bertya opponens* flowers (NPWS 2002a).

Flowering is generally believed to occur between July and August (Harden 1990), although timing is more dependent on the individual site characteristics and it has been observed flowering as early as June (NPWS 2002a).

9.5.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.5.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.5.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.6 *Cadellia pentastylis*

9.6.1 Status

Vulnerable – listed 16 July 2000

9.6.2 Biology and ecology

9.6.2.1 Characteristics

Cadellia pentastylis (Ooline) is a tree to 10 m (occasionally 25 m) high with a bushy crown and dark grey bark which is hard and fissured (Threatened Species Scientific Committee (TSSC) 2008b; Santos 2007). Leaves are alternate, simple (undivided) on short hairy stalks (petioles) which are 2 to 7 mm long, glossy (including when juvenile), green on top, paler and dull underneath. The leaf blades are obovate (egg-shaped) to elliptical usually 1 cm to 7 cm long and 1.5 cm to 2 cm wide with broad rounded tips. Veins are prominent on both sides when dry (TSSC 2008b; Harden et al 2006).

The flowers are single with five petals and approximately 20 mm in diameter. Flowers are usually white in colour, but may also appear greenish or reddish. The main flowering period is usually between October and November, but the timing of flower may vary depending on environmental factors (TSSC 2008b; Santos 2007). Fruit is brownish in colour with a wrinkled surface. Fruit are presented in a cluster of 3 to 5 balls (drupes) at the centre of the old flower. Each segment is 3 to 5 mm long and contains a single, hard-coated seed (Santos 2007).



Plate 6: *Cadellia pentastylis* (Source: Stark 2014)

9.6.2.2 Distribution

The range of *Cadellia pentastylis* extends from the western edge of the New South Wales north-west slopes, from Mt Black Jack near Gunnedah to west of Tenterfield into Queensland to the Carnarvon Range and Callide Valley, south-west of Rockhampton (TSSC 2008b).

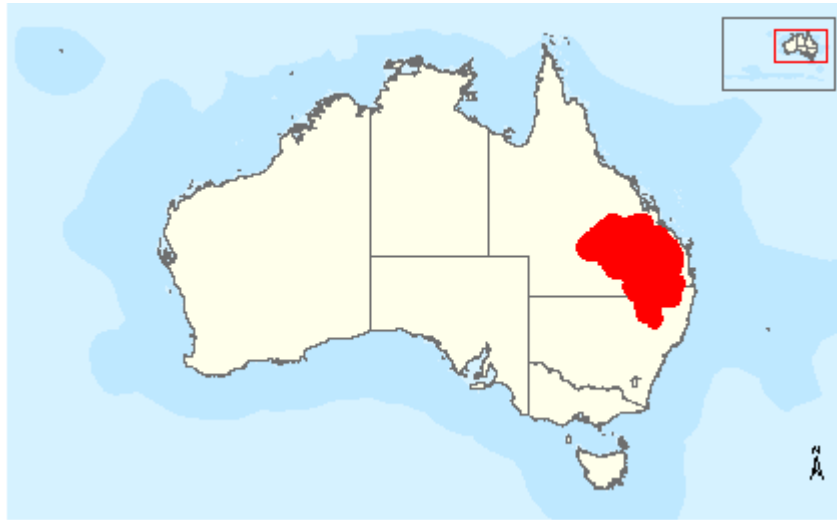


Figure 9: Mapped distribution range of *Cadellia pentastylis* (Source: DSEWPac 2011c)

9.6.2.3 Known species populations within the CSG fields

Cadellia pentastylis has been observed within the Scotia and Arcadia gas fields. Further ecological surveys are required to confirm additional locations within the fields.

9.6.2.4 Habitat

Ooline occurs in a range of vegetation types, and often associates with *Acacia harpophylla* (Brigalow), *Casuarina cristata* (Belah), *Acacia catenulata* (Bendee) and *Lysiphyllum carronii* (Red bauhinia) species in dry rainforest, semi-evergreen vine thicket and sclerophyll communities. *Cadellia pentastylis* may be observed as the locally dominant species within such communities. This species is found on clay plains, sandstone slopes, and ridgelines between 200 and 500 m above sea level, often on the moderately fertile soils preferred for agriculture and pasture development (TSSC 2008b; Santos 2007).

9.6.2.5 Biology and reproduction

The primary flowering period for *Cadellia pentastylis* in Queensland is October through to November, although the intensity and timing of flowering often varies between years (Santos 2007). Fruiting has been recorded between November and December. Dispersal of seed is likely to occur as a result of “passive fall” or from birds. Seeds show a high rate of infertility, although they have been successfully germinated using heat application (TSSC 2008b). *Cadellia pentastylis* has the capacity to resprout and coppice, hence the number of genetic individuals in some stands may be much lower than the number of stems present (NSW Scientific Community 1998).

9.6.3 **Anticipated threats and potential impacts from the Project**

Threats affecting this species from gas field development are outlined in Section 6.0.

9.6.4 **Anticipated impact from the Project**

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area

will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.6.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.7 *Calytrix gurulumundensis*

9.7.1 Status

Vulnerable – listed 16 July 2000

9.7.2 Biology and ecology

9.7.2.1 Characteristics

Calytrix gurulumundensis is a shrub up to two metres tall, with cream to yellow star-shaped flowers that have also been recorded as white or pinkish-white (ANPS 2008; Craven 1987). The species, like many *Calytrix* species, has fine hairs (awns) that extend beyond the petals (ANPS 2008) and there can be up to 60 to 70 stamens in each flower. Leaves are linear and 4 to 11 mm long, 0.5 to 1 mm wide and aromatic when crushed (Craven 1987).



Plate 7: *Calytrix gurulumundensis* (Source: Clarke n.d)

9.7.2.2 Known distribution

Restricted to south-eastern Queensland, *Calytrix gurulumundensis* is known from the Gurulmundi, Guluguba and Barakula areas (QDNR 2000), north-west of Toowomba (ANPS 2008).

The extent of occurrence of *Calytrix gurulumundensis* is less than 100 km² (Briggs & Leigh 1996).



Figure 10: Mapped distribution range of *Calytrix gurulmundensis* (Source: DOTE 2014g)

9.7.2.3 Known species populations within the CSG fields

Calytrix gurulmundensis is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.7.2.4 Habitat

The species is recorded as occurring in open shrubland with sparse, stunted *Eucalyptus*, *Casuarina* and *Acacia* spp. and in *Triodia* hummock grassland with scattered shrubs (Craven 1987; QDNR 2000). The habitat at Gurulmundi State Forest is consistent with Queensland Regional Ecosystem Shrubland Community RE11.7.5 (Unidel 2009). At this site, grader activity is suggested to have moved the species along tracks so that its distribution covers an area of several square kilometres. Plants are stated to be denser in sunlit areas than in shade, suggesting the species is tolerant of disturbance but shade sensitive (Unidel 2009).

This species grows on the tops of low, heavily eroded, laterised sandstone ridges on Tertiary formations. The soils are well-drained, usually shallow and either gravelly, sandy clay or sandy in texture (QDNR 2000).

9.7.2.5 Biology and reproduction

Flowers are recorded from June to October (QDNR 2000).

9.7.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.7.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area

will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.7.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.8 *Daviesia discolor*

9.8.1 Status

Vulnerable – listed 16 July 2000

9.8.2 Biology and ecology

9.8.2.1 Characteristics

Daviesia discolor, Family Fabaceae, is a multi-stemmed shrub to 2 m tall with hairless, angular branchlets. Phyllodes are spirally arranged, more or less sickle-shaped, tapered to both ends, 4 to 16 cm long, 4 to 11 mm wide, thin and green. Flowers are in inflorescences borne in the angles between the upper phyllodes and branchlets. Inflorescences are 3 to 8 flowered, the axis 2.5 to 10 mm long. Flowers are of a typical “pea” form with a large petal at the back (the standard), two smaller lateral petals (wings) and two inner petals fused together to form the keel. The standard is yellow with dull red markings surrounding an intense yellow spot in the centre. Wings are yellow towards the apex, dull red towards the base. The keel is pale green with a dull red tip. Pods are 7 to 8.5 mm long, 5.5 to 6 mm wide, lead grey or purple. Flowering occurs from August to October (Crisp 1991).

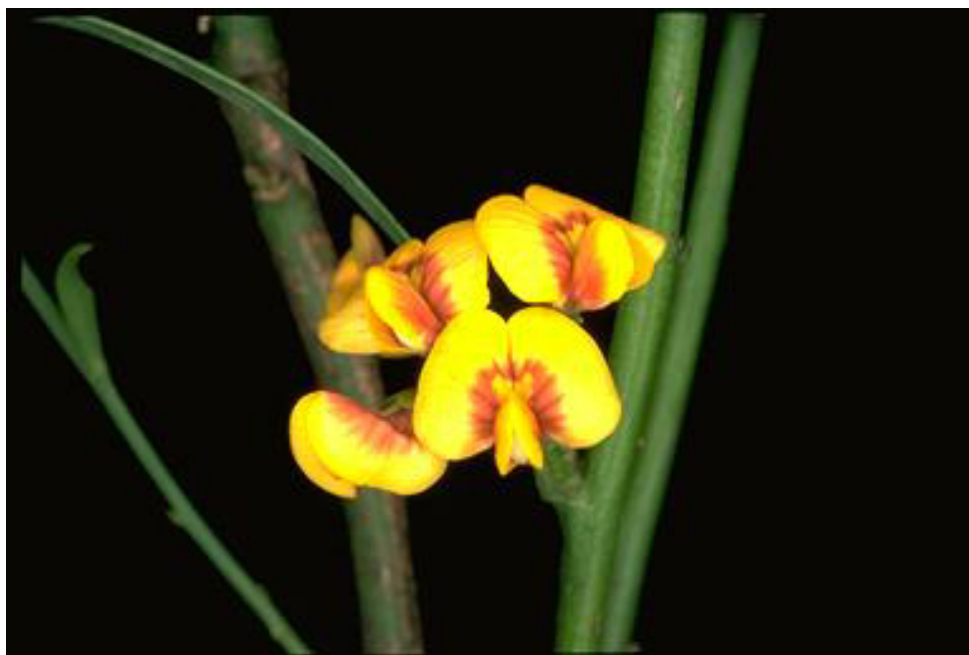


Plate 8: *Daviesia discolor* (Source: Hotchkiss n.d)

9.8.2.2 Known distribution

Daviesia discolor is known from three widely disjunct localities in Queensland, near Blackwater on the Blackdown Tableland, in the Mount Walsh area near Biggenden (Crisp 1991) and north of Mount Playfair within Carnarvon National Park (TSSC 2008o).

The species is conserved within Blackdown Tableland National Park (Briggs & Leigh 1996), Mount Walsh National Park (Halford 1998) and Carnarvon National Park. Surveys in the Mount Walsh area in 1997 indicated that there were two populations, at Mount Walsh National Park and State Forest 1344, with a combined total of about 17,800 plants over an area of 2.5 ha, all being mature individuals to 1.5

m tall (Halford 1998). The Mount Walsh National Park population contained approximately 90% of the total population (Halford 1998). There are no survey data available for the Blackdown Tableland area but herbarium notes indicate that the species was regarded as locally common when collected in the area in 1977, 1990 and 1997 (TSSC 2008o). No data are available on the size of the population in Carnarvon National Park. This species occurs within the Fitzroy and Burnett Mary (Queensland) Natural Resource Management Regions (TSSC 2008o).

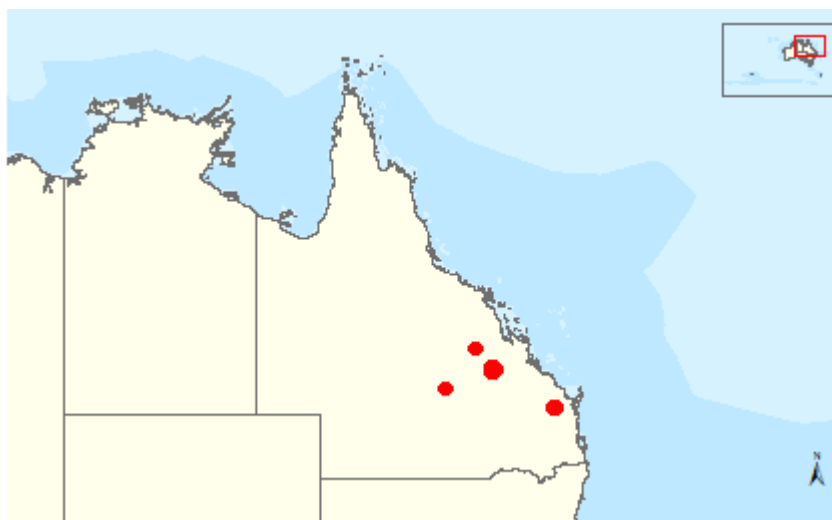


Figure 11: Mapped distribution range of *Daviesia discolor* (Source: DOTE 2014h)

9.8.2.3 Known species populations within the CSG fields

Daviesia discolor is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.8.2.4 Habitat

On the Blackdown Tableland, *Daviesia discolor* occurs on sandy soil derived from sandstone and on lateritic clay, at altitudes of 600 to 900 m, in open eucalypt forest dominated by species such as Blackdown stringybark (*Eucalyptus sphaerocarpa*) and Black stringybark (*Eucalyptus nigra*) (Crisp 1991). In the Mount Walsh area, *Daviesia discolor* grows in very tall open forests of Bloodwood (*Corymbia trachyphloia*) and White mahogany (*Eucalyptus acmenoides*) on hillcrests and slopes at 500 to 580 m altitude on well-drained, shallow sandy loam to sandy clays (Halford 1998). The population in Carnarvon National Park occurs on brown sandy loam of creek banks, in mixed shrubland with scattered *Triodia* sp. hummocks and *Angophora* sp. trees (TSSC 2008o).

The distribution of this species overlaps with the Brigalow (*Acacia harpophylla* dominant and co-dominant) EPBC Act-listed threatened ecological community (TSSC 2008o).

9.8.2.5 Biology and reproduction

Flowering of *Daviesia discolor* occurs from August to October and seed pods have been recorded in October (Queensland Herbarium 2012).

9.8.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.8.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.8.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.9 *Dichanthium queenslandicum*

9.9.1 Status

Endangered - listed 26 February 2013

9.9.2 Biology and ecology

9.9.2.1 Characteristics

Dichanthium queenslandicum (King bluegrass) is a perennial, tufted, erect grass up to 80 cm tall. Clumes rarely branched, nodes bearded (Stanley & Ross 1989). Leaf sheaths with long spreading tubercular-based hairs; ligules up to 1.5 mm long; leaf blades linear, apex attenuate, with long spreading tubercular-based hairs (Stanley & Ross 1989). Racemes solitary, rarely paired, up to 10 cm long, rachis and pedicels with long spreading hairs; sessile spikelet 7.5 to 8.5 mm long, lower glume as long as spikelet, glabrous, scabrid on margin, upper glume as long as spikelet, glabrous (Stanley & Ross 1989).



Plate 9: *Dichanthium queenslandicum* (Source: Queensland Herbarium 2002)

9.9.2.2 Distribution

This species is endemic to Queensland where it is usually observed in black clay soils around the Darling Downs, Leichhardt and Port Curtis pastoral districts (Stanley & Ross 1989; Sharp & Simon 2002).

Dichanthium queenslandicum occurs within the South Eastern Queensland, Brigalow Belt South, Brigalow Belt North, Central Mackay Coast, Desert Uplands, Mitchell Grass Downs and Einasleigh Uplands Bioregions; and the South East Queensland, Condamine, Border Rivers Maranoa-Balonne, Burnett Mary, Fitzroy, Burdekin, Mackay Whitsunday, Southern Gulf and Desert Channels Natural Resource Management Regions (TSSC 2008t).

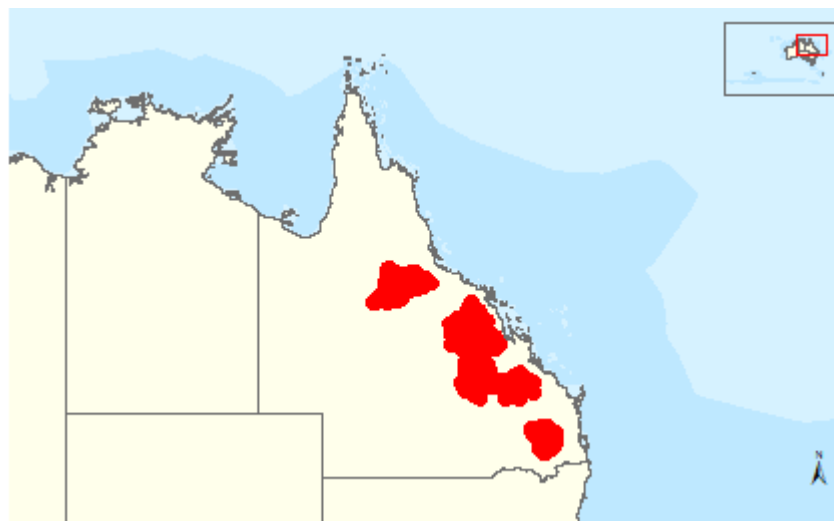


Figure 12: Mapped distribution range of *Dichanthium queenslandicum* (Source: DSEWPaC 2011e)

9.9.2.3 Known species populations within the CSG fields

Dichanthium queenslandicum has been observed within the Arcadia gas fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.9.2.4 Habitat

Dichanthium queenslandicum occurs on black cracking clay in tussock grasslands mainly in association with other species of blue grasses (*Dichanthium* spp. and *Bothriochloa* spp.) but also with other grasses restricted to this soil type (Fletcher 2001; Simon 1982). *Dichanthium queenslandicum* is mostly confined to natural grassland on the heavy black clay soils (basalt downs, basalt cracking clay, open downs) on undulating plains. Other communities where *Dichanthium queenslandicum* can be found include *Acacia salicina* thickets in grassland and eucalypt woodlands (ie *Corymbia dallachiana*, *Corymbia erythrophloia*, *Eucalyptus orgadophila*) (Fensham 1999; Queensland Herbarium 2012).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Weeping Myall Woodlands
- Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and southern Queensland
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (TSSC 2008t)

9.9.2.5 Biology and reproduction

Sessile spikelet is bisexual, dorsally compressed and straw-coloured to pale mauve. Pedicelled spikelets are male, straw-coloured to pale mauve (Sharp & Simon 2002).

9.9.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.9.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.9.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.10 *Dichanthium setosum*

9.10.1 Status

Vulnerable – listed 16 July 2000

9.10.2 Biology and ecology

9.10.2.1 Characteristics

Dichanthium setosum (Bristly bluegrass) is an upright perennial grass to 1 m tall, with mostly hairless leaves 2 to 3 mm wide. The flowers are densely hairy and clustered together along a cylinder shape stalk (TSSC 2008d).



Plate 10: *Dichanthium setosum* (Source: Queensland Herbarium 2002)

9.10.2.2 Distribution

In Queensland, this species has been recorded from the Leichhardt, Moreton, North Kennedy and Port Curtis pastoral districts.

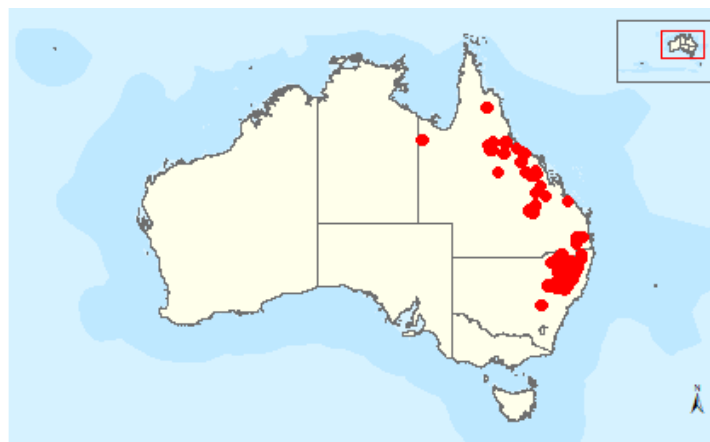


Figure 13: Mapped distribution range of *Dichanthium setosum* (Source: DSEWPac 2011f)

9.10.2.3 Known species populations within the CSG fields

Dichanthium setosum is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.10.2.4 Habitat

Dichanthium setosum is associated with heavy basaltic black soils and stony red-brown loam with clay subsoil and has been observed in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pastures (TSSC 2008d).

9.10.2.5 Biology and reproduction

The flowers are densely hairy and clustered together along a cylinder shape stalk and appear mostly during summer. The species can form pure swards or occur as scattered clumps (TSSC 2008d).

9.10.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.10.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.10.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.11 *Eucalyptus beaniana*

9.11.1 Status

Vulnerable – listed 16 July 2000

9.11.2 Biology and ecology

9.11.2.1 Characteristics

Eucalyptus beaniana, Family Myrtaceae, is a medium sized tree 14 to 22 m high. The bark is persistent on the trunk and most branches, being hard, grey to black, and longitudinally furrowed (an ironbark). Branches less than about 4 cm in diameter are smooth and white. The adult leaves are narrowly lance-shaped, 8 to 15 mm wide, somewhat pendulous, the same colour on both sides. The flowers occur in terminal clusters and flower buds are egg-shaped, 6 to 7 mm long and 2 to 3 mm wide, with stalks. The fruit is cup-shaped or funnel-shaped, 5 to 6 mm long, with 4 or 5 cavities, and the valves are at rim level or protruding (Brooker & Kleinig 2004).

Eucalyptus beaniana is closely related to *Eucalyptus taurina*, but differs by the linear juvenile leaves, the fruits with valves scarcely exerted, the narrower adult leaves and greater amount of smooth bark on the branches (TSSC 2008p).

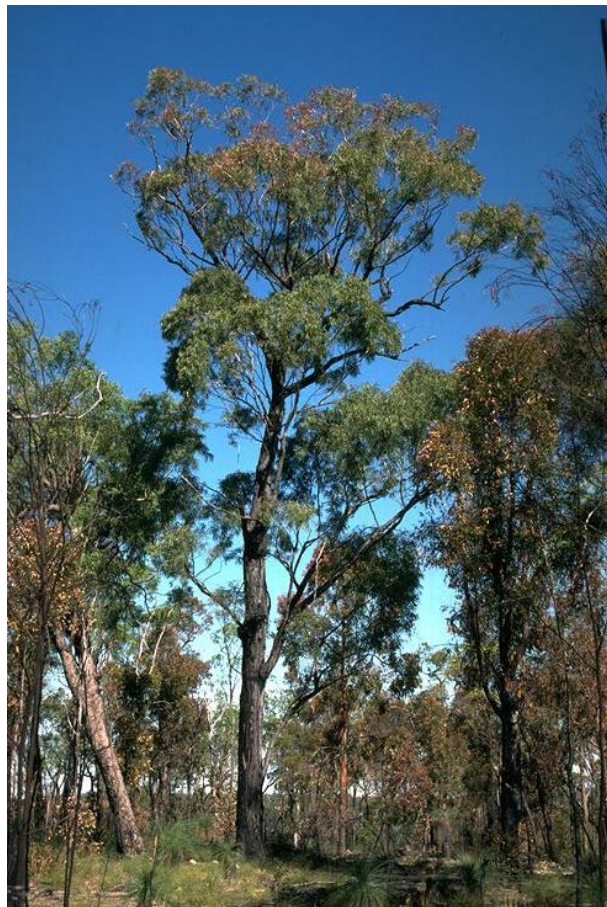


Plate 11: *Eucalyptus beaniana* (Source: Brooker & Kleinig n.d)

9.11.2.2 Known distribution

Eucalyptus beaniana is known only from two locations at Isla Gorge and north-east of Baroondah station, Queensland. The total number of plants is unknown. This species occurs within the Fitzroy (Queensland) Natural Resource Management Region (TSSC 2008p).



Figure 14: Mapped distribution range of *Eucalyptus beaniana* (Source: DOTE 2014i)

9.11.2.3 Known species populations within the CSG fields

Eucalyptus beaniana is known to occur in the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.11.2.4 Habitat

Eucalyptus beaniana grows in woodland with numerous other eucalypt species, on quartzose sandstone ridges. Soils are shallow and sandy (Queensland Herbarium 2008c). All populations occur in areas of remnant vegetation and are therefore currently protected from broad-scale clearing (TSSC 2008p).

The distribution of *Eucalyptus beaniana* overlaps with the following EPBC Act-listed threatened ecological communities:

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (TSSC 2008p)

9.11.2.5 Biology and reproduction

Very little is known about the life history of *Eucalyptus beaniana*. The species flowers in September and fruits have been recorded in April, June and September to November (Queensland Herbarium 2008).

9.11.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.11.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.11.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.12 *Homopholis belsonii*

9.12.1 Status

Vulnerable – listed 16 July 2000

9.12.2 Biology and ecology

9.12.2.1 Characteristics

Homopholis belsonii (Belson's panic) is an erect perennial grass growing up to 40 cm tall (Stanley & Ross 1989). Leaves with ligule up to 1.5 mm long; blade 2 to 4.5 mm wide, glabrous (Stanley & Ross 1989). Inflorescence not fully exerted, common axis 8 to 15 cm long; primary branches 8 to 15 cm long, with hairy axils (TSSC 2008f).

Panicles up to 25 cm long, up to 20 cm broad, with primary and secondary branching; spikelets 4.5 to 6 mm long; lower glume with sparse minute hairs, upper glume minutely hairy (Stanley & Ross 1989).

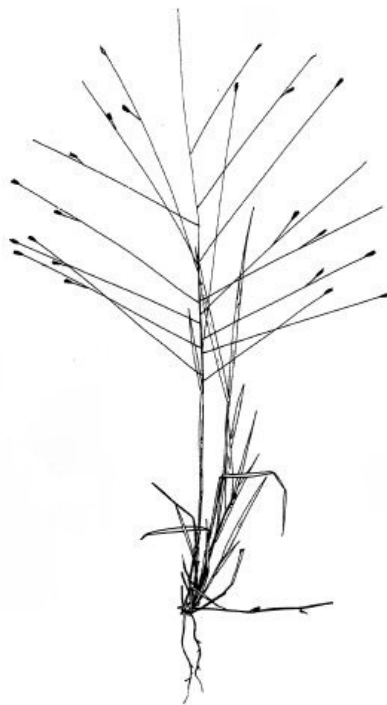


Plate 12: *Homopholis belsonii* (Source: Tropical Grassland Society of Australia Inc 1996)

9.12.2.2 Distribution

In Queensland, this species is known to occur within the southern Brigalow Belt within the Border Rivers Maranoa–Balonne and Condamine (Queensland) Natural Resource Management Regions and has been recorded as far west as the area between Miles and Roma (TSSC 2008f).



Figure 15: Mapped distribution range of *Homopholis belsonii* (Source: DSEWPac 2011h)

9.12.2.3 Known species populations within the CSG fields

This species is known to occur within the Roma gas fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.12.2.4 Habitat

Homopholis belsonii is usually found in dry woodland habitats at elevations ranging from 200 to 520 m altitude including rocky hills supporting White box (*Eucalyptus albens*) and in Wilga (*Geijera parviflora*) woodland; flat to gently undulating alluvial areas supporting Belah (*Casuarina cristata*) forest; soils and plant communities of Poplar box (*Eucalyptus populnea*) woodlands and shadier areas of Brigalow (*Acacia harpophylla*), Yarran (*Acacia melvillei*), and Weeping myall (*Acacia pendula*) communities; in Mountain coolibah (*Eucalyptus orgadophila*) communities; and on roadsides (TSSC 2008f). Within these habitats, the species is associated with fallen timber at the base of trees or shrubs, among branches and leaves of trees hanging to ground level or along the bottom of netting fences (TSSC 2008f).

9.12.2.5 Biology and reproduction

Homopholis belsonii is proposed to have the ability to recolonise cleared or a highly disturbed area as it has been found in regenerating vegetation along roadsides (Menkins 1998).

Flowering occurs February to May (Sharp & Simon 2002) and possibly November to December as fruiting has been recorded in February (Leigh *et al* 1984). The exact viability time for seeds is not known. However, initial trials have indicated that it germinates readily without the need for a dormancy period (Menkins 1998; Trémont & Whalley 1993). Dispersal of seed occurs when the panicle dries after seed formation and breaks off in the wind. The wind causes the panicle to migrate forward in a continuous rolling motion until an obstacle is encountered (Menkins 1998). Menkins (1998) suggests that the seed is then discarded with the further drying of the panicle.

9.12.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.12.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.12.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.13 *Homoranthus decumbens*

9.13.1 Status

Endangered – listed 26 February 2013

9.13.2 Biology and ecology

9.13.2.1 Characteristics

Homoranthus decumbens, Family Myrtaceae, is a shrub growing to 15 cm high and 2 m across. Leaves are opposite, lacking a distinct leaf stalk and are whitish-green when growing then change to reddish-brown. Flowers occur singularly in the leaf axils (Craven & Jones 1991).

H. decumbens is similar to *H. melanostictus* which also occurs in the Barakula State Forest. Both have small linear leaves and their yellow flowers are of about the same size. *H. decumbens* differs by the purplish foliage and the procumbent habit (TSSC 2013).



Plate 13: *Homoranthus decumbens* (Source: © plant.nerd 2010)

9.13.2.2 Known distribution

Homoranthus decumbens is endemic to Queensland, where it is known from two areas: Blackdown Tableland and Barakula State Forest (Queensland Herbarium 2009). The extent of occurrence is 3 km² and area of occupancy is estimated to be less than 1 km² (Queensland Herbarium 2009).

This species occurs within the Brigalow Belt South Bioregion and the Condamine and Fitzroy Natural Resource Management Regions (TSSC 2013).

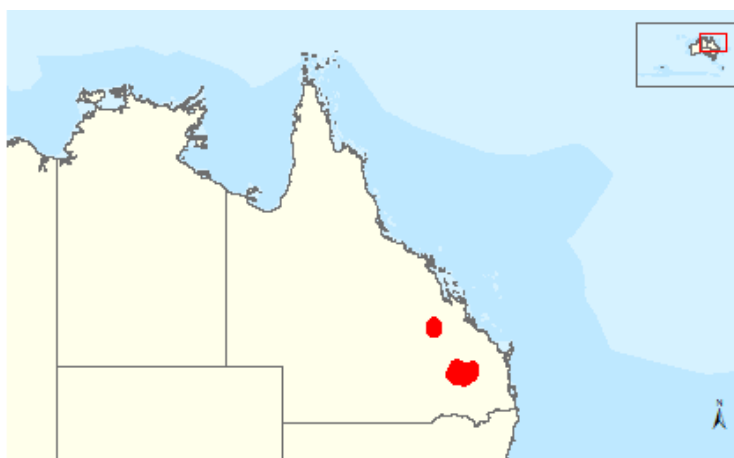


Figure 16: Mapped distribution range of *Homoranthus decumbens* (Source: DOTE 2014j)

9.13.2.3 Known species populations and their relationship within the CSG fields

Homoranthus decumbens is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.13.2.4 Habitat

The species is found in tall shrubland or heath up to 800 m in altitude. It occurs on the edges of sandstone cliffs or in shallow sandy soil containing lateritic pebbles, and is often associated with species such as *Goodenia racemosa*, *Petrophile* spp. (Cone bush), *Xanthorrhoea* spp. (Grasstree) and *Banksia oblongifolia* (Dwarf banksia) (Wang 1995).

The distribution of this species is not known to overlap with any EPBC Act-listed threatened ecological community (TSSC 2013).

9.13.2.5 Biology and reproduction

Homoranthus decumbens flowers from September to December. There is no information available on its fruiting period (Wang 1995).

9.13.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.13.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.13.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.14 *Macrozamia platyrhachis*

9.14.1 Status

Endangered – listed 16 July 2000

9.14.2 Biology and ecology

9.14.2.1 Characteristics

Macrozamia platyrhachis has mature leaves that number two to eight in the crown, are erect, or reclining with the ends ascending, 45 to 80 cm long. The leaf stalk is 9 to 13 mm wide at the top (at first leaflet). Leaflets are usually 10 to 20 mm wide, mid-green and glossy above, paler green beneath. Male cones are quadrangular in cross section, 10 to 23 cm long, 2.7 to 4.5 cm diameter and straight or slightly curved with age. Female cones are oval-shaped, 12 to 17 cm long, 8 to 9 cm wide and mid-green. Seeds are 22 to 28 mm long, 18 to 25 mm wide and red when ripe (Queensland Herbarium 2007).



Plate 14: *Macrozamia platyrhachis* (Source: Dowling n.d.)

9.14.2.2 Known distribution

Macrozamia platyrhachis has a restricted distribution in the Blackdown Tableland – Planet Downs area of the Dawson Range in central Queensland. There are also historical records from the Ceres Holding south-east of Springsure (1973) and from Spring Creek (1972), but these populations have not yet been relocated. The total area of occupancy is estimated to be less than 400 ha. It is found in at least 12 populations within a latitudinal and longitudinal range of about 40 x 40 km and is both more widespread and more common than previously thought (Whitelock 2002).

The 12 populations of *Macrozamia platyrhachis* have a projected number of individuals between 1,000 and 198,000 individuals. Adult plants may be densely distributed with a large number of individuals in close proximity to one another, or may consist of solitary individuals. All populations are considered to be viable in the long-term (Queensland Herbarium 2007).

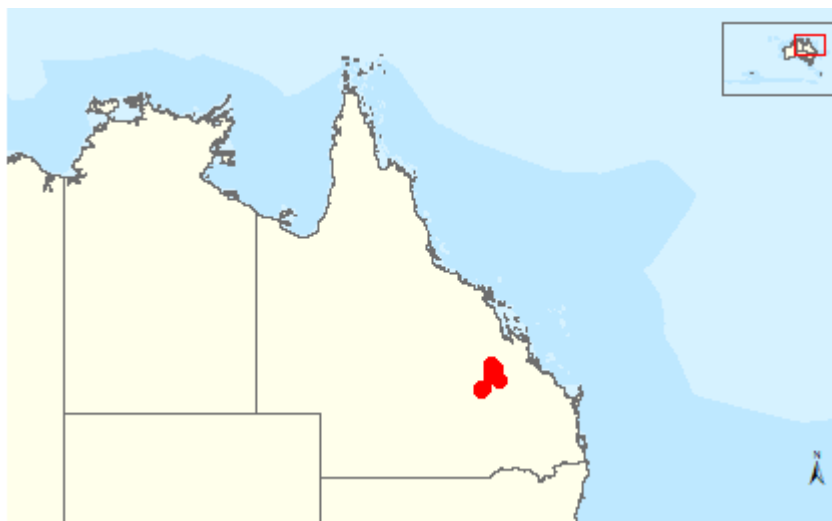


Figure 17: Mapped distribution range of *Macrozamia platyrhachis* (Source: DOTE 2014I)

9.14.2.3 Known species populations within the CSG fields

Macrozamia platyrhachis is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.14.2.4 Habitat

Populations of *Macrozamia platyrhachis* are found in eucalypt woodland or open forest. Dominants include *Angophora leiocarpa*, *Corymbia bunites*, *Corymbia citriodora* subsp. *citriodora*, *Corymbia hendersonii*, *Corymbia watsoniana*, *Eucalyptus baileyana*, *Eucalyptus cloeziana*, *Eucalyptus crebra*, *Eucalyptus melanoleuca*, *Eucalyptus suffulgens*, *Lophostemon suaveolens* and *Lysicarpus angustifolius* on deep sandy soils derived from sandstone at altitudes between 300 and 780 m. The mid- and under-stories of the vegetation may be quite dense, but this is variable depending on fire history (Queensland Herbarium 2007).

9.14.2.5 Biology and reproduction

Macrozamia platyrhachis is unusual in being pollinated by *Cycadothrips* thrips in a mutualistic relationship, a trait shared with *Macrozamia farnsidei* (Queensland Herbarium 2007).

Seed becomes ripe in March to April. As with all *Macrozamia* species, the fresh seed is not ready to germinate for another 12 months, due to the delayed fertilisation process unique to cycads (Norstog & Nicholls 1997).

Limited dispersal of ripe seeds from cycad species may occur via mammals such as possums, rodents or fruit bats. Although cycad seeds are brightly coloured, they are highly toxic and few vertebrate dispersers of seed or fruit of a similar size to cycad seed now exist in Australia (Queensland Herbarium 2007)

There is limited information on the dispersal or recruitment levels of *Macrozamia platyrhachis* (Queensland Herbarium 2007).

9.14.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.14.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.14.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.15 *Phaius australis*

9.15.1 Status

Endangered – listed 16 July 2000

9.15.2 Biology and ecology

9.15.2.1 Characteristics

Phaius australis (Lesser swamp-orchid) is a terrestrial (ground dwelling) orchid and produces the largest flowers of any Australian orchid (QLD EPA & QPWS 2006). The species has four to eight large, pleated leaves and one to two spikes (flower stalks). The leaves of this orchid are long (approximately 70 cm), relatively narrow (3 to 10 cm wide) and are very similar to the other swamp-orchids (Benwell 1994). The flowers grow on the top of stalks that are 70 to 110 cm long and, unlike the other swamp orchids, are red-brown with yellow veins inside the flower (NH NSW 2006). The flowers are perfumed and are 10 to 15 cm across (QLD EPA & QPWS 2006).



Plate 15: *Phaius australis* (Source: Woodard 2010)

9.15.2.2 Known distribution

Phaius australis is endemic to Australia and occurs in southern Queensland and northern NSW. The distribution of *Phaius australis* has been tentatively described as being north from Lake Cathie (near Port Macquarie), but mainly north of the Evans Head area to the Barron River in north-east Queensland, although it is rare in the latter region (only one or two records) and the populations are now thought to be destroyed (Benwell 1994).

Most populations of *Phaius australis* are sporadically distributed between Coffs Harbour and Fraser Island. There is a large discontinuity in this species' range in central-eastern Queensland, between the Fraser Island populations and an isolated population at Byfield National Park. There is a further range disjunction between this latter population and the suspected former population in north-east Queensland (Benwell 1994).

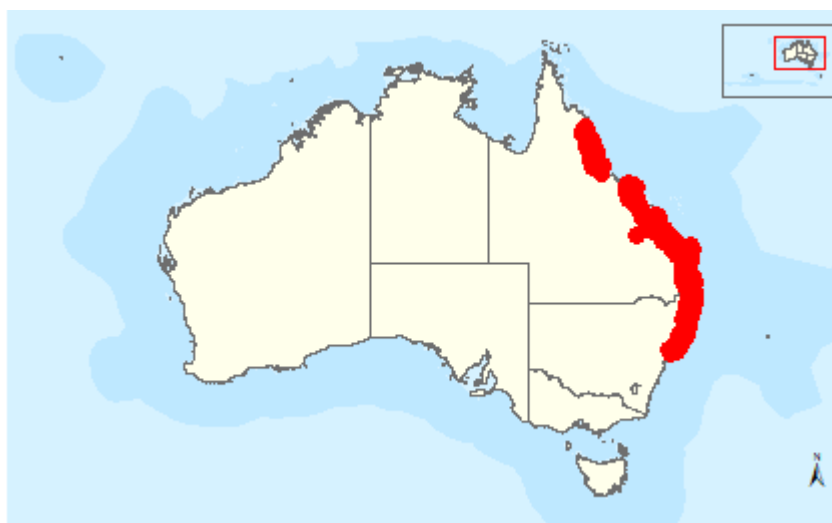


Figure 18: Mapped distribution range of *Phaius australis* (Source: DOTE 2014m)

9.15.2.3 Known species populations within the CSG fields

Phaius australis is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.15.2.4 Habitat

Phaius australis is commonly associated with coastal wet heath/sedgeland wetlands (Barry 2005), swampy grassland or swampy forest and often where Broad-leaved paperbark or Swamp mahogany are found (NH NSW 2006; Sparshott & Bostock 1993). Typically, *Phaius australis* is restricted to the swamp-forest margins, where it occurs in swamp sclerophyll forest (Broad-leaved paperbark/Swamp mahogany/Swamp box (*Lophostemon suaveolens*)), swampy rainforest (often with sclerophyll emergents), or fringing open forest. It is often associated with rainforest elements such as Bangalow palm (*Archontophoenix cunninghamiana*) or Cabbage tree palm (*Livistona australis*) (Benwell 1994; Bishop 1996; Weston in Harden 1993).

This orchid species is relatively adaptable in its requirements for light and soil type. Soils range from acidic waterlogged peat, with a pH of 4.2 to peaty-sand, with a pH of 7.0 (Sparshott & Bostock 1993). Soil parent materials include marine aeolian sand, the most common substrate, alluvium, granite, metasediments, hailstone gravel and sandstone. Soil types on sand range from shallow peat to humus/groundwater podzol (Benwell 1994b; Bishop 1996; Harden 1993).

9.15.2.5 Biology and reproduction

Phaius australis flowers in spring (September to November) and can reproduce sexually (by pollination) (Field 2006) and asexually (by dormant buds along the flower spikes). Although vegetative reproduction is thought to occur only infrequently in the wild, it is common in cultivation (Sparshott & Bostock 1993). Most flowers of *Phaius australis* set fruit (Benwell 1994) and like most orchids, thousands of tiny seeds may be produced within each fruit (1992; Sparshott & Bostock 1993).

Information on the pollination biology of this species is limited, but it is thought that members of this genus are pollinated by bees (Benwell 1994). Other members of the genus *Phaius* have a 'rostellum', a structure that acts like a cap and prevents the male and female parts of an individual flower coming into contact, but is removed by the pollinator to enable cross-pollination. *Phaius australis* lacks this cap

and it is possible that the abundant fruit set of this species is indicative of self pollination (Benwell 1994).

9.15.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.15.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.15.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.16 *Swainsona murrayana*

9.16.1 Status

Vulnerable – listed 16 July 2000

9.16.2 Biology and ecology

9.16.2.1 Characteristics

Swainsona murrayana (Slender darling pea) is a slender herb to 25 cm tall. Leaves are 5 to 10 cm long and grow on a slender stem with dense hairs (TSSC 2008h). It has pink or purple flowers and produces leathery elliptical seed pods 20 to 65 mm long (TSSC 2008h).



Plate 16: *Swainsona murrayana* (Source: Knight 2005)

9.16.2.2 Distribution

In Queensland the species is known from near Surat in the Border Rivers Maranoa-Balonne catchment (TSSC 2008h).

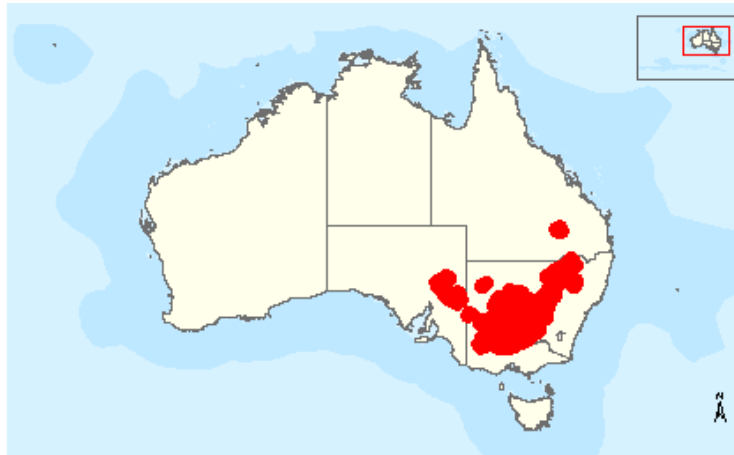


Figure 19: Mapped distribution range of *Swainsona murrayana* (Source: DSEWPac 2011j)

9.16.2.3 Known species populations within the CSG fields

This species is predicted to occur and suitable habitat is present within the CSG fields. Therefore, this species has a moderate likelihood of occurring. Ecological surveys are required to confirm exact locations within all relevant fields.

9.16.2.4 Habitat

Swainsona murrayana is found in grassland, herbland, and open Black-box woodland, often in depressions. This species grows in heavy grey or brown clay, loam, or red cracking clays. It is often associated with low Chenopod shrubs (*Maireana* spp.), Wallaby-grass (*Austrodanthonia* spp), and Spear grass (*Austrostipa* spp). The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (TSSC 2008h).

9.16.2.5 Biology and reproduction

Swainsona murrayana has pink or purple flowers, which appear between spring and early summer. It produces leathery elliptical seed pods 20 to 65 mm long (TSSC 2008h).

9.16.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.16.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.16.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.17 *Thesium australe*

9.17.1 Status

Vulnerable – listed 16 July 2000

9.17.2 Biology and ecology

9.17.2.1 Characteristics

Thesium australe (Austral toadflax) is a hairless, yellowish-green perennial herb with slender, wiry stems to 40 cm high and tiny, white flowers (George 1984; Harden 1992).



Plate 17: *Thesium australe* (Source: Office of Environment and Heritage n.d.)

9.17.2.2 Known distribution

Thesium australe occurs in New South Wales, the Australian Capital Territory, Queensland and Victoria (Scarlett *et al* 2003; NSW OEH 2013). Its current distribution is sporadic but widespread, occurring between the Bunya Mountains in south-east Queensland to north-east Victoria (Scarlett *et al* 2003) and as far inland as the southern, central and northern tablelands in New South Wales and the Toowoomba region (ALA 2012). There is an outlier in Carnarvon National Park on the Consuelo Tableland of the southern Brigalow Belt (ALA 2012). It had been recorded once in Tasmania from the Derwent River valley in 1804, but is considered extinct in the state (TAS DPIWE 2003). Many other previously known sites do not have recent records (ALA 2012; Leigh & Briggs 1984).

Thesium australe was considered extinct in Queensland prior to the mid-1980s (Griffith 1996). Collections since the 1990s have been made from Kumbia, Glen Rock Regional Park, Carnarvon National Park, Crows Nest, Clifton, Warwick, Greenmount, Cambooya, Dalby, the Bunya Mountains, Blackbutt and Imbil (ALA 2012). In the 1990s, the species was described as common at a site at Clifton and rare at sites at Mt Moffatt National Park, Bunya Mountains and Blackbutt (ALA 2012).



Figure 20: Mapped distribution range of *Thesium australe* (Source: DOTE 2014n)

9.17.2.3 Known species populations and their relationship within the CSG fields

Thesium australe is known to occur within the CSG fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.17.2.4 Habitat

Thesium australe is semi-parasitic on roots of a range of grass species, notably Kangaroo grass (*Themeda triandra*) (Scarlett *et al* 1994). It occurs in subtropical, temperate and subalpine climates over a wide range of altitudes. It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils including black clay loams to yellow podzolics and peaty loams (Leigh & Briggs 1984; Hunter *et al* 1999; Cohn 2004).

It occurs in shrubland, grassland or woodland, often on damp sites (George 1984; Harden 1992). Vegetation types include open grassy heath dominated by Swamp myrtle (*Leptospermum myrtifolium*), Small-fruit hakea (*Hakea microcarpa*), Alpine bottlebrush (*Callistemon sieberi*), Woolly grevillea (*Grevillea lanigera*), Coral heath (*Epacris microphylla*) and *Poa* spp. (Griffith 1991); Kangaroo grass grassland surrounded by *Eucalyptus* woodland; and grassland dominated by Barbed-wire grass (*Cymbopogon refractus*) (Leigh & Briggs 1984; Hunter *et al* 1999).

9.17.2.5 Biology and reproduction

Thesium australe flowers and fruits throughout the year on the coast and during summer at higher altitudes (Cohn 2004; Griffith 1996). In subalpine and tableland climates, the species dies back to rootstock during winter and resprouts in spring. In coastal areas the species persists all year round and may live for longer than two years (Cohn 2004).

The species appears to cope well with but does not require frequent disturbance. The existence of buds near the soil surface allows the species to resprout after disturbance. It is observed to germinate well after fire; however fire is not essential for germination (Scarlett *et al* 1994).

9.17.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.17.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.17.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.18 *Tylophora linearis*

9.18.1 Status

Endangered – listed 16 July 2000

9.18.2 Biology and ecology

9.18.2.1 Characteristics

Tylophora linearis, Family Asclepiadaceae, is an herbaceous climber with clear latex that grows to about 2 m long. The stems are cylindrical, up to 3 mm in diameter with internodes up to 100 mm long. Leaves are dark green, linear, up to 100 mm long and 4 mm wide and extra-floral nectaries are absent from the base of the leaf. Flowers are clustered in radiating groups of three to eight. Flowers are 6 to 22 mm in diameter, with petals olive-green externally, dark purple internally and with short hairs internally concentrated towards the tip. Fruits form follicles 95 to 100 mm long and 5 mm wide (Forster 1992; Forster *et al* 2004).



Plate 18: *Tylophora linearis* (Source: © Carr n.d.)

9.18.2.2 Known distribution

Tylophora linearis has rarely been collected and is known from eight localities in the Dubbo area and Mount Crow near Barraba in NSW, and “Myall Park” near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo State Forest, Pilliga West State Forest and Coolbaggie Nature Reserve (TSSC 2008r).



Figure 21: Mapped distribution range of *Tylophora linearis* (Source: DOTE 2014o)

9.18.2.3 Known species populations and their relationship within the CSG fields

This species is predicted to occur and suitable habitat is present within the CSG fields. Therefore, this species has a moderate likelihood of occurring. Ecological surveys are required to confirm exact locations within all relevant fields.

9.18.2.4 Habitat

Tylophora linearis grows in dry scrub, open forest and woodlands associated with *Melaleuca uncinata*, *Eucalyptus fibrosa*, *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Callitris endlicheri*, *Callitris glaucophylla*, *Allocasuarina luehmannii*, *Acacia hakeoides*, *Acacia lineata*, *Myoporum* spp. and *Casuarina* spp. (NSW OEH 2014; Forster et al 2004). This species occurs within the Border Rivers–Gwydir, Central West, Namoi (NSW), and Border Rivers Maranoa–Balonne (Queensland) Natural Resource Management regions (TSSC 2008r).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

9.18.2.5 Biology and reproduction

Flowers in spring, with flowers recorded in November or May with fruiting probably two to three months later (NSW OEH 2014).

9.18.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.18.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.18.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.19 *Westringia parvifolia*

9.19.1 Status

Vulnerable – listed 16 July 2000

9.19.2 Biology and ecology

9.19.2.1 Characteristics

Westringia parvifolia is a small 'twiggy' shrub that grows to approximately one metre in height, and has tiny oval shaped leaves 1.5 to 3 mm long, with slightly recurved margins. Leaves are arranged along the stem in groups of three forming a ring (whorl) at each node. Flowers are pale purple to white with reddish spots and occur in the upper leaf axils, forming a terminal leafy head of three to seven flowers. Young shoots and flowers are covered with small, white hairs pressed closely to the surface and the branchlets are often hexagonal (Boivin 1949; Galbraith 1977; White & Francis 1921).

9.19.2.2 Known distribution

Westringia parvifolia is known from four collections near Yelarbon, Inglewood and Goondiwindi in south-east Queensland and from near Yetman in northern New South Wales (BRI n.d.; The Royal Botanic Gardens and Domain Trust 2011). The distribution range is approximately 80 km (BRI n.d.; White & Francis 1921).

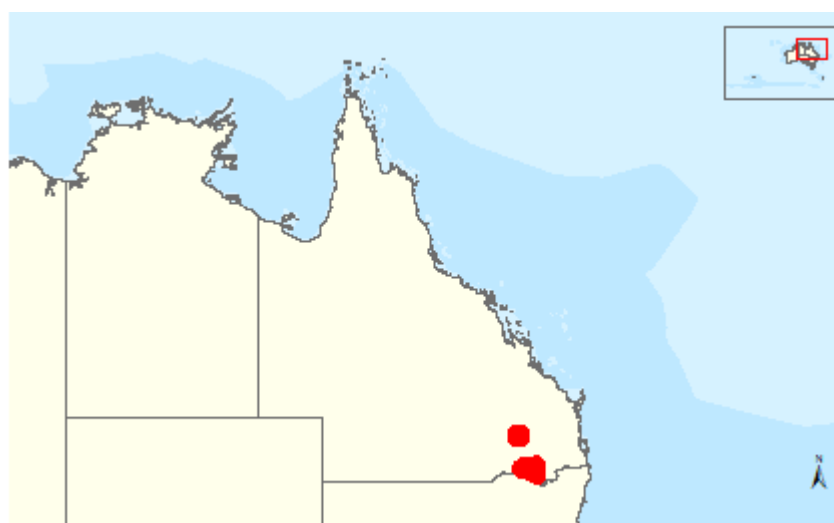


Figure 22: Mapped distribution range of *Westringia parvifolia* (Source: DOTE 2014p)

9.19.2.3 Known species populations within the CSG fields

This species is predicted to occur and suitable habitat is present within the CSG fields. Therefore, this species has a moderate likelihood of occurring. Ecological surveys are required to confirm exact locations within all relevant fields.

9.19.2.4 Habitat

Westringia parvifolia grows with Baker's mallee (*Eucalyptus bakeri*) and Green mallee (*Eucalyptus viridis*) and between clumps of Spinifex (*Triodia* sp.) on sandy and stony soils (BRI n.d.; White & Francis 1921).

9.19.2.5 Biology and reproduction

Flowering has been recorded in September and November (BRI n.d.).

9.19.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.19.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.19.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.20 *Xerothamnella herbacea*

9.20.1 Status

Endangered – listed 16 July 2000

9.20.2 Biology and ecology

9.20.2.1 Characteristics

Xerothamnella herbacea, Family Acanthaceae, is a sparse, sprawling, perennial herb growing to a height of 30 cm. Stems arise from a central point but can root at the nodes where they contact the soil. Leaves in opposite pairs are soft, linear to narrowly ovate in outline, dark green above and paler beneath. Flowers are small, bright pink to mauve, two lipped, to 6.5 mm long, and occur in the upper leaf axils (Barker 1986).



Plate 19: *Xerothamnella herbacea* (Source: Queensland Herbarium 2007)

9.20.2.2 Distribution

Xerothamnella herbacea is known from a site north-west of Theodore Brigalow Research Station, a site south-east of Medlow, at Burraburri Creek, west of Durong, at two sites north east of Chinchilla, at a site on the Millmerran-Goondiwindi road, north-east of Kindon and at a site near Yelarbon, east of Goondiwindi, Queensland (Atlas of Living Australia 2012).

This species occurs within the Condamine, Border Rivers Maranoa–Balonne and Fitzroy (Queensland) Natural Resource Management Regions (TSSC 2008i).

This species is not known to occur in any conservation reserves. Some of the known populations occur in cleared areas or non-remnant vegetation that are not protected under the *Vegetation Management Act 1999* (Queensland) (TSSC 2008i).

This distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities (TSSC 2008i):

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- White box-Yellow box-Blakely's red gum Grassy Woodland and Derived Native Grassland

In November 2011, *Xerothamnella herbacea* was identified at the Santos GLNG GTP ROW crossing location in Gratz Gully on Lonesome Holding, in the southern end of Arcadia Valley by Boobook Ecological Consulting (Boobook). Samples were sent to Queensland Herbarium for verification and the population at Gratz Gully represented a newly recorded and outlying location for the species in Queensland.

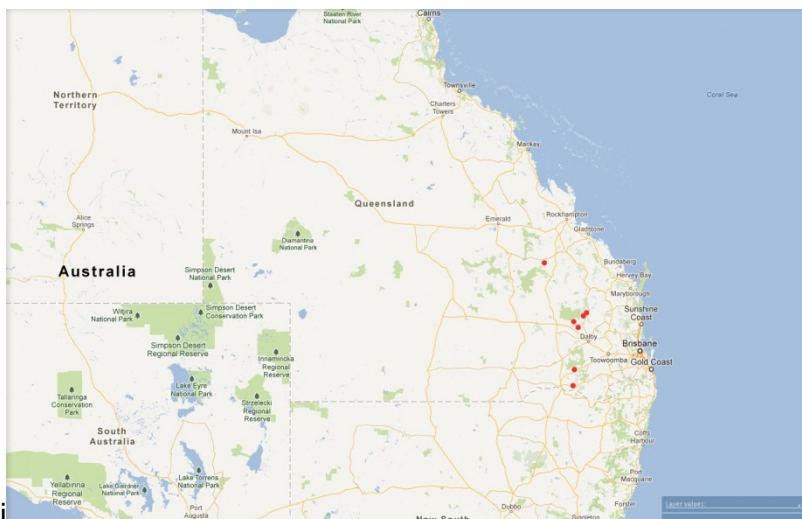


Figure 23: Mapped distribution range of *Xerothamnella herbacea* (Source: Atlas of Living Australia 2012)

9.20.2.3 Known species populations within the CSG fields

Xerothamnella herbacea has been recorded from the southern end of the Arcadia Valley. Ecological surveys are required to confirm exact locations within all relevant fields.

9.20.2.4 Habitat

Xerothamnella herbacea occurs in Brigalow (*Acacia harpophylla*) dominated communities in shaded situations, often in leaf litter and is associated with gilgais (shallow ground depressions). Soils are heavy, grey to dark brown clays (Queensland Herbarium 2008a).

The preferred habitat of *Xerothamnella herbacea* at Gratz Gully (Boobook 2012) appeared to be:

- Floodplain flats, channel banks and beds, no greater than 0.5 m elevation above the channel; usually within 50 cm elevation of the top of the ditch/channel ie mounds, low ridges and rises between drainage ditches, gutters, rills and channels, and flood ponds
- Soils with high clay content
- Shade of greater than 40%

- Shade provided by Brigalow (*Acacia harpophylla*) and Wilga (*Geijera parviflora*) most often, and Poplar box (*Eucalyptus populnea*) to a lesser degree (more often on the southern side of small shade patches)
- Areas of notable leaf litter coverage
- Sometimes associated with gilgais (shallow ground depressions)

Associated herbaceous species most frequently detected with *Xerothamnella herbacea* included Blue trumpet (*Brunoniella australis*), Slender sedge (*Cyperus gracilis*), Curly windmill grass (*Enteropogon ramosus*), Creeping shade grass (*Oplismenus aemulus*) and Pink tongues (*Rostellularia adscendens*) (Boobook 2012).

Xerothamnella herbacea plants look similar to *Brunoniella australis* and *Rostellularia adscendens*, two very common forbs throughout the search area. *Xerothamnella herbacea* plants are distinguishable from a distance by a neater, more symmetrical leaf arrangement, more glabrous (smooth or hairless) foliage and stems, lighter and more consistent shade of green, a thinner more delicate appearance to leaves, fruit spade shaped (*Brunoniella australis* fruit rod shaped), flowers arising together in heads, corolla with distinct upper petals (*Rostellularia adscendens* upper petals absent or not obvious, flowers arranged along spikes 2 to 7 cm long) (Boobook 2012).

9.20.2.5 Biology and reproduction

There is no published information on the fruiting and flowering period for this species however it has been recorded flowering during the pre-clearance surveys in November/December (Ecologica 2012).

Based on visual observations, Aurecon noted that *Xerothamnella herbacea* could have the ability to propagate from cuttings and/or grown from seeds based on its ability to colonise recently disturbed areas as evident between the September and November 2012 survey periods.

Xerothamnella herbacea plants were suspected to be in the process of dying-off during a survey in March and April 2012 where soil moisture was declining. It is suspected that the species relies on available soil moisture in the top 30 cm of soil (Boobook 2012).

9.20.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.20.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.20.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.21 *Eriocaulon carsonii*

9.21.1 Status

Endangered – listed 16 July 2000

9.21.2 Biology and ecology

9.21.2.1 Characteristics

Eriocaulon carsonii (Salt pipewort) is a hairless, perennial, aquatic herb that has a circular cluster of leaves at its base and clustered flowers (DEHP 2011a). *Eriocaulon carsonii* usually forms mat-like colonies and can vary in appearance. For example, smaller plants (up to 10 cm tall) with hairless flower heads are found in western Queensland, while larger plants (up to 50 cm tall) with hairy flower heads occur in southern, eastern and northern Queensland (DEHP 2014).

Flowers are tiny (3 to 4 mm in diameter) and white in colour. Fruit are a membranous, swollen, three celled capsule (NPWS 2002b).



Plate 20: *Eriocaulon carsonii* (Source: DEHP n.d)

9.21.2.2 Distribution

Eriocaulon carsonii is an aquatic plant only found on permanent, spring-fed wetlands with a groundwater source from the Great Artesian Basin. Populations generally occur on relatively flat landscapes in Queensland, New South Wales and South Australia. In Queensland *Eriocaulon carsonii* is known from 12 spring complexes (group of springs on similar landforms located no more than 6 km apart) (DEHP 2014). With the exception of two populations in the Einasleigh Uplands region of north Queensland, the Great Artesian Basin sustains the wetlands which support this species (DEHP 2014).

Spring wetlands in the Great Artesian Basin have been well surveyed and there is a high level of certainty that no further complexes containing *Eriocaulon carsonii* will be found (DEHP 2014). Two populations are known to have become extinct as a consequence of Great Artesian Basin springs becoming inactive; one of these is in southern Queensland and is in the largest spring of the Eulo region (Wiggera Springs) (Fensham & Fairfax 2003).

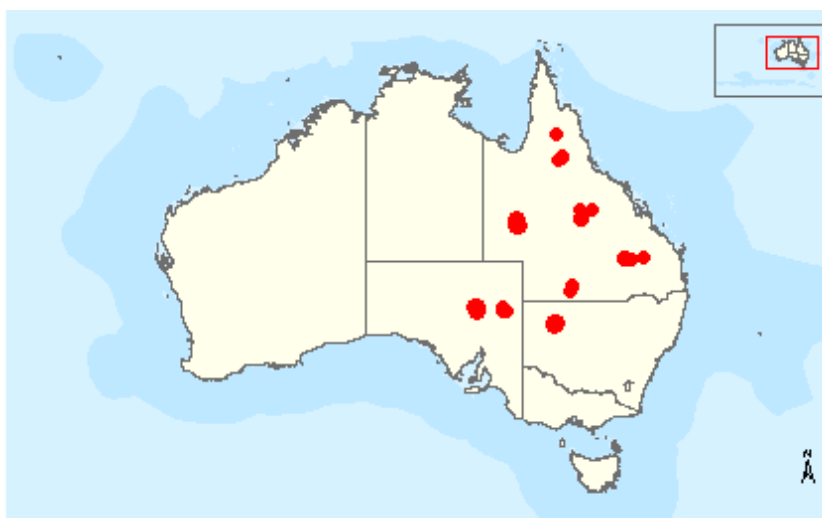


Figure 24: Mapped distribution range of *Eriocaulon carsonii* (Source: DSEWPac 2011k)

9.21.2.3 Known species populations within the CSG fields

Eriocaulon carsonii has been observed within the Fairview gas fields. Ecological surveys are required to confirm exact locations within all relevant fields.

9.21.2.4 Habitat

Eriocaulon carsonii is entirely restricted to flowing mound springs. Such springs occur on all margins of the Great Artesian Basin (Ponder 1986). The springs lie on faults, which provide direct access for the artesian water to reach the surface. Accumulated evaporite and mud deposits at the springs form mounds from 1 to 10 m high and 2 to greater than 100 m diameter. *Eriocaulon carsonii* is generally associated with vegetated mounds that, over considerable time, have formed organic fen soils. Fen soils are the alkaline equivalent to the acidic peat bog. The species appears to prefer areas of shallow standing water with slow flow (Fatchen & Fatchen 1993). Populations are generally found at the tail of the spring or above the vent of slow flowing springs (NPWS 2002b).

9.21.2.5 Biology and reproduction

Flowers are tiny (3 to 4 mm in diameter) and white in colour, with female flowers forming first, followed by the male flowers. Flowering is known to occur between summer and late autumn. Fruit are a membranous, swollen, three celled capsule (NPWS 2002b).

9.21.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.21.4 Unavoidable impact from the Project

If this species is located within a CSG field development site appropriate measures will be applied as per the Protocol.

Where disturbances cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Works within this area will require further assessment and advice from an Ecologist to ensure that there will be minimal, short term, recoverable and no adverse impacts on threatened flora species.

9.21.5 Management measures and methods

Management measures for this species are outlined in Section 7.0.

9.22 Boggomoss snail

9.22.1 Status

Critically Endangered – listed 2 June 2003

9.22.2 Biology and ecology

9.22.2.1 Characteristics

The helicoid shell of the Boggomoss snail (*Adclarkia dawsonensis*) is light brown, becoming greenish-yellow towards the apex, with a white lip. It is thin and semi-transparent, with an average diameter of about 2.3 cm, and is made up of five 1/8 to five 5/8 whorls. The shell is 1.5 cm high with a slightly elevated spire and a very small central depression. The animal itself is light brown to white, with the amount of grey around the neck, on the sides of the foot and above the tail differing between specimens. Black blotches on the lung roof are visible through the shell (DSEWPaC 2011I). The species may potentially be confused with several other species of camaenid land snails.



Plate 21: Boggomoss snail (*Adclarkia dawsonensis*) (Source: White 2006)

9.22.2.2 Known distribution

The Boggomoss snail is found in the greater Taroom area of south-eastern Queensland. It occurs in the Dawson Valley, north-east of Taroom, on the Dawson River. There are two main subpopulations of the snail. One subpopulation is found in boggomoss (artesian spring) habitat on private property on the Dawson River near Taroom. The other population occurs on a camping and water reserve between Tarooma and Theodore, at the Isla-Delusion crossing of the Dawson River (DSEWPaC 2011I). Several small populations have also been discovered in the greater Taroom area in recent years.



Figure 25: Mapped distribution range of Boggomoss snail (Source: DSEWPac 2011l)

9.22.2.3 Known species populations within the CSG fields

This species is known to occur within the CSG fields and suitable habitat occurs within the Scotia gas fields.

9.22.2.4 Biology and reproduction

It is assumed that, like many other snails, the Boggomoss snail feeds on decaying plant matter, bacteria and fungi (Clarke & Spier-Ashcroft 2003).

The life history of the Boggomoss snail is unknown. Stanistic (2008) suggests that the species may have a similar lifespan (10 to 20 years) to that of other land snails in arid northern Australia. The Boggomoss snail is known to aestivate (hibernate) in very dry periods. It is a free sealer, hibernating in the litter or soil under logs and sealing the opening of the shell with a calcified mucous covering (Stanistic 2008).

9.22.3 Habitat

Based on knowledge of the species' current distribution in the Taroom area, the Boggomoss snail prefers grassy eucalypt woodlands on alluvial flats along drainage lines. This species typically occurs on Gilgai black soils within Eucalypt and Brigalow communities.

Essential microhabitat for the Boggomoss snail includes intact drainage lines where populations are known or highly likely to occur. This species is dependent upon an intact overstorey, which retains sufficient moisture for the snails to survive. This species is also expected to occur in non-remnant areas adjoining watercourses where there are suitable microhabitat features including fallen logs, leaf litter and other cover (Stanistic 2008). Essential microhabitat requirements for the Boggomoss snail are a well-developed leaf litter layer for food, shelter (eg logs, fallen bark) and breeding sites, and a good coverage of vegetation to support the leaf litter environment and maintain a moist microclimate (Stanistic 2008).

9.22.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been

used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in of this SSMP. The Boggomoss snail habitat assessment assumptions are presented below.

9.22.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is found in moister riparian (riverside) and boggomoss habitats on alluvial flats (DSEWPaC 2011). As such, areas mapped as 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'riverine', 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered habitat for this species
- Suitable habitat where the Boggomoss snail has been identified is dominated by Forest red gum (*Eucalyptus tereticornis*), Palm trees (*Livistona* sp.), Sandpaper fig (*Ficus* sp.), Coolibah trees (*Eucalyptus coolibah*), sedges, ferns and mosses with a dense groundcover inclusive of leaf litter and/or logs

9.22.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

9.22.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.22.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as 'essential/core habitat'. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. General habitat may include areas of suboptimal habitat for species.

9.22.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.22.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.22.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied as during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.22.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.23 Australasian bittern

9.23.1 Status

Endangered – listed 3 March 2011

9.23.2 Biology and ecology

9.23.2.1 Characteristics

The Australasian bittern (*Botaurus poiciloptilus*) is a large, stocky, thick-necked heron-like bird with camouflage-like plumage growing to a length of 66 to 76 cm, with a wingspan of 1,050 to 1,180 cm. The male weighs 1,400 g and the female weighs 900 g (Marchant & Higgins 1990). The upperparts are brown and dark brown to black, mottled buff in complex patterns that aid the bird's concealment in swamp vegetation; the underparts are streaked and scalloped brown and buff. The bird has a prominent black-brown stripe running down the side of the neck, the eyebrow is pale, and the chin and upper throat are white. The bill is straight and pointed, straw yellow to buff in colour, with a dark grey culmen (dorsal ridge of the bill); the legs and feet are pale green to olive; and the iris orange-brown or yellow (Marchant & Higgins 1990; Pizzey & Knight 1997; DOTE 2014r). Dark and pale variants of the plumage have been observed in adults, but the variations are not understood. The sexes appear similar, but females are smaller (Marchant & Higgins 1990). Juveniles are generally paler than adults (Marchant & Higgins 1990; Pizzey & Knight 1997), with heavier buff flecking on the back; adults and juveniles are probably not separable in the field (Marchant & Higgins 1990).



Plate 22: Australasian bittern (*Botaurus poiciloptilus*) (Source: Turner 2008)

9.23.2.2 Known distribution

The Australasian bittern occurs from south-east Queensland to south-east South Australia, Tasmania and in the southwest of Western Australia (Marchant & Higgins 1990).

In Queensland, the bittern occurs in the far south-east; it has been reported north to Baralaba and west to Wyandra, although in most years it is probably confined to a few coastal swamps (Marchant &

Higgins 1990; DOTE 2014r). Today, it is rarely recorded in Queensland, and possibly survives only in protected areas such as the Cooloolo and Fraser regions (DOTE 2014r).

The extent of occurrence is stable at an estimated 1,000,000 km² (DOTE 2014r). The estimate is considered to be of high reliability.

The estimated area of occupancy is 1,200 km² but is considered to be of low reliability (Garnett & Crowley 2000). Documented data shows that the area of occupancy is decreasing (Garnett & Crowley 2000).

The Australian population of the Australasian bittern is estimated at 2,500 breeding birds. This estimate is considered to be of low reliability (Garnett & Crowley 2000).

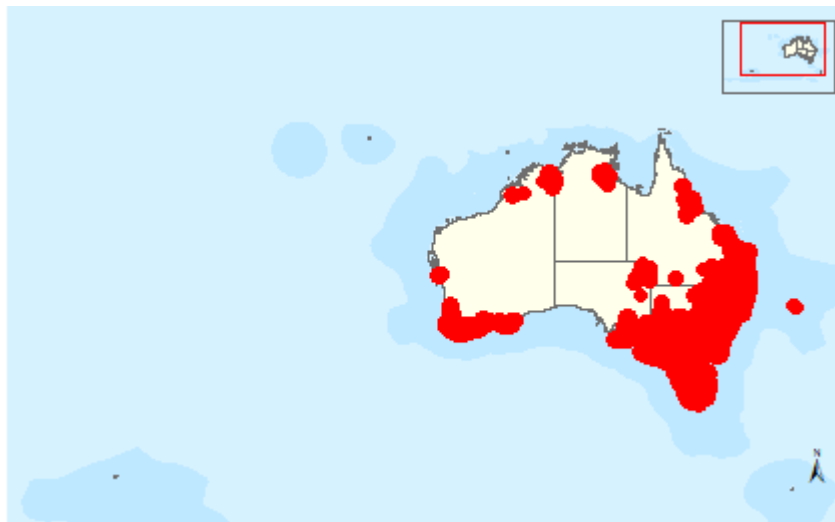


Figure 26: Mapped distribution range of Australasian bittern (Source: DOTE 2014r)

9.23.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate likelihood of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.23.2.4 Biology and reproduction

The Australasian bittern feeds mostly on animals taken from or around pools and waterways. It forages in still shallow water up to 0.3 m in depth, often at the water's edge, or from platforms or mats of flattened vegetation over deeper water (Heather & Robertson 2000; Marchant & Higgins 1990).

In Australia, the bittern has been recorded feeding on freshwater crayfish, fish (including goldfish), weevils, snakes, leaves and fruit (Marchant & Higgins 1990), and frogs and tadpoles are also likely to be eaten (DOTE 2014r).

Little information is available on the breeding biology of the Australasian bittern. It breeds in single solitary pairs, but sometimes several nests may be placed quite close together. In Australia, breeding is said to occur from October to February (Marchant & Higgins 1990).

The nest is a well-constructed saucer of flat pieces of reeds or rushes that are laid across one another; it measures about 35 to 40 cm across and 20 to 22 cm thick, and may be sheltered above by stems of the surrounding vegetation. The eggs are oval, smooth and glossy, and pure olive in colour; they

measure 49.0 to 53.8 mm (Marchant & Higgins 1990). Clutch-size is usually four or five, but can range from three to six (Marchant & Higgins 1990; Serventy & Whittell 1976).

9.23.3 Habitat

The Australasian bittern occurs mainly in densely vegetated freshwater wetlands and, rarely, in estuaries or tidal wetlands (Marchant & Higgins 1990).

In Australia, this species occurs in terrestrial wetlands and, rarely, estuarine habitats, mainly in the temperate southeast and southwest. It favours wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (eg *Phragmites*, *Cyperus*, *Eleocharis*, *Juncus*, *Typha*, *Baumea*, *Bolboschoenus*) or Cutting grass (*Gahnia*) growing over muddy or peaty substrate (Marchant & Higgins 1990).

Knowledge of the breeding ecology of the Australasian bittern is poor. Available data indicate that the bittern breeds in relatively deep, densely vegetated freshwater swamps and pools, building its nests in deep cover over shallow water (Marchant & Higgins 1990). In rushland, it may avoid breeding in the densest areas (Marchant & Higgins 1990); alternatively, this may simply reflect the accessibility of the few nests that have been found (DOTE 2014r). If population density is high, it may resort to open wetlands for nesting, eg in stunted *Acacia* swamps (Marchant & Higgins 1990).

The bittern appears to be capable of moving between habitats as suitability changes. It can occur in high densities in temporary or infrequently filled wetlands during exceptionally wet years, and will also use ephemeral wetlands when irrupting from drying floods (Garnett 1992).

9.23.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Australasian bittern habitat assessment assumptions are presented below.

9.23.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is most often associated with freshwater terrestrial wetlands (DOTE 2014r). As such, areas mapped as 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered habitat for this species along with some anthropogenic permanent water sources (such as large farm dams)

9.23.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Australian bittern, all wetlands that are indicated on the Queensland Wetland Mapping (Version 3.0), which overlap with areas identified in the BPA mapping that have been identified as

containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'Core habitat'.

9.23.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.23.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Australasian bittern all areas that are mapped as 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as estuarine, 'riverine', 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered to constitute 'General habitat' for this species.

9.23.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.23.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.23.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.23.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.24 Red goshawk

9.24.1 Status

Vulnerable – listed 16 July 2000

9.24.2 Biology and ecology

9.24.2.1 Characteristics

The Red goshawk (*Erythrotriorchis radiates*) is a large, swift and powerful rufous-brown hawk, growing to a length of 45 to 60 cm, with a wingspan of 100 to 135 cm (DSEWPac 2011m). The two sexes of this species are quite different in size and appearance (NPWS 2002). The females weigh approximately 1.1 kg, the males approximately 0.63 kg. The Red goshawk is boldly mottled and streaked, with rufous scalloping on the back and upper wings, rufous underparts that are brightest and lack streaking on the thighs, and with massive yellowish legs and feet, and boldly barred underwings. Females are larger, more powerfully built, paler and more heavily streaked below, showing some white on the under body. Juveniles have redder upper-parts, and the head and underparts are rich rufous with fine dark streaks. The juvenile's rufous head distinguishes it from adults (DSEWPac 2011m).

The Red goshawk can further be distinguished from other similar raptors by its broad 'six-fingered' wings that are held at slightly angled planes when soaring, the lack of pale markings on upperparts, the heavy and dark streaking on the head and chest, the flat head, the deep bill (female), the broad deep chest, and the long tail which is square-tipped to slightly rounded at the tip (DSEWPac 2011m).

The Red goshawk is solitary and very thinly dispersed. It is usually observed singly, and occasionally in pairs or family groups (DSEWPac 2011m). Red goshawk pairs are believed to remain within the nesting territory all year, but some may expand their home range when not breeding (Aumann & Baker-Gabb 1991, Debus & Czechura 1988).



Plate 23: Red goshawk (Source: Baker-Gabb 2008)

9.24.2.2 Known distribution

It was estimated that there were 1000 breeding birds in 2000 and this estimate was made with medium reliability (Garnett & Crowley 2000).

The Red goshawk is endemic to Australia. It is very sparsely dispersed across approximately 15% of coastal and sub-coastal Australia, from western Kimberley Division (north of 19°S) to north-eastern

NSW (north of 33°), and occasionally on continental islands (Aumann & Baker-Gabb 1991; Marchant & Higgins 1993).

There appears to have been a recent coastal contraction of the range in parts of eastern Australia, and a northward contraction of about 500 km in NSW where it is now virtually extinct (Blakers *et al* 1984; Debus & Czechura 1988b; Debus 1991; Debus *et al* 1993; Marchant & Higgins 1993).

The estimated extent of occurrence is likely to be stable at 1,000,000 km and the estimated area of occupancy is suspected to be 200,000 km², though the reliability of this estimate is low (DSEWPac 2011m).

The area of occupancy has declined since European settlement. While this decline cannot be quantified, the lack of any breeding records in NSW over the last 50 years, and the decline in sightings of Red goshawk further from the coast especially in Queensland suggest that fewer areas are now being used for breeding (Debus & Czechura 1988b). It is suggested that since European settlement, development and habitat alteration have rendered about 20% of the predicted Red goshawk's range unsuitable for breeding, especially in coastal Queensland (Aumann & Baker-Gabb 1991).

The distribution of the Red goshawk is not severely fragmented. It is suspected that there is some fragmentation (BirdLife International 2004), but there is no evidence that fragmentation in the Red goshawk distribution is severe. However, some fragmentation may have occurred in the more heavily settled and cleared regions of the species range, such as in the coastal lowlands of eastern Queensland (DSEWPac 2011m).

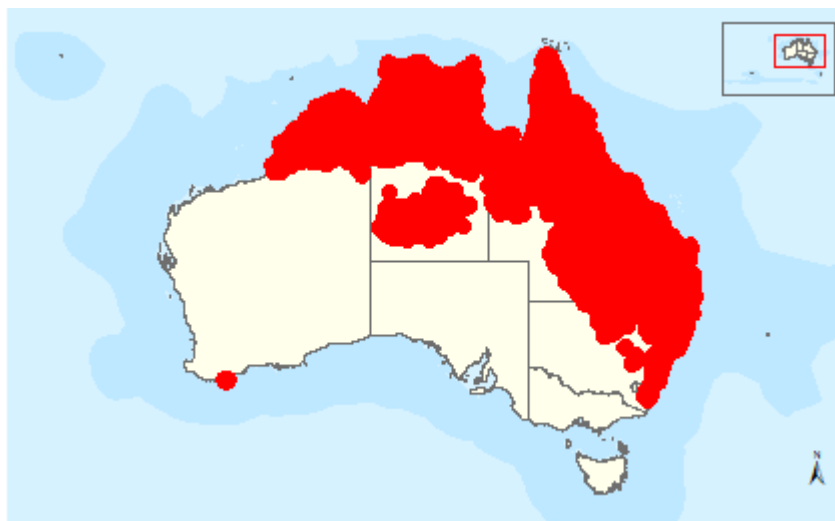


Figure 27: Mapped distribution range of Red goshawk (Source: DSEWPac 2011m)

9.24.2.3 Known species populations within the CSG fields

There are no known resident or breeding populations of Red goshawk within the CSG fields. However, The CSG fields are within the known distribution of the species and suitable habitat is present.

9.24.2.4 Biology and reproduction

Ages of sexual maturity, life expectancy and natural mortality remain very poorly known (Marchant & Higgins 1993). The generation length was estimated at 10 years, but this estimate has low reliability as there is no reliable life history data to base it on. The estimate was made primarily based on data from other taxa (Garnett & Crowley 2000).

The breeding season for Red goshawks is long with courtship starting as early as April and young not leaving their natal territories until as late as the end of December (Aumann & Baker-Gabb 1991). Breeding occurs generally in the spring with eggs laid between May and October in the north (Aumann & Baker-Gabb 1991), and between August and October in the southeast of its range (Debus & Czechura 1988).

The Red goshawk breeds solitarily, in forested or wooded areas, within one kilometre of permanent water, and in a large (over 20 m tall) tree. They are probably monogamous (Aumann & Baker-Gabb 1991). Breeding pairs use the same nesting territories year after year, renovating the nest used in the previous year or nesting nearby (Aumann & Baker-Gabb 1991). Conspecific interactions have been observed with Wedge-tailed eagles and Black-breasted buzzards which appear to prey on goshawk nests (Aumann & Baker-Gabb 1991).

Courtship is first observed 110 to 120 days before egg-laying. Nest-building and refurbishment is done 50 to 70 days before eggs are laid. The nest is a large structure (0.6 to 1.2 m across) made of dead sticks with a saucer-shaped hollow at top, thickly lined with finer twigs and green eucalyptus leaves. There is no conclusive information about clutch size, but it is probably one or two eggs (DSEWPaC 2011m). The female carries out incubation exclusively, but the male may shelter a clutch when the female is off the nest. The male appears to bring all the food from about 25 days before egg-laying through the incubation period. The incubation period is 39 to 43 days. The male also provides most of the food for nestlings, with two to five deliveries per day, during the first 25 to 40 days. The female guards the chick(s) constantly for the first 10 to 14 days. The nestling period is 51 to 53 days, probably slightly longer for females (DSEWPaC 2011m). Fledglings depend on the parents and remain in natal territory for 25 to 30 days, frequently being fed by the nest, and continue to be at least partially food dependent for 70 to 80 days after fledging (Aumann & Baker-Gabb 1991).

9.24.3 Habitat

The Red goshawk occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia (Marchant & Higgins 1993). Riverine forests are also used frequently (Debus 1991, 1993). Such habitats typically support high bird numbers and biodiversity, especially medium to large species which the goshawk requires for prey. The Red goshawk nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within one kilometre of permanent water (Aumann & Baker-Gabb 1991; Debus & Czechura 1988).

The Red goshawk occurs over wooded and forested lands of tropical and warm-temperate Australia, coastal and sub-coastal (Marchant & Higgins 1993).

This species prefers forest and woodland with a mosaic of vegetation types, large prey populations (birds), and permanent water. The vegetation types include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins (DSEWPaC 2011m).

Habitat has to be open enough for fast attack and manoeuvring in flight, but provide cover for ambushing of prey. Therefore, forests of intermediate density are favoured, or ecotones between habitats of differing densities, eg between rainforest and eucalypt forest, between gallery forest and woodland, or on edges of woodland and forest where they meet grassland, cleared land, roads or watercourses (DSEWPaC 2011m). They avoid very dense and very open habitats (Marchant & Higgins 1993). These habitats provide appropriate foraging conditions for the large Red goshawk, and a diversity and abundance of the medium to large birds taken as food (Aumann & Baker-Gabb 1991).

Immature birds have been reported from mangroves, open river floodplains, low open woodland, agricultural land and pasture, but such habitats are not used regularly (Marchant & Higgins 1993).

Nests are in tall trees within one kilometre of and often beside, permanent water (river, swamp, pool), usually in fairly open, biologically rich forest or woodland. The average distance of the nest tree to water was 164 m. Nest trees were significantly taller, with larger crown diameters, greater girth at breast height, and the height of the lowest live branch was higher than the tallest trees found in the immediate vicinity of random locations along rivers. Nest trees had an average height of 31.4 m, and an average girth at breast height of 2.9 m. Trees in 0.2 ha plots around the nest tree also had significantly higher canopy height, fewer small trees (girth less than 0.5 m), and more large trees (girth greater than 1 m) than random plots (Aumann & Baker-Gabb 1991). Nests tend to be placed on a substantial horizontal limb often against a vertical branch arising from it (DSEWPaC 2011m).

This species is a local migrant throughout Australia and inhabits coastal areas, islands, estuaries, inlets, rivers and inland lakes. The species will overfly a variety of terrestrial habitats (such as coastal dunes, tidal flats, grasslands, heathlands, woodland, eucalypt forests, rainforests and urban areas) but will also forage over wide expanses of open water (DSEWPaC 2011m).

9.24.4 Habitat assessment

Information from expert opinions obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Red goshawk habitat assessment assumptions are presented below.

9.24.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Preferred habitat consists of tall open forest/woodland, especially near rivers, wetlands and rainforest fringes (DSEWPaC 2011m; Pizzey & Knight 1997). Habitat has to be open enough for fast attack and manoeuvring in flight, but provide cover for ambushing of prey. Therefore, forests of intermediate density are favoured (DSEWPaC 2011m)
- Nests are located in tall trees within 1 km of and often beside, permanent water (river, swamp, pool), usually in fairly open, biologically rich forest or woodland (DSEWPaC 2011m). As such, it is assumed that the species will not utilise areas for breeding that are further than 1 km from a source of water. Therefore, any inland REs identified within the dot-point above, that are contained within 1 km of areas mapped as 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) and within 1 km of a stream-order 3 or greater watercourse as indicated on DNRm's watercourse mapping are considered to constitute potential habitat for this species
- Suitable habitats have been mapped based upon their habitat structure being consistent with that required for nesting or hunting
- Vegetated areas within the Project footprint that are not mapped as suitable habitat, despite their proximity to the 'general habitat', are due to the vegetation community structure; being either very sparsely wooded (representing unlikely habitat) or too densely vegetated for nesting or hunting movements (also representing unlikely habitats) as verified during pre-clearance surveys
- Other unsuitable habitat based on the absence of structural requirements are the grassland pastures that have been extensively cleared of remnant vegetation through historic grazing land management practices which are currently in place as verified through pre-clearance surveys

9.24.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Red goshawk, all REs that contain a specimen backed record, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.24.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.24.4.4 General habitat

"General habitat" consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

For the Red goshawk, all areas that contain REs that have been identified by DOTE or site based observations as containing habitat suitable for the occurrence of this species, are included within the 'general habitat' category.

9.24.4.5 Unlikely habitat

Unlikely habitat areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species such as vegetation structures that are either too dense or too open for this species to nest or hunt (ie areas that do not meet the habitat and general assumptions identified above).

9.24.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.24.6 Unavoidable impacts from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.24.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.25 Squatter pigeon – southern subspecies

9.25.1 Status

Vulnerable - listed 16 July 2000

9.25.2 Biology and ecology

9.25.2.1 Characteristics

The Squatter pigeon (southern) (*Geophaps scripta scripta*) is a medium sized ground dwelling pigeon (approximately 30 cm long). Both sexes are of similar appearance. Adults are generally grey-brown in colour with black and white stripes on the face and throat, blue-grey skin around the eyes, dark brown (with some patches iridescent green or violet) wings, a blue-grey lower breast and white flanks and lower belly. The species has a black bill, dark brown iris, and dull purple feet and legs. Juveniles are duller in colour with patchy and less distinctive black and white facial stripes and paler facial skin. The Squatter pigeon (southern) is typically seen in pairs or small groups up to 20 or more individuals (DSEWPac 2011n).



Plate 24: Squatter pigeon (southern) (Source: Dreis 2010)

9.25.2.2 Known distribution

The total population of the Squatter pigeon (southern) is estimated to be 40,000 breeding birds, however this is considered to be of low reliability (DSEWPac 2011n). Despite this the species is thought to occur as a single, contiguous and stable population (DSEWPac 2011n).

The Squatter pigeon (southern) occurs on the inland slopes of the Great Dividing Range. The species distribution extends from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Port Curtis (near Gladstone), and south to scattered sites throughout south-eastern Queensland (eg south of the Carnarvon Range). The distribution extends from 19° 00' S to 29° 00' S, and 141° 00' E to 153° 30' E. The extent of occurrence is estimated to be 440,000 km² while the area of occupancy is estimated to be 10,000 km² (DSEWPac 2011n).

Population decline is considered to have slowed and the Squatter pigeon remains locally abundant in parts of Queensland, for example, groups of up to 30 are still observed in Central Queensland (Curtis *et al* 2012).

No populations have been identified as being especially important to the long-term survival or recovery of the Squatter pigeon. It has been claimed that the southern and northern subspecies of the Squatter pigeon cross-breed in a hybrid zone centred around the Burdekin-Lynd Divide in central Queensland (DSEWPaC 2011n).

The Action Plan for Australian Birds 2010 also noted that the reasons for not including the Squatter pigeon was there were no recent declines between 2000 and 2010 and the species occurs across numerous sites within its broad distribution (Garnett *et al* 2010).

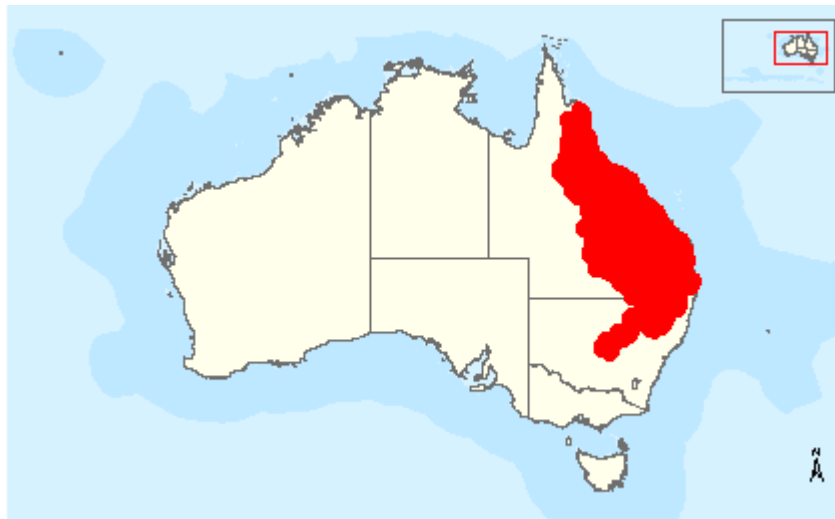


Figure 28: Mapped distribution range of Squatter pigeon (southern) (Source: DSEWPaC 2011n)

9.25.2.3 Known species populations within the CSG fields

Squatter pigeons (southern) has been observed and essential habitat has been mapped for this species within the Arcadia gas fields.

9.25.2.4 Biology and reproduction

The Squatter pigeon (southern) is typically seen in pairs or small groups of up to 20 or more individuals (DSEWPaC 2011n). Whilst predominantly terrestrial (ie feeding, resting and nesting on the ground), this species is also known to roost in trees (Curtis *et al* 2012).

The squatter pigeon is a granivore but will supplement its diet with invertebrates subject to season resource availability (Curtis *et al* 2012).

This species will breed throughout the year, however breeding is influenced by heavy rainfall and most commonly occurs during the dry season between May and June (Pizzey & Knight 2007). The Squatter pigeon incubation period is approximately 17 days and chicks will remain in the nest for a further 2 to 3 weeks after hatching, however they appear capable of only short flights for up to four weeks after fledging and remain dependent on their parents during this period (DSEWPaC 2011n). Nests are usually shallow depressions in the ground lined with grass and leaves (NPWS 1999a; Pizzey & Knight 1997).

9.25.3 Habitat

Well-draining, gravelly, sandy or loamy soils support the open-forest to woodland communities with patchy, tussock-grassy understories that support the subspecies' foraging and breeding requirements. Given that the subspecies nests in shallow depressions in the ground, it requires well-draining soils. The subspecies also prefers to forage and dust-bathe on bare ground under an open canopy of trees (Squatter Pigeon Workshop 2011).

Natural foraging habitat for the Squatter pigeon (southern) is any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species, on sandy or gravelly soils, within 3 km of a suitable, permanent or seasonal waterbody (Squatter Pigeon Workshop 2011).

Breeding habitat occurs on stony rises occurring on sandy or gravelly soils, within 1 km of a suitable, permanent waterbody (Squatter Pigeon Workshop 2011).

Typically, the ground covering vegetation layer in foraging and breeding habitat is considerably patchy consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs. This patchy, ground layer of vegetation rarely exceeds 33% of the ground area. The remaining ground surface consisting of bare patches of gravelly or dusty soil and areas lightly covered in leaf litter and coarse, woody debris (eg fallen trees, logs and smaller debris). The patchiness of the ground layer vegetation in patches of foraging and breeding habitats tends to be variable over a given area (Squatter Pigeon Workshop 2011).

In Queensland, Squatter pigeon (southern) foraging and breeding habitat is known to occur on well-draining, sandy or loamy soils on low, gently sloping, flat to undulating plains and foothills (ie Queensland Regional Ecosystem Land Zone 5), and lateritic (duplex) soils on low 'jump-ups' and escarpments (ie Queensland Regional Ecosystem Land Zone 7) (Squatter Pigeon Workshop 2011).

The Squatter pigeon (southern) is known to access suitable waterbodies to drink on a daily basis. Waterbodies suitable for the subspecies include permanent or seasonal rivers, creeks, lakes, ponds, waterholes and artificial dams. The subspecies prefers to drink where there is gently sloping, bare ground on which to approach and stand at the water's edge. While patchy to moderate ground covering vegetation may occur along the banks of suitable water bodies, a small patch (less than a square metre) of bare ground at the water's edge is all that the bird requires (Squatter Pigeon Workshop 2011).

Squatter pigeon (southern) dispersal habitat is any forest or woodland occurring between patches of foraging or breeding habitat, and suitable waterbodies. Such patches of vegetation tend not to be suitable for the subspecies' foraging or breeding, but facilitate the local movement of the subspecies between patches of foraging habitat, breeding habitat and/or waterbodies, or the wider dispersal of individuals in search of reliable water sources during the dry season or during droughts (Squatter Pigeon Workshop 2011).



Plate 25: Habitat examples for Squatter pigeon (Source: Wain 2012)

9.25.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Squatter pigeon habitat assessment assumptions are presented below.

9.25.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is found within walking distance to a water source (ie within 3 km of a stream-order 3 or greater watercourse as indicated on DEHP's mapping and/or within 3 km of areas mapped as 'lacustrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) and permanent farm dams etc)

9.25.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Squatter pigeon all REs or Pre-REs that contain a specimen backed record, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.25.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

The BPA expert panel (EPA 2006) states that as the Squatter Pigeon inhabits such a wide range of habitats within the Brigalow Belt South Bioregion, all habitats are defined as 'general habitat', although based on known records for the Squatter pigeon, all REs or Pre-REs that contain a specimen backed record have been mapped as 'essential habitat'. This mapping is restricted only to the relevant polygon in which the record falls (ie as per the DEHP certified RE or Pre RE mapping).

9.25.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as 'essential/core habitat'. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. General habitat may include areas of suboptimal habitat for species.

For the Squatter pigeon all areas contained within a 3 km buffer from watercourses mapped as 'Stream order 3' and above as indicated on the DEHP certified mapping, that have REs or Pre-REs as identified above have been included within this category. Non-flowing permanent water bodies which might be utilised by the species (ie lacustrine wetlands, artificial ponds and billabongs) are also included within this category. Where records occur outside of this buffer zone, a 1 km buffer (ie radius) from the specimen's record has been established and this area is also included within the 'general habitat' category.

9.25.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.25.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.25.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.25.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.26 Swift parrot

9.26.1 Status

Marine and Endangered – listed 16 July 2000

9.26.2 Biology and ecology

9.26.2.1 Characteristics

The Swift parrot (*Lathamus discolor*) is mostly bright green in colour, with dark-blue patches on the crown, a prominent red face, and the chin and throat are narrowly bordered with yellow. It is approximately 25 cm in length, the wingspan is 32 to 36 cm and it weighs about 65g. It is a slim, medium-sized parrot with angular pointed wings and a slender tail giving it the characteristic streamlined flight-silhouette (Higgins 1999).

This species is sometimes confused with lorikeets, most likely when seen flying overhead. In this situation the Swift Parrot is then best distinguished by calls, all of which are quite different from the harsh screeching or buzzing calls of lorikeets, and also by its slimmer build and distinctly longer finely pointed tail. No lorikeet has the combination of red underwing-coverts and undertail-coverts seen in the adult male Swift Parrot (Higgins 1999).

The Swift parrot can be distinguished from the Musk lorikeet (*Glossopsitta concinna*) by its red (compared with green) underwing-coverts. It can be distinguished from the Scaly-breasted lorikeet (*Trichoglossus chlorolepidotus*) by the uniformly yellow-green breast and belly, less red on underwing-coverts and (when present) shorter creamy underwing-bar and red undertail-coverts (scaly-breasted always has scaly, yellow markings over underbody, long pink-orange underwing-bar extending farther out onto primaries, and green undertail-coverts) (Higgins 1999).



Plate 26: Swift parrot (*Lathamus discolor*) (Source: Harrison 2010)

9.26.2.2 Known distribution

This species breeds in Tasmania during spring and summer, dispersing widely across south-eastern Australia during winter. The principal wintering grounds are the inland slopes of the Great Dividing Range and along the eastern coastal plains (Kennedy & Overs 2001; Kennedy & Tzaros 2005; Saunders 2002).

Recent records from southern Queensland have come from the Gold Coast, Noosa, Toowoomba, Warwick and Lockyer Valley areas and the species is rarely recorded outside these regions (Swift Parrot Recovery Team 2001).



Figure 29: Mapped distribution range of Swift parrot (Source: DOTE 2014s)

9.26.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate likelihood of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.26.2.4 Biology and reproduction

The Swift parrot feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. It is a mostly arboreal forager, foraging mainly in eucalypts, but occasionally coming to the ground to feed on seeds, fallen flowers, fruit and lerp, and to drink (Higgins 1999; Mallick *et al* 2004; Swift Parrot Recovery Team 2001).

During the non-breeding season this species feeds extensively on nectar and lerp and other items from eucalypt foliage. Swamp mahogany (*Eucalyptus robusta*), Spotted gum (*Corymbia maculata*), Coastal grey box (*Eucalyptus moluccana*) and Red bloodwood (*Corymbia gummifera*) are important nectar sources in coastal parts of the non-breeding range. Forest red gum (*Eucalyptus tereticornis*) and Yellow box (*Eucalyptus melliodora*) are used in northern New South Wales and south-eastern Queensland (Saunders & Heinsohn 2008; Swift Parrot Recovery Team 2001). Over large parts of their box-ironbark winter range, they also consume both developed and undeveloped racemes of Golden wattle (*Acacia pycnantha*) (Cheers & Cheers 2005; Kennedy & Tzaros 2005; Mac Nally & Horrocks 2000).

The species does not breed on mainland Australia (Swift Parrot Recovery Team 2001).

9.26.3 Habitat

The Swift parrot inhabits dry sclerophyll eucalypt forests and woodlands. It occasionally occurs in wet sclerophyll forests (Higgins 1999; Swift Parrot Recovery Team 2001). Saunders and Heinsohn (2008) observed that the Swift Parrot predominantly forages within habitats that have been so significantly cleared that they are classified as endangered ecological communities.

The Swift parrot migrates from its Tasmanian breeding grounds to overwinter in the box-ironbark forests and woodlands of Victoria, New South Wales and southern Queensland (DOTE 2014s).

In northern New South Wales and south-eastern Queensland, Narrow-leaved red ironbark (*Eucalyptus crebra*), Forest red gum forests and Yellow box forest are commonly utilised (Kennedy & Tzaros 2005; Swift Parrot Recovery Team 2001). While on the western slopes Mugga ironbark (*Eucalyptus sideroxylon*) and Grey box (*Eucalyptus microcarpa*) woodlands are used (Saunders & Heinsohn 2008).

9.26.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Swift parrot habitat assessment assumptions are presented below.

9.26.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is most often associated with Narrow-leaved red ironbark (*Eucalyptus crebra*), Forest red gum forests and Yellow box forest in south-eastern Queensland (Kennedy & Tzaros 2005; Swift Parrot Recovery Team 2001)
- Species is associated with Mugga ironbark (*Eucalyptus sideroxylon*) and Grey box (*Eucalyptus microcarpa*) woodlands on the western slopes (Saunders & Heinsohn 2008)

9.26.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

9.26.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.26.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to

potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

9.26.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.26.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.26.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.26.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.27 Star finch

9.27.1 Status

Endangered – listed 16 July 2000

9.27.2 Biology and ecology

9.27.2.1 Characteristics

The Star finch (eastern) or Star finch (southern) (*Neochmia ruficauda ruficauda*) is a small and compact bird. Adults of both sexes are greyish-olive with a red face and bill, bold white spots on the head, breast and flanks, a cream belly and vent, and a crimson tail. The males and females are not known to differ in appearance, although the other more common and better-known subspecies of the Star finch, *Neochmia ruficauda clarescens* and *Neochmia ruficauda subclarescens*, are sexually dimorphic (ie the sexes differ in appearance) (Higgins *et al* 2006), and it is highly likely that the Star finch (eastern) is sexually dimorphic as well, but this dimorphism is yet to be recorded (TSSC 2008s).

The Star finch (eastern) occurs in pairs and in small flocks of up to 20 (or rarely, 50) birds. No information is available on the breeding dispersion but, like other subspecies of the Star finch, it probably nests in loose colonies (Higgins *et al* 2006).

The total population of the Star finch (eastern) is estimated to consist of 50 or less breeding birds. This estimate is considered to be of low reliability. No permanent populations (or, more specifically, areas of permanently occupied habitat) have been identified (Garnett & Crowley 2000).



Plate 27: Star finch (*Neochmia ruficauda ruficauda*) (Source: Harrison n.d)

9.27.2.2 Known distribution

The Star finch (eastern) occurs in central Queensland and its population is extremely limited. Garnett and Crowley (2000) considered it critically endangered and Higgins *et al* (2006) considered it had an estimated total population of 50 individuals. This taxon is extinct in New South Wales (TSSC 2008s).

The distribution of this subspecies is poorly known, and it has disappeared from much of its former range. The most recent records occur in an area from near Wowan, north to Bowen, west to beyond Winton. It is possible that the subspecies could occur (or occurred) north of Bowen, based on historic records of Star finches at Mount Surprise and in the Cloncurry- Mount Isa region, but these records cannot be definitively attributed to the eastern subspecies. The Star finch (eastern) is suspected to occur in four discrete subpopulations (Holmes 1996 & 1998)

The Star finch (eastern) occurs within the Desert Channels, Burdekin and Fitzroy (Queensland) Natural Resource Management Regions. It has been recorded from damp grasslands, sedgeland or grassy woodlands near permanent water or areas of regular inundation. Occasionally, individuals have been reported in disturbed habitat and suburban areas (TSSC 2008s).

The extent of occurrence is estimated to be 300,000 km². However, this estimate, which is based on published maps, is considered to be of low reliability. The distribution of the Star finch (eastern) is probably severely fragmented (Garnett & Crowley 2000).

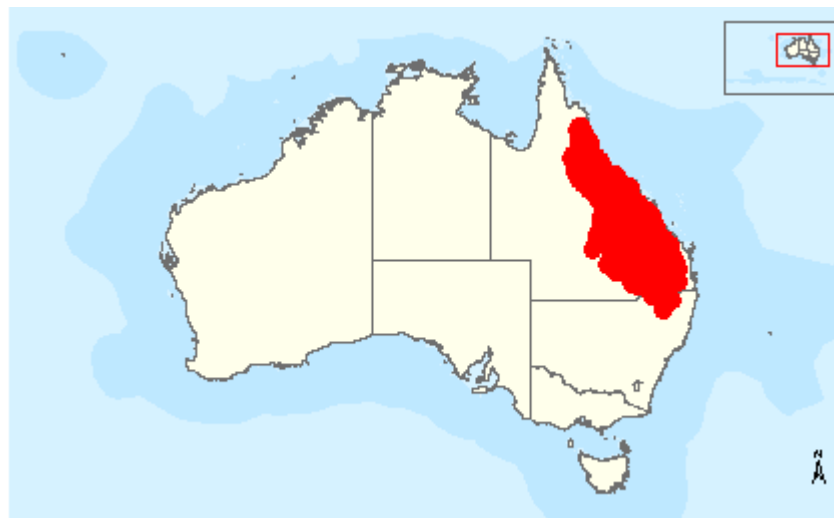


Figure 30: Mapped distribution range of Star finch (Source: DOTE 2014t)

9.27.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate chance of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.27.2.4 Biology and reproduction

The Star finch (eastern) has been recorded nesting in November (Holmes 1996; Storr 1984). The single clutch recorded contained four eggs (Storr 1984). Its breeding biology is otherwise unknown, although a likely but uncertain record from the Cardwell district in Queensland described the nests as 'bottle-shaped' and said that the nests were often placed in trees at heights of ten to thirty feet (approximately 3 to 9 m) above the ground (DOTE 2014t).

Other aspects of the breeding biology of the Star finch (eastern) are likely to be similar to those described for the Star finch at the species level (DOTE 2014t).

At the species level, the Star finch is a monogamous species (Higgins *et al* 2006; Immelmann 1982). It breeds in loose colonies that often include nests of the Chestnut-breasted mannikin (*Lonchura castaneothorax*).

It has been recorded breeding in all months of the year, although eggs have only been recorded from February to May and in September (Higgins *et al* 2006).

The Star finch builds a globular (or possibly bottle-shaped) nest that is made from grass and placed in a shrub or tree or amongst grass, sedges or reeds (Campbell 1900; Coate *et al* 2001; Higgins *et al* 2006; Holmes 1998; Immelmann 1982).

The female lays three to six or seven white eggs that are incubated by both sexes for a period of approximately 13 days (Campbell 1900; Higgins *et al* 2006; Immelmann 1982; Robinson 1939).

9.27.3 Habitat

The Star finch (eastern) occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water (Garnett 1993; Gould 1865; Holmes 1996). It also occurs in cleared or suburban areas such as along roadsides and in towns (Baldwin 1975; Cayley 1932; Holmes 1996 & 1998; Marshall 1932).

The Star finch (eastern) was observed on the Namoi River in New South Wales, on sloping river banks covered with grass and herbs, and amongst beds of rushes growing along the side of the river (Gould 1865).

Studies at nine former sites of the Star finch (eastern) found that the habitat consisted mainly of woodland. These habitats are dominated by trees that are typically associated with permanent water or areas that are regularly inundated; the most common species are *Eucalyptus coolabah*, *Eucalyptus tereticornis*, *Eucalyptus tessellaris*, *Melaleuca leucadendra*, *Eucalyptus camaldulensis* and *Casuarina cunninghamii* (Holmes 1996).

Sites from which recent records have been obtained have been dominated by grasses or have been in areas where the native vegetation has been partially cleared (DOTE 2014t). For example, at Wowan, the Star finch (eastern) was recorded near a road running through grassland (formally eucalypt woodland interspersed with vine forest) with some scattered shrub regrowth, and at Aramac, it was recorded in the grounds of a hotel (Holmes 1996 & 1998).

These latter records support earlier reports from Blackall in Queensland, where the Star finch (eastern) was said to have foraged in the streets and yards of the township (Cayley 1932; Marshall 1932), and at Inverell in New South Wales, where 20 were observed feeding in fig trees near a house (Baldwin 1975).

The distribution of the Star finch (eastern) overlaps with the following EPBC Act listed threatened ecological communities (TSSC 2008s):

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin
- Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)
- Brigalow (*Acacia harpophylla* dominant and co-dominant)

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

9.27.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Star finch habitat assessment assumptions are presented below.

9.27.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water (DOTE 2014t). As such, 'non-remnant' areas within 1 km of areas mapped as 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'riverine', 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered habitat for this species
- Area that the species utilised are dominated by trees that are typically associated with permanent water or areas that are regularly inundated; the most common associated dominant vegetation species are *Eucalyptus coolabah*, *Eucalyptus tereticornis*, *Corymbia tessellaris*, *Melaleuca leucadendra*, *Eucalyptus camaldulensis* and *Casuarina cunninghamii* (Holmes 1996)

9.27.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Star finch, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'. However, it should be noted that this species is considered to be locally extinct within the area (Brigalow Belt South Fauna Expert Panel Report).

9.27.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As there are no current site based observations for the Star finch within or adjacent to the CSG fields and the BPA expert panel (EPA 2006) states that the Star finch is considered to be locally extinct in the Brigalow Belt South Bioregion, there is no 'essential habitat' considered to occur within the CSG fields footprint.

9.27.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat.

'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Star finch all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'. However, it should be noted that this species is considered to be locally extinct within the area (Brigalow Belt South Fauna Expert Panel Report).

9.27.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.27.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.27.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.27.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.28 Plains-wanderer

9.28.1 Status

Endangered – listed 16 July 2000

9.28.2 Biology and ecology

9.28.2.1 Characteristics

The Plains-wanderer (*Pedionomus torquatus*) is a small, quail-like bird that, when fully grown, measures 15 to 19 cm in length, has a wing-span of 28 to 36 cm, and has a mass of 40 to 80 g in males and 55 to 95 g in females (Marchant & Higgins 1993).

In adult plumage, the sexes differ in appearance. The males are light brown or buff above, with white streaks and blackish scallops and vermiculations, and spots and streaks on the head and neck. They are mostly buff to orange-buff below, with blackish crescents, spots and streaks, but have a white and unmarked belly. They have a cream-coloured iris, a cream to pale yellow bill that has a dusky to dark-brown culmen (ie dorsal surface), and cream to pale yellow legs and feet (Marchant & Higgins 1993). The females have a broad black collar around the neck, with white streaks and spots, and a broad rufous patch on the upper breast. The females are also more brightly coloured than the males, and tend to be more yellow on the bill, iris, legs and feet, especially during the breeding season when the bill and legs can become orange-yellow (Marchant & Higgins 1993).

Juveniles are similar in appearance to adult males, but can be distinguished by the dark-brown spots on the breast, flanks and undertail coverts (in the adults, this area is marked with blackish crescents). They cannot be distinguished from the adult males after their post-juvenile moult is completed (Marchant & Higgins 1993).



Plate 28: Plains-wanderer (*Pedionomus torquatus*) (Source: Bishop n.d)

9.28.2.2 Known distribution

The Plains-wanderer occurs at scattered sites in Queensland, New South Wales, Victoria and South Australia. The primary 'stronghold' of the species is the Riverina region of south-western NSW (Baker-Gabb *et al* 1990; Bennett 1983).

In Queensland, more than 80% of records have been made in the channel country in the far west of the state (Baker-Gabb 2002; Bennett 1983). These records are concentrated in the northern reaches of Astrebla Downs National Park (which was formerly part of Davenport Downs Station), the southern reaches of Diamantina Lakes National Park, and on Sandringham Station (Baker-Gabb 2002). There have been scattered records of the species in native grasslands extending east and south-west from this region (Baker-Gabb 1990; Bennett 1983) and it is possible that these areas may harbour some important sites that have not yet been discovered (Baker-Gabb 2002).

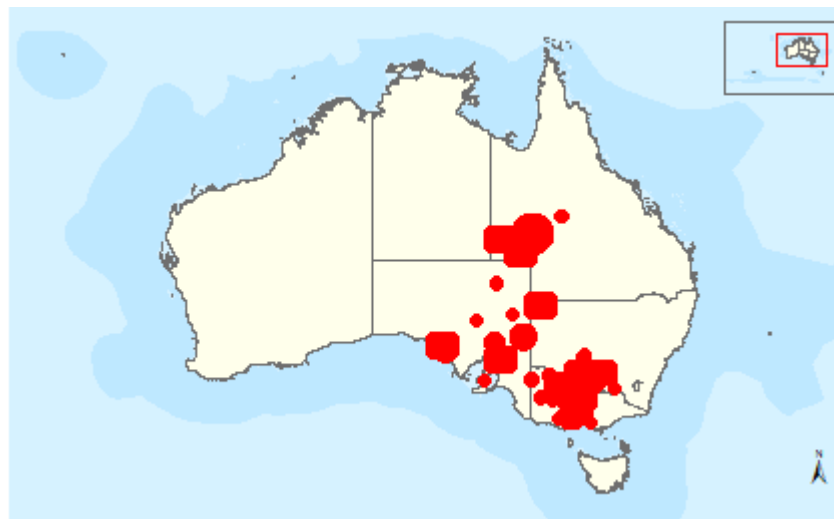


Figure 31: Mapped distribution range of Plains-wanderer (Source: DOTE 2014u)

9.28.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate chance of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.28.2.4 Biology and reproduction

The Plains-wanderer feeds on a mixture of seeds, invertebrates and leaves. Seeds are taken from grasses (including species of *Austrotipa*, *Sporobilis*, *Panicum*, *Austrodanthonia*, *Vulpia* and *Eragrostis*), chenopods (including species of *Atriplex*, *Maireana*, *Chenopodium* and *Sclerolaena*) and other plants (such as species of *Asperula*, *Galium*, *Spergularia*, *Carthamus* and *Euphorbia*). The invertebrate food consists of insects (including beetles, ants, bugs, caterpillars and locusts) and spiders (Baker-Gabb 1988; Bennett 1983).

The Plains-wanderer is capable of breeding in its first year and it breeds in solitary pairs (Baker-Gabb *et al* 1990; Crome & Rushton 1975; Ridley 1986).

Breeding has been recorded in most months of the year. The nest is a hollow or 'scrape' that is scratched into the ground and lined with grass. In some instances nearby grasses may be pulled over the nest to form a concealing cone or tent. The nests are placed amongst native grasses and herbs, or sometimes amongst crops (DOTE 2014u).

Clutch-size is usually four, but can range from two to five (Bennett 1983). The male does most of the incubation during the 23 day incubation period (Baker-Gabb *et al* 1990; Bennett 1983; Ridley 1986). The young are attended by the male (Baker-Gabb *et al* 1990), and perhaps sometimes by the female (Marchant & Higgins 1993), and become independent at about two months of age (DOTE 2014u).

9.28.3 Habitat

The Plains-wanderer inhabits sparse, treeless, lowland native grasslands with approximately 50% bare ground, most vegetation less than 5 cm in height, with some widely-spaced plants up to 30 cm high (DOTE 2014u; Garnett *et al* 2011; Harrington *et al* 1988).

These sparse native grasslands usually occur on hard, red-brown clay soils that do not support dense pasture growth under any conditions. The (approximately) 50% cover typically consist of 40% grasses and herbs, and 10% organic litter. The majority of the vegetation is less than 5 cm tall, but larger plants, mostly up to 30 cm tall and generally spaced 10 to 20 cm apart, are important because they provide shelter from predators. The grasslands can support a variety of ephemeral and perennial species of grasses and herbs. However, the composition of plant species in grasslands occupied by the Plains-wanderer is very similar to that found in dense native grasslands that are not occupied by the Plains-wanderer, which suggests that the structure of the grassland is more important than the species composition in determining its suitability for the Plains-wanderer (Baker-Gabb 2002; Harrington *et al* 1988; Llewellyn 1975, DOTE 2014u).

The Plains-wanderer occasionally occurs in other types of habitat: it has been recorded in the stubble, and amongst low crops, of cereal grasses (Bennett 1983; Llewellyn 1975; Souter 1938; Sutton 1927) and in chenopod shrublands (Harrington *et al* 1988).

The Plains-wanderer is known to actively avoid areas of dense grass or other vegetation (Radford *et al* 2013).

The Plains-wanderer is not known to associate with any other listed threatened species of fauna. However, it does often occur in areas that support threatened species of grassland plants, such as the Red darling-pea (*Swainsona plagiotropus*) and Slender darling-pea (*Swainsona murrayana*), both of which are listed as Vulnerable under the EPBC Act 1999 (DOTE 2014u).

9.28.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Plains-wanderer habitat assessment assumptions are presented below.

9.28.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs mainly in sparse, treeless, lowland native grasslands with approximately 50% bare ground, most vegetation less than 5 cm in height, with some widely-spaced plants up to 30 cm high
- This species occasionally occurs in the stubble, and amongst low crops, of cereal grasses and in chenopod shrublands (DOTE 2014u)

9.28.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Plains-wanderer, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.28.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.28.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Plains-wanderer, all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'.

9.28.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.28.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.28.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.28.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.29 Superb parrot

9.29.1 Status

Vulnerable – listed 16 July 2000

9.29.2 Biology and ecology

9.29.2.1 Characteristics

The Superb parrot (*Polytelis swainsonii*) is a medium-sized (length: 40 cm; weight: 130 to 160 g) parrot with bright green plumage and a long tail. The males and females are dimorphic. Males are generally bright green, though slightly paler and yellowish below, with a blueish wash on the crown and nape, a bright-yellow face and bright red band across the throat, slightly darker green tail, and a blue leading edge to the upperwing. The bill is brownish red, the eyes red; and the legs and feet are grey. Females are paler than males, being generally dull green with a blueish-green wash to the face, grading to greyish green on the upper throat, a pale pinkish patch on the lower throat, and a dull yellow-green underbody with pink-red thighs. The bill is brownish red, the eyes crimson and the legs and feet grey. Juveniles are generally similar to adult females except without any blueish wash to the face or pink wash to the throat (Higgins 1999).



Plate 29: Superb parrot (*Polytelis swainsonii*) (Source: Palmer 2012)

9.29.2.2 Known distribution

The Superb parrot occurs only in south-eastern Australia. The Superb Parrot is found in New South Wales and northern Victoria, where it occurs on the inland slopes of the Great Divide and on adjacent plains, especially along the major river-systems; vagrants have also been recorded in southern Queensland (DOTE 2014v).

The extent of occurrence of the Superb parrot is estimated, with high reliability, to be 81,000 km² (Garnett & Crowley 2000).

The area of occupancy of the Superb parrot is estimated at 1,000 km². However, this estimate is considered to be of low reliability (Garnett & Crowley 2000).

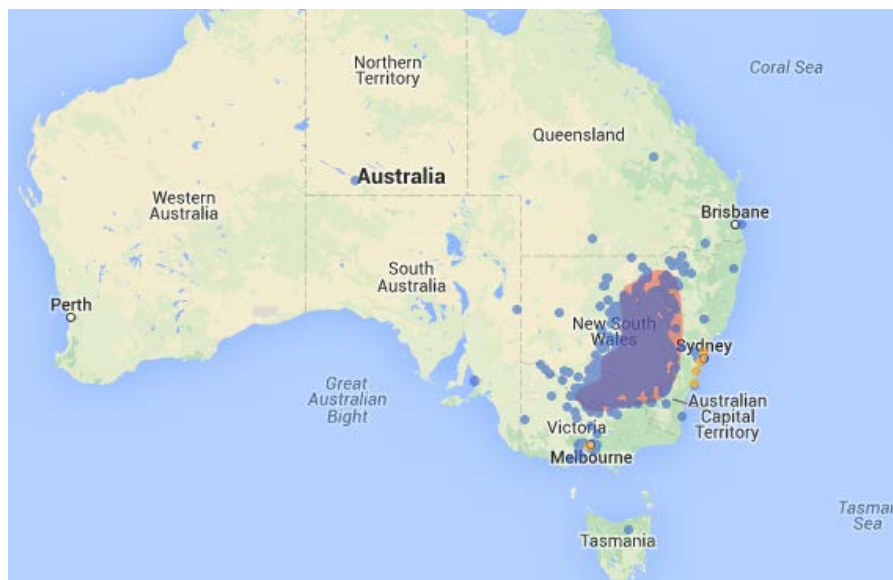


Figure 32: Mapped distribution range of the Superb parrot (Source: Atlas of Living Australia 2014)

9.29.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate chance of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.29.2.4 Biology and reproduction

The Superb parrot forages on many different species of plants, most of which occur in woodlands dominated by gum and box eucalypts, and, in some areas, in woodlands dominated by Boree, native pine (*Callitris*) or box-native pine associations (Higgins 1999; Webster 1988). When foraging on the ground, Superb parrots often eat the seeds of plants such as the native Ringed wallaby-grass (*Danthonia caespitosa*), barley-grasses (*Critesion*), as well as cereal crops including wheat, oats and canola (*Brassica napus*); and spilt grain (Christie 2004; Webster 1988; Webster & Ahern 1992). They also eat the seed-pods of many understorey species of wattles such as Gold-dust wattle (*Acacia acinacea*), Silver wattle (*Acacia dealbata*) and Deane's wattle (*Acacia deanei*) and cultivated Cootamundra wattle (*Acacia baileyana*) (Christie 2004; Webster 1988, 1991). When foraging in the forest canopy, Superb parrots eat the flowers and fruits of eucalypts, especially in spring and summer (Christie 2004; Frith & Calaby 1953; Webster 1988), the berries of mistletoe, such as Box mistletoe

(*Amyema miquelii*) and Grey mistletoe (*Amyema quandang*) (Webster 1998), and, in winter, lerps from the foliage of eucalypts (Webster 1998).

There is no information on the age of sexual maturity of wild Superb parrots, but captive birds usually first breed successfully when two to three years old (DOTE 2014v).

The Superb parrot breeds between September and January. Between four and six white eggs are laid on a bed of decayed wood in a hollow branch or a hole in the trunk of a large tree, usually a eucalypt, especially in River red gums and Blakely's red gum, but also other species including Yellow box, Grey box, Apple box, White box, Inland red box and Red box (DOTE 2014v). Nest sites are always within 10 km of areas of suitable foraging habitat (Webster 1988). Nest trees are usually near a watercourse, and may be living and healthy, or dead trees (Webster 1988, 1998). Incubation of the eggs is by the female only. In captivity, the incubation period lasts 22 days (West 1957).

9.29.3 Habitat

The Superb parrot mainly inhabits forests and woodlands dominated by eucalypts, especially River red gums (*Eucalyptus camaldulensis*) and box eucalypts such as Yellow box (*Eucalyptus melliodora*) or Grey box (*Eucalyptus microcarpa*). The species also seasonally occurs in box-pine (*Callitris*) and Boree (*Acacia pendula*) woodlands (Webster 1998).

The Superb parrot uses a number of habitats for different activities. Superb parrots breed in either River red gum forests and woodlands or box woodlands (Webster 1998).

9.29.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Superb parrot habitat assessment assumptions are presented below.

9.29.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- This species occurs in forests and woodlands dominated by eucalypts, especially River red gums (*Eucalyptus camaldulensis*) and box eucalypts such as Yellow box (*Eucalyptus melliodora*) or Grey box (*Eucalyptus microcarpa*) (Webster 1998)
- This species also seasonally occurs in box-pine (*Callitris*) and Boree (*Acacia pendula*) woodlands (Webster 1998)

9.29.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Superb parrot, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.29.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.29.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Superb parrot, all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'.

9.29.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.29.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.29.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.29.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.30 Black-throated finch

9.30.1 Status

Endangered – listed 14 February 2005

9.30.2 Biology and ecology

9.30.2.1 Characteristics

At the species level, the Black-throated finch (southern) (*Poephila cincta cincta*) is a sleek but thickset grass-finch, which measures approximately 12 cm in length, and weighs approximately 15 g (DOTE 2014w). It has a grey head and neck, with a short black loreal stripe, and a conspicuous, large black 'bib' over the chin, throat and upper breast. The bill is short, thick, conical and coloured black. The eye is a dark reddish-brown. The breast, back, and most of the belly, is brown. The wings are a darker shade of brown, and when folded have a narrow white stripe along the leading edge. The rump and the tail, which is short and rather rounded or square-tipped, are both black. The lower underbody is white, but with a black patch on the rear flanks. The legs and feet are a bright pinkish-red. Juveniles appear very similar to adults, but with duller colouring (Higgins *et al* 2006).

The subspecies can be distinguished primarily by the colouring of the upper-tail coverts; these are white in the southern subspecies, black in the northern subspecies, and of intermediate colour in hybrid birds (Ford 1986; Higgins *et al* 2006; Keast 1958; Zann 1976). The brown plumage of the body is also said to be richer in the southern subspecies than in the northern subspecies (BTF Recovery Team 2004; Schodde & Mason 1999).



Plate 30: Black-throated finch (*Poephila cincta cincta*) (Source: Williamson 2009)

9.30.2.2 Known distribution

The Black-throated finch (southern) occurs in the Townsville region, where it is considered to be locally common at a few sites around Townsville and Charters Towers (BTF Recovery Team 2004; Garnett & Crowley 2000); and at scattered sites in central-eastern Queensland (BTF Recovery Team 2004).

The Black-throated finch (southern) historically occurred from far south-eastern Queensland, near the Queensland-New South Wales border, through eastern Queensland north to the divide between the Burdekin and Lynd Rivers (Blakers *et al* 1984; Schodde & Mason 1999). The subspecies is now extinct at most sites south of Burdekin River, and is confined to a very few remaining 'pockets' of suitable habitat (DOTE 2014w).

There have been very few records of the subspecies south of 23° S since the late 1970s, and there have been almost no records from this region since 1995 (Barrett *et al* 2003; Blakers *et al* 1984; BTF Recovery Team 2004). Black-throated finches (southern) were recorded from the Severn River, near Ballandean in southern Queensland, in the early 1980s and mid-1990s (BTF Recovery Team 2004) and there is a single record from Stanthorpe, near Brisbane in 2002 (BTF recovery Team 2008).

No reliable estimates of the size of the Black-throated finch (southern) population are available. The population has been estimated at 20,000 breeding birds (based on area of occupancy and available data on densities of populations), but this estimate is considered to be of low reliability (Garnett & Crowley 2000).

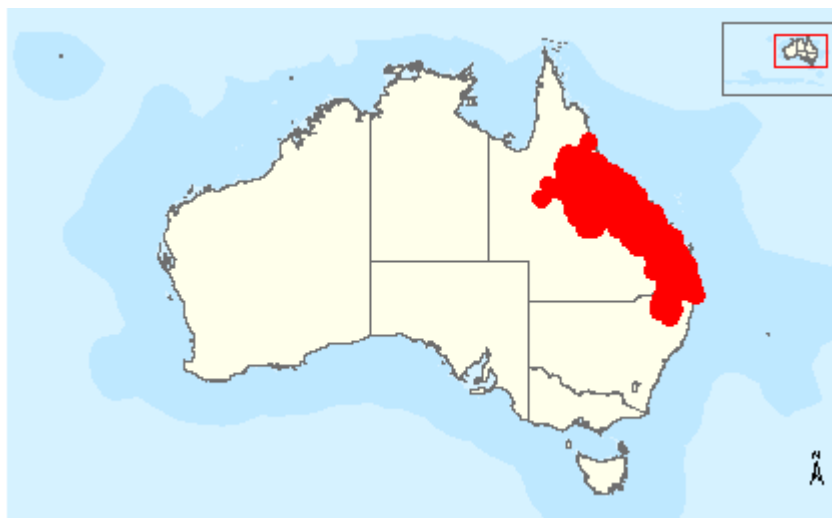


Figure 33: Mapped distribution range of the Black-throated finch (Source: DOTE 2014w)

9.30.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate chance of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.30.2.4 Biology and reproduction

Black-throated finches (southern) feed on the seeds of grasses (such as *Urochloa mosambicensis*, *Digitaria ciliaris*, *Melinis repens*, *Chloris inflata*) and herbaceous plants (Mitchell 1996; NRA 2005).

At the species level, Black-throated finches feed mainly on the half-ripe seeds of grasses (for example, *Dactyloctenium*, *Digitaria*, *Eremochloa*, *Paspalidium*, *Setaria*), and less often on the seeds of other plants (for example *Stylosanthes*). They also eat insects (for example termites) and their larvae, especially during the wet (breeding) season (BTF Recovery Team 2004; DOTE 2014w).

Breeding can occur throughout the year under optimal conditions and varies throughout its range (Mitchell 1996; Higgins *et al* 2006; NRA 2007). In the Townsville area, breeding typically occurs during the wet season, usually between February and May (Mitchell 1996; Higgins *et al* 2006; NRA 2007). In

other parts of their range, eggs are laid mainly from August to December, but clutches have also been recorded in March, April and July (DOTE 2014w). Five or six white eggs are usually laid, however, clutch-size is reported to range from three to nine (Campbell 1974; Mitchell 1996; North 1901-14).

Both sexes of the subspecies participate in the construction of the nest, the incubation of the clutch, and in the feeding and brooding of the young (NRA 2005; Zann 1976).

Black-throated finches (southern) breed in colonies, mainly in non-remnant native vegetation associated with solodic soils and alluvial plains (NRA 2005), with the dispersion of nests within colonies varying. A single tree may contain up to three nesting pairs or, alternatively, individual nests may be separated by distances of up to 50 m (NRA 2005).

The nests are often built in a hollow branch of a tree, or in a fork of a tree, shrub or sapling. However, it is not uncommon for nests to be placed in other sites, such as in tall grass, amongst mistletoe, beneath active raptor nests, or in an old nest of a Babbler (*Pomatostomus* spp.) or Diamond firetail (*Stagonopleura guttata*) (Baldwin 1976; Campbell 1974; North 1901-14; NRA 2005; Roberts 1955). Nest sites tend to be located in close proximity to water.

The nests are oval in shape and have a spout-like entrance (an arrangement also described as 'bottle-shaped'). They are usually composed of grass (Campbell 1974; North 1901-14). In addition to their breeding nests, Black-throated finches (southern) also build non-breeding nests that are used for roosting during the non-breeding and (sometimes) breeding periods (NRA 2005).

9.30.3 Habitat

The Black-throated finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by *Eucalyptus*, *Corymbia* and *Melaleuca*, and occasionally in tussock grasslands or other habitats (for example freshwater wetlands), often along or near watercourses, or in the vicinity of water (Baldwin 1976; Britton & Britton 2000; BTF Recovery Team 2004; Ley & Cook 2001; NRA 2005; Wieneke 1989). Almost all recent records of the finch from south of the tropics have been in riparian habitat (Baldwin 1976; BTF Recovery Team 2004; Ley & Cook 2001). The subspecies is thought to require a mosaic of different habitats in which it can find seed during the wet season (Mitchell 1996).

Some of the more common species of eucalypts in woodlands and forests frequented by the subspecies include Narrow-leaved ironbark (*Eucalyptus crebra*), River red gum (*Eucalyptus camaldulensis*), Silver-leaved ironbark (*Eucalyptus melanophloia*), Reid river box (*Eucalyptus brownii*), Yellow jacket (*Eucalyptus similis*) and Forest red gum (*Eucalyptus tereticornis*). The subspecies occasionally occurs in *Melaleuca* woodlands, or in grasslands comprised of genera such as *Astrelba*, *Dichanthium* or *Panicum* (BTF Recovery Team 2004).

In south-eastern Queensland, it was formerly recorded in open forest on ridges, on grassy hillsides, and on 'mountain flats' (Lord 1956). Recent studies conducted further north (near Townsville) have recorded the Black-throated finch (southern) in both modified and relatively intact vegetation communities (Mitchell 1996; NRA 2005).

The Black-throated finch (southern) has occasionally been recorded in other habitats, including in freshwater wetlands (BTF Recovery Plan 2004), in cultivation surrounded by woodland (Hall 1974) and in a heavily grazed paddock (Ley & Cook 2001). It is likely that permanent sources of water (and the habitat surrounding these) provide refuge for Black-throated finches (southern) during the dry season, especially during drought years (NRA 2007).

Refer to Figure 3.1 for the habitat assessment process.

9.30.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Black-throated finch habitat assessment assumptions are presented below.

9.30.4.1 General assumptions

9.30.4.2 The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The Black-throated finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by *Eucalyptus*, *Corymbia* and *Melaleuca*, and occasionally in tussock grasslands (DOTE 2014w)
- It is usually found within a few kilometres of fresh water (Curtis *et al* 2012). As such, areas mapped as 'riverine' 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems are considered habitat for this species

9.30.4.3 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Black-throated finch, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.30.4.4 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.30.4.5 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Black-throated finch, all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a

'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'.

9.30.4.6 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.30.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.30.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.30.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.31 Australian painted snipe

9.31.1 Status

Endangered – listed 15 May 2013

Marine and Migratory (CAMBA)

9.31.2 Biology and ecology

9.31.2.1 Characteristics

The Australian painted snipe (*Rostratula australis*) is a stocky wading bird around 220 to 250 mm in length with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye and a white crown stripe, and metallic green back and wings, barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down its upper back. The adult female is slightly larger and more brightly coloured than the male (DSEWPac 2011o).

This species is generally seen singly or in pairs, or less often in small flocks (Marchant & Higgins 1993). Flocking occurs during the breeding season, when adults sometimes form loose gatherings around a group of nests. Flocks can also form after the breeding season, and at some locations small groups regularly occur (DSEWPac 2011o).



Plate 31: Australian painted snipe (Source: Aviceda 2002a)

9.31.2.2 Known distribution

The Australian painted snipe has been recorded at wetlands in all states of Australia (Barrett *et al* 2003; Blakers *et al* 1984; Hall 1910b). It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia (DSEWPac 2011o).

The extent of occurrence of the Australian painted snipe is estimated, with low reliability, to be 4,500,000 km² (Garnett & Crowley 2000).

The total population size of the Australian painted snipe is effectively unknown, but tentative estimates range from a few hundred individuals to 5,000 breeding adults (Garnett & Crowley 2000; Lane & Rogers 2000; Oring *et al* 2004; Watkins 1993).

The Australian painted snipe is considered to occur in a single, contiguous breeding population (Garnett & Crowley 2000).

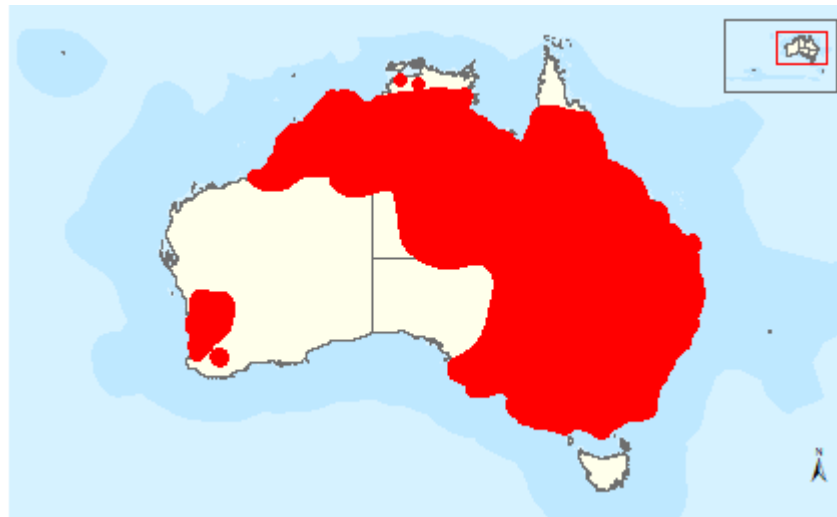


Figure 34: Mapped distribution range of Australian painted snipe (Source: DSEWPac 2011o)

9.31.2.3 Known species populations within the CSG fields

This species has been recorded within the Roma gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.31.2.4 Biology and reproduction

The Australian painted snipe may breed in response to wetland conditions rather than during a particular season. It has been recorded breeding in all months in Australia. In southern Australia most records have been from August to February. Eggs have been recorded from mid-August to March, with breeding in northern Queensland also recorded between May and October (Marchant & Higgins 1993).

Australian painted snipe breeding habitat requires shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby and nests usually occur on or near small islands in freshwater habitats (DSEWPac 2011o).

The Australian painted snipe loafs on the ground under clumps of lignum, tea-tree and similar dense bushes (Marchant & Higgins 1993).

In some situations this species is loosely colonial, although nests are widely separated (Lowe 1963). The Australian painted snipe often breeds near nesting Red-necked Avocets (*Recurvirostra novaehollandiae*), Banded Stilts (*Cladorhynchus leucocephalus*), Red-kneed Dotterels (*Erythrogonyx cinctus*) and Black-tailed Native-hens (*Gallinula ventralis*) (Lowe 1963).

The Australian painted snipe has also been recorded nesting in and near swamps, canegrass swamps, flooded areas including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch (*Paspalum*), saltbush (*Halosarcia*) and grass, also in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (Marchant & Higgins 1993).

The nest is usually placed in a scrape in the ground (Pringle 1987), and either has scant lining or is a shallow bowl-shaped nest of dry grass or other plant material (Marchant & Higgins 1993). The Australian painted snipe can also use modified habitats, such as low-lying woodlands converted to grazing pasture, sewage farms, dams, bores and irrigation schemes (Marchant & Higgins 1993).

Rostratula benghalensis and the Australian painted snipe are known to lay two to six (usually three or four) eggs and females may lay up to four clutches in a year. Incubation takes 15 to 21 days (DSEWPac 2011o).

The female Australian painted snipe mostly breed every two years (del Hoyo *et al* 1996; Marchant & Higgins 1993).

9.31.3 Habitat

The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*) (DSEWPac 2011o). The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (Marchant & Higgins 1993).

This species requires suitable wetland areas even in drought conditions. The species can move to suitable habitat if necessary (Marchant & Higgins 1993).

The Australian painted snipe is not known to associate with any other species or subspecies of fauna or flora that is listed as threatened under the EPBC Act (DSEWPac 2011o).

9.31.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Australian painted snipe habitat assumptions are presented below.

9.31.4.1 General assumption

The following general habitat assumption has been made based on current scientific knowledge of this species:

- Species is often associated with freshwater and/or saline wetlands (DSEWPac 2011o). As such, areas mapped as 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'riverine', 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species along with permanent anthropogenic water sources such as farm dams

9.31.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Australian painted snipe all wetlands that are indicated on the Queensland Wetland Mapping (Version 3.0), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.31.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.31.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation. For the Australian painted snipe all areas that are mapped as wetlands on the Queensland Wetland Mapping (Version 3.0) are considered to constitute 'general habitat' for this species.

9.31.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.31.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.31.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.31.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.32 Black-breasted button-quail

9.32.1 Status

Vulnerable – listed 16 July 2000

9.32.2 Biology and ecology

9.32.2.1 Characteristics

The Black-breasted button-quail is a large, plump, pale-eyed button-quail. It is similar in size to the Painted button-quail. The male Black-breasted button-quails are about 18 cm long, with a wingspan of 32 to 35 cm, and weighing 65 g. The females are larger, weighing approximately 100 g. The sexes differ in plumage. No seasonal variation in plumage occurs in this species. Males have finely patterned backs and wings with brown, black, grey and white mottling. The face and throat are whitish and the breast is black with numerous white half-moon markings (DSEWPac 2011p). The female is similar to the male in regards to colouration and patterning, except for the presence of a black face and throat, a larger dark area over the upper and lower breast and heavier white half-moon markings on the upper and lower breast. The bill is grey and the legs are pale yellow. Juveniles resemble males in colouration, but are duller (Marchant & Higgins 1993).

Black-breasted button-quail are commonly seen in pairs or occasionally in small groups. Being territorial, females are occasionally seen singly (Hughes & Hughes 1991; Marchant & Higgins 1993).



Plate 32: Black-breasted button-quail (Source: Hogan 1996)

9.32.2.2 Known distribution

The Black-breasted button-quail is endemic to eastern Australia. It is restricted to coastal and near-coastal regions of south-eastern Queensland and north-eastern New South Wales. The main populations occur within south-east Queensland (DSEWPac 2011p).

Present-day known distribution in Queensland extends from near Byfield in the north, south to the New South Wales border and westwards to Palm Grove National Park and Barakula State Forest (Marchant & Higgins 1993, DSEWPac 2011p). The most significant populations appear to be in the Yarraman-Nanango, Jimna-Conondale and Great Sandy regions (Bennett 1985; Hamley *et al* 1997; DSEWPac 2011p).

The extent of occurrence is estimated to be approximately 5,200 km², but this estimate is only of medium reliability (Garnett & Crowley 2000). Total area of occupancy is estimated to be approximately 750 km², but this estimate is of low reliability (Garnett & Crowley 2000).

Populations have become severely fragmented since European settlement, mostly due to clearance of forests and bushland for agriculture (Hamley *et al* 1997). There are approximately 25 sub-populations of this species and most of these are probably isolated in fragments (Garnett & Crowley 2000). A survey in south-eastern Queensland indicated that there were 14 discrete areas where this species occurs, and there is also some fragmentation within these areas (Hamley *et al* 1997; Garnett & Crowley 2000).

The total population is estimated at 5,000 breeding birds. However, this estimate is of low reliability (Garnett & Crowley 2000).



Figure 35: Mapped distribution range of Black-breasted button-quail (Source: DSEWPac 2011p)

9.32.2.3 Known species populations within the CSG fields

This species has been historically recorded within the CSG fields which are within the known distribution of the species and suitable habitat is present. Therefore, this species has a moderate likelihood of occurring.

9.32.2.4 Biology and reproduction

The diet is mostly invertebrates, taken from litter on the forest floor (Hughes & Hughes 1991; Lees & Smith 1998; Marchant & Higgins 1993; McConnell & Hobson 1995), but seeds are also possibly taken (Smyth 1997).

There is no information concerning sexual maturity or life-span of birds in the wild (DSEWPac 2011p).

The breeding season generally occurs from September to April/May (DSEWPac 2011p). At one site in south-eastern Queensland, juveniles were observed in all except one month, suggesting that breeding can occur throughout the year at certain localities (Hughes & Hughes 1991; Smyth & Young 1996). The onset and finish of the breeding season may be affected by climatic factors such as minimum daily temperature and rainfall, eg a reduction in the amount of food available, caused by dropping temperatures, probably causes the breeding season to end (Smyth & Young 1996; DSEWPac 2011p). However, the relationship between rainfall and breeding season is not clear (Smyth & Young 1996).

Between three and five eggs are laid, with a mean clutch-size of 3.88 (Smyth & Young 1996). Nests consist of a scrape in the ground, lined with leaves, grass or moss. Nests are well-concealed and placed in the buttress root of a tree or sapling, the base of a fern or under a low bush or grass tussock (Marchant & Higgins 1993; Smyth & Young 1996).

Nests are often in areas where the common understorey plants include species such as Bracken (*Pteridium esculentum*), Rasp fern (*Doodia aspera*) and Lantana (*Lantana camara*) (Smyth & Young 1996).

The incubation period in the wild is 18 to 21 days (Smyth & Young 1996). Only the male incubates (Marchant & Higgins 1993; Smyth & Young 1996). During the breeding season, females are territorial toward other females, but not males. Males possibly hold small temporary territories for courtship and mating, these being within a female's larger territory. The female apparently mates with several males in succession (Smyth & Young 1996). Mating takes place within the female's own territory and, on occasions, within the adjacent territories of other females (DSEWPac 2011p). The female can lay two clutches 8 to 10 days apart (Smyth & Young 1996).

9.32.3 Habitat

The Black-breasted button-quail is restricted to rainforests and forests, mostly in areas with 770 to 1,200 mm rainfall per annum (Bennett 1985; Hughes & Hughes 1991; Marchant & Higgins 1993). They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest (Bennett 1985; Hughes & Hughes 1991; Marchant & Higgins 1993; Milledge & McKinley 1998; Smyth *et al* 2001). They may also be found in low, dense acacia thickets and, in littoral area, in vegetation behind sand dunes (Smith & Mathieson 2004).

Many areas of optimum habitat are located on highly fertile soils. It is believed that the highly fertile soils promote rapid leaf growth on plants (DSEWPac 2012p). During dry periods, much of the foliage then drops to the ground thus maintaining the deep leaf litter layer which is crucial to the foraging requirements of the species (Smith & Mathieson 2004).

Many reports are from dry forest described as Bottle tree scrub, comprising Brigalow (*Acacia harpophylla*), Belah (*Casuarina cristata*) and Bottle tree (*Brachychiton rupestris*), with or without emergent Hoop pine (*Araucaria cunninghamii*), with a shrub understorey and thick litter layer (Bennett 1985). Much of this vegetation type, especially in the Fitzroy and Dawson valleys has been grossly depleted (Hamley *et al* 1997).

In Googa State Forest, south-eastern Queensland, birds are most commonly associated with remnant microphyll vine forest with no lantana in the understorey, but lantana is often used for diurnal foraging and nocturnal roosting. This species has been recorded as far as 60 m into mature Hoop Pine plantations. A mosaic of Lantana and emergent vine forest species appears to be important for cover (Smith *et al* 1998).

In littoral areas, the species associates with vegetation behind dunes, namely vine scrubs and thickets, acacia thickets and areas densely covered in shrubs, particularly Midgen Berry (*Austromyrtus dulcis*) and Lantana (Smith & Mathieson 2004). In the Great Sandy region of southeast Queensland, Black-breasted button-quail occur in Brush box (*Lophostemon confertus*), Pink bloodwood (*Corymbia intermedia*) and Forest red gum (*Eucalyptus tereticornis*) forest, with an understorey of Black she-oak (*Allocasuarina littoralis*), Acacias, Lantana and berry-bearing shrubs (Bennett 1985).

In south-eastern Queensland, they are recorded on rare occasions in open eucalypt forest (Smyth *et al* 2001). An extensive dense leaf-litter layer is required for foraging (Hughes & Hughes 1991) and

possibly also roosting (McConnell & Hobson 1995). Fallen logs and a dense, heterogeneously distributed shrub layers are also considered to be important habitat characteristics for shelter and breeding (Smith *et al* 1998; Smyth & Young 1996).

The species has also recorded from vine forest remnants between Hoop Pine plantations and agricultural land (Smith *et al* 1998) and occasionally in areas of pasture grass adjacent to habitat areas (Hughes & Hughes 1991).

9.32.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Black-breasted button-quail habitat assumptions are presented below.

9.32.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Preferred habitat of this species consists of drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest (DSEWPac 2011p; EPA 2006)

9.32.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Black-breasted button-quail, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.32.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

For the Black-breasted button-quail, all REs that contain a specimen backed record have been mapped as 'essential habitat'. This mapping is restricted only to the relevant polygon in which the record falls (ie as per the DEHP certified RE mapping).

9.32.4.4 General habitat

"General habitat" consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal

habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

For the Black-breasted button-quail, all areas that contain REs that have been identified by DOTE or site based observations as containing habitat suitable for the occurrence of this species, are included within the 'general habitat' category.

9.32.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.32.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.32.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.32.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.33 Five-clawed worm-skink

9.33.1 Status

Vulnerable – listed 16 July 2000

9.33.2 Biology and ecology

9.33.2.1 Characteristics

The Five-clawed worm-skink (*Anomalopus mackayi*) is a medium sized species of the Scincidae family. It is a burrowing skink which is characterised by three fingers and two toes and grows up to 27 cm long. It has smooth scales with an overall greyish-brown upper body with longitudinal rows of dark spots. The ventral surface is yellow-green with dark flecking. In the southern region of its range the Five-clawed worm-skink is unpatterned, while in the north of its range, it has longitudinal rows of dark spots over the dorsal and lateral surfaces (Cogger 2000; Queensland EPA 2007).



Plate 33: Five-clawed worm-skink (*Anomalopus mackayi*) (Source: Dolley n.d)

9.33.2.2 Known distribution

The known distribution of the Five-clawed worm-skink is patchy in north-eastern New South Wales and south-eastern Queensland (Brigalow Belt Reptiles Workshop 2010; NSW DECCW 2005; Sadler & Pressey 1994).

In south-eastern Queensland, the species' known distribution is on the upper Condamine River Floodplain from Warwick in the south to the Jimbour region in the north and bordered by the western edge of the granite belt (DOTE 2014x).

Specimens have been recorded at (Greer & Cogger 1985; Shea *et al* 1987):

- Allora
- Bongeen
- Cecil Plains
- Oakey

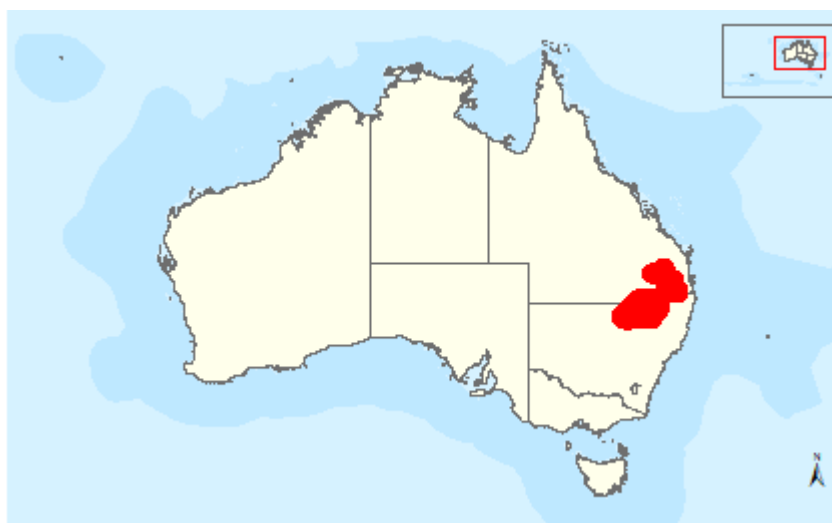


Figure 36: Mapped distribution range of the Five-clawed worm-skink (Source: DOTE 2014x)

9.33.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate chance of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.33.2.4 Biology and reproduction

No information is available about the species' feeding behaviour in the wild; however, it is believed to feed on arthropods, such as white ants. Captive specimens have been recorded eating mealworms (Brigalow Belt Reptiles Workshop 2010; NSW DECCW 2005).

Very little is known about the species' biology. Average clutch size or mortality rates for newborns are unknown. One specimen was observed laying three eggs in spring (NSW DECCW 2005).

9.33.3 Habitat

The Five-clawed worm-skink is known to occur in both remnant and non-remnant woodlands and grasslands. In areas modified by agriculture and other human activities, the species has been found sheltering under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales (Brigalow Belt Reptiles Workshop 2010; Richardson 2006).

On the Darling Downs, the species occurs in Bluegrass (*Dichanthium sericeum*) and/or Mitchell grass dominated grasslands or mixed grasslands dominated by other grass species, but still categorised RE 11.3.21 (Brigalow Belt Reptiles Workshop 2010). In south-east Queensland, the species may occur in River red gum–Queensland blue gum–Coolibah–Bimble/Poplar box grassy woodland/open forests (Brigalow Belt Reptiles Workshop 2010).

Whilst a single specimen was found under a railway sleeper on sandy soil north of Oakey (Cogger *et al* 1993), the species is not likely to be found in soils in which deep cracks do not form, such as hard-setting brown clays or sandy soils types (Spark 2010).

The Five-clawed Worm-skink occurs in the following threatened ecological communities (Brigalow Belt Reptiles Workshop 2010):

- Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and Southern Queensland ecological community

- Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community
- Weeping Myall Woodlands ecological community
- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community

9.33.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Five-clawed worm-skink habitat assessment assumptions are presented below.

9.33.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs in Bluegrass (*Dichanthium sericeum*) and/or Mitchell grass dominated grasslands or mixed grasslands dominated by other grass species and in River red gum–Queensland blue gum–Coolibah–Bimble/Poplar box grassy woodland/open forests (Brigalow Belt Reptiles Workshop 2010)
- The species occurs in non-remnant areas under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales (Brigalow Belt Reptiles Workshop 2010)

9.33.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Five-clawed worm-skink, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.33.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.33.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for

species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Five-clawed worm-skink, all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'.

9.33.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.33.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.33.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.33.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.34 Dunmall's snake

9.34.1 Status

Vulnerable – listed 16 July 2000

9.34.2 Biology and ecology

9.34.2.1 Characteristics

Dunmall's snake (*Furina dunmalli*) is a venomous snake that belongs to the Elapidae family. Dunmall's snake is found only in Australia (Cogger 2000; Ehmann 1992).

Dunmall's snake has a uniform dark grey-brown colour above that fades to white at the lower flanks. The scales are smooth and light edged, with most of the scales near the upper lip having pale blotches (Cogger 2000; Ehmann 1992). The snake is small to medium sized, growing to a length to 60 cm. The head is large and distinct from the neck (Cogger 2000; Ehmann 1992).

Observations of a captive specimen suggest it is nocturnal, docile and terrestrial. It appears to favour dark places (Queensland CRA/RFA Steering Committee 1997).



Plate 34: Dunmall's snake (Source: Wilson 2009)

9.34.2.2 Known distribution

Given the rarity and difficulty of detecting this declining species, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats (DSEWPaC 2011q). Similarly, any suitable remnant vegetation or vegetation corridors within the range of Dunmall's snake is considered important habitat for the species (Brigalow Belt Reptiles Workshop 2010).

Whilst Dunmall's snake has been recorded in Expedition National Park and Lake Broadwater Conservation Park, the species is not actively managed in these reserves (Cogger *et al* 1993; Covacevich *et al* 1996; Covacevich *et al* 1988; McDonald *et al* 1991).

The distribution of Dunmall's snake extends from near the Queensland border throughout the Brigalow Belt South and Nandewar bioregions, as far south as Ashford in New South Wales (DSEWPaC 2011q).

Dunmall's snake occurs primarily in the Brigalow Belt region in the south-eastern interior of Queensland. Records indicate sites at elevations between 200 to 500 m above sea level. The snake is very rare or secretive with limited records existing (DSEWPaC 2011q). It has been recorded at Archokoora, Oakey, Miles, Glenmorgan, Wallaville, Gladstone, Lake Broadwater, Mount Archer, Exhibition Range National Park, roadside reserves between Inglewood and Texas, Rosedale, Yeppoon and Lake Broadwater Conservation Park (Cogger *et al* 1993; Covacevich *et al* 1988; Covacevich *et al* 1996; McDonald *et al* 1991).

The distribution of Dunmall's snake is highly fragmented due to cropping and grazing, especially in the Darling Downs. As a result, the species has declined dramatically and is considered to be of particular conservation significance (Covacevich 1995).

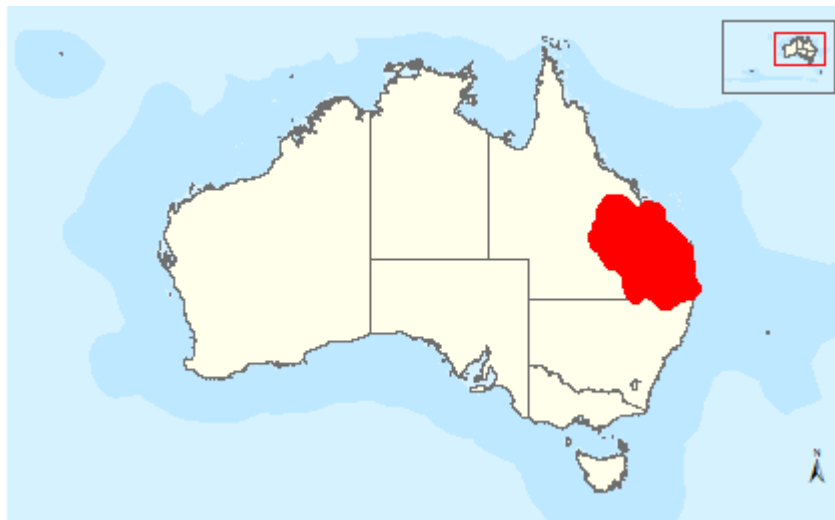


Figure 37: Mapped distribution range of Dunmall's snake (Source: DSEWPaC 2011q)

9.34.2.3 Known species populations within the CSG fields

Dunmall's snake has been historically observed within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.34.2.4 Biology and reproduction

The diet of Dunmall's snake consists of small skinks and geckos. Specific studies have found the gut contents of one specimen containing the remains of the Tree Skink, *Egernia striolata* (Shine 1981).

Little is known about the life cycle or reproduction behaviour of Dunmall's snake (Queensland CRA/RFA Steering Committee 1997). While there is no information on the breeding season or clutch size of the species (Forests Taskforce 1997), it is known that the species lays eggs rather than live young (Threatened Species Network (TSN) 2008).

9.34.3 Habitat

Dunmall's snake has been found in a broad range of habitats, including:

- Forests and woodlands on black alluvial cracking clay and clay loams dominated by Brigalow (*Acacia harpophylla*), other Wattles (*A. burowii*, *A. deanii*, *A. leioclyx*), native Cypress (*Callitris* spp.) or Bull-oak (*Allocasuarina luehmannii*) (Brigalow Belt Reptiles Workshop 2010; Covacevich *et al* 1988; Stephenson & Schmida 2008)

- Various Blue spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), White cypress pine (*Callitris glaucophylla*) and Bull-oak open forest and woodland associations on sandstone derived soils (Brigalow Belt Reptiles Workshop 2010; Stephenson & Schmida 2008; TSN 2008)

In other environments, one specimen was found on the edge of dry vine scrub near Tarong Power Station, Queensland, whilst another was found in hard ironstone country (Queensland Regional Ecosystem Land Zone 7) at Lake Broadwater near Dalby, Queensland (DSEWPac 2012q).

Little is known about the ecological requirements of Dunmall's snake, however, the species has been found sheltering under fallen timber and ground litter (Brigalow Belt Reptiles Workshop 2010; Cogger *et al* 1993) and may use cracks in alluvial clay soils (DERM 2010b; Richardson 2006).

Records indicate the species prefers habitats between 200 to 500 m above sea level (DSEWPac 2012q).

9.34.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The habitat assumptions for Dunmall's snake are presented below.

9.34.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Forests and woodlands on black alluvial cracking clay (ie Land zones 3 and 8) and clay loams (ie Land zone 4) dominated by Brigalow (*Acacia harpophylla*), other Wattles (*Acacia burrowii*, *Acacia deanei*, *Acacia leiocalyx*), native Cypress (*Callitris* spp.) or Bull-oak (*Allocasuarina luehmannii*) (Brigalow Belt Reptiles Workshop 2010; Covacevich *et al* 1988; Stephenson & Schmida 2008)
- Various Spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *Eucalyptus melanophloia*), White cypress pine (*Callitris glaucophylla*) and Bull-oak open forest and woodland associations on sandstone derived soils (Brigalow Belt Reptiles Workshop 2010; Stephenson & Schmida 2008; Threatened Species Network 2008)

9.34.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For Dunmall's snake, all REs that contain a specimen backed record (from any data source), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.34.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either

migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.34.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

For Dunmall's snake, all areas that do not contain a specimen backed record, and do not fulfil the requirements of 'core' and 'essential habitat' are considered to be 'general habitat'. These include areas noted as potential habitat within the pre-clearance survey.

9.34.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.34.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.34.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.34.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.35 Ornamental snake

9.35.1 Status

Vulnerable – listed 16 July 2000

9.35.2 Biology and ecology

9.35.2.1 Characteristics

The Ornamental snake (*Denisonia maculata*) is a stout-bodied snake which grows to a total length of about 50 cm. The overall body colour is brown, greyish brown or almost black, under surfaces are cream, often with darker streaks or flecks on the outer edges of the belly. The skin between the scales is black. The entire head, and at least the fore body, is very finely peppered with dark brown or black markings. Lips distinctly barred. Scales are smooth and are arranged in 17 rows at mid-body (Cogger 2000; Richardson 2006).

Important populations occur in remnant vegetation in close proximity to Gilgai mounds and depressions (DSEWPac 2011r).



Plate 35: Ornamental snake (Source: Wilson 2008)

9.35.2.2 Known distribution

The species is endemic to Queensland and mostly occurs in the Brigalow Belt from Inglewood, north to Emerald and east to Gladstone (Cogger 2000). The centre of the species distribution lies within the drainage system of the Fitzroy and Dawson Rivers (DSEWPac 2011r).

Known localities occur in Blackwater; Dysart, Peak Downs; Moranbah; Coppabella; Rockhampton region; east of Midgee; Yeppoon Crossing; Emerald; near Moura; the Dawson Valley; Charters Towers; Biloela; Duaringa; St Lawrence; St George; Goondiwindi; Dipperu National Park; and adjacent to South Walker Creek near Nebo (DSEWPac 2011r).

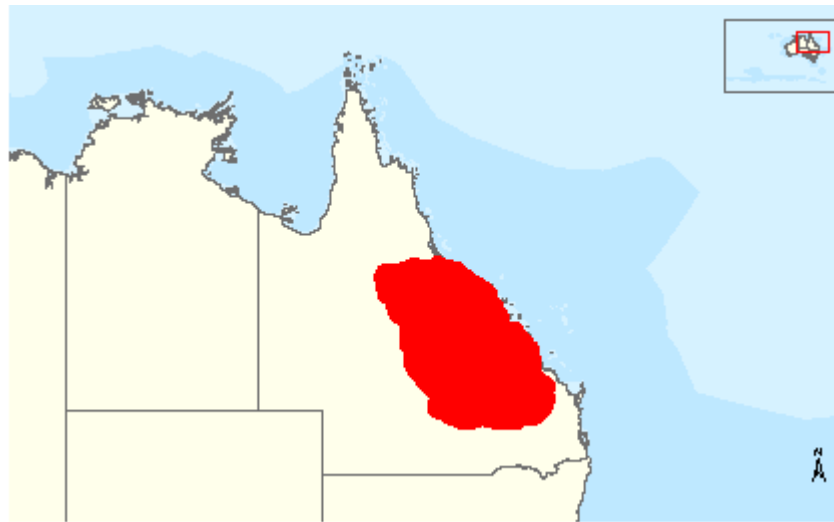


Figure 38: Mapped distribution range of Ornamental snake (Source: DSEWPaC 2011r)

9.35.2.3 Known species populations within the CSG fields

This species has been historically observed within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.35.2.4 Biology and reproduction

This species is nocturnal and feeds almost exclusively on frogs. The species is more active during the summer months, but may be encountered throughout the year. Activity peaks generally correlate to heavy rains when frogs congregate to breed, and later when young frog emerge (Curtis *et al* 2012).

The Ornamental snake is a live-bearing species with an average of three to 11 young per litter produced between September to November (Cogger 2000; Curtis *et al* 2012).

9.35.3 Habitat

The species is associated with moist or ephemeral areas (eg floodplains, clay pans and water bodies), with appropriate resources in the form of shelter (eg fallen timber, deep cracking soils) and prey species (ie frogs) (Curtis *et al* 2012).

This species is known only within the Fitzroy and Dawson River drainage systems in the Brigalow Belt region of Queensland where it has been found to be most abundant in heavily gilgaied (melonhole) Brigalow (DSEWPaC 2011r). However, this species is also known from habitats without Brigalow.

This species tolerates relatively simple habitat structure (ie grasslands and cleared paddocks) and as such may be encountered within unmapped sections of project footprint where shelter and frogs are present (Curtis *et al* 2012). During dry periods, the species seeks refuge within soil cracks on gilgai mounds (DSEWPaC 2011r).

Important microhabitats for this species are likely to include cracking soils and ground cover (including perennial grass clumps, leaf litter, rocks, fallen timber etc) (Richardson 2006).



Plate 36: Photo of habitat example (Source: Aurecon 2013)

9.35.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP.

9.35.4.1 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Ornamental snake, all REs that have been identified by DOTE to support the species (primary habitat areas), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.35.4.2 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.35.4.3 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal

habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation. For the Ornamental snake, all areas that contain REs that have been identified by DSEWPaC (2011s) as containing habitat suitable for the occurrence of Ornamental snake are included within the 'general habitat' category.

9.35.4.4 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.35.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.35.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.35.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.36 Collared delma

9.36.1 Status

Vulnerable – listed 16 July 2000

9.36.2 Biology and ecology

9.36.2.1 Characteristics

The Collared delma (*Delma torquata*) is endemic to Queensland and is the smallest member of the family Pygopodidae. This small legless lizard is generally uniform brown; but with belly shields that are darker at the margins, and a dark-brown banded head and neck with cream-yellow interspaces (DSEWPac 2011s). The species has a maximum snout-vent length of 7 cm and maximum total length of approximately 19 cm (Peck & Hobson 2007). The species average weight is about 2 g and the mid-body scales are in 16 rows. The snout is relatively short and blunt (Cogger 2000).



Plate 37: Collared delma (Source: Peck 2006)

9.36.2.2 Known distribution

Despite difficulties in estimating the Collared delma population size, it is known that the species occurs in small isolated populations throughout its distribution (DSEWPac 2011s). Important populations include Mt Crosby, the Toowoomba Range, stock route areas (especially the Donnybrook Stock Route region) and the Brisbane area (DSEWPac 2011s).

The species has been recorded at the Bunya Mountains (approximately 200 km northwest of Brisbane), the Blackdown Tablelands National Park (approximately 200 km west of Rockhampton), Expedition National Park (Central Queensland), Western Creek (approximately 200 km south-west of Brisbane) and the Toowoomba Range. A large concentration of records come from the western suburbs of Brisbane (DSEWPac 2011s).

Due to specific habitat requirements of Collared delma, the species distribution is highly fragmented and restricted to only a few locations within the area that is defined by the habitat boundary (Peck 2003).

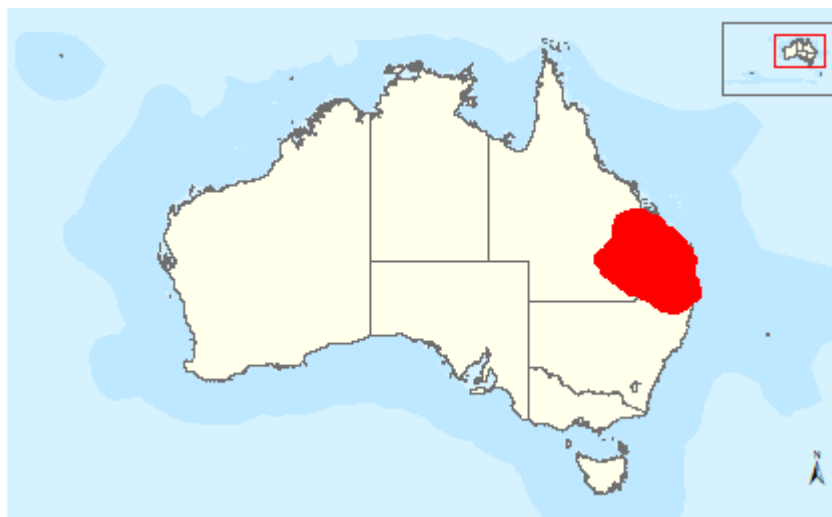


Figure 39: Mapped distribution range of Collared delma (Source: DSEWPac 2011s)

9.36.2.3 Known species populations within the CSG fields

This species has been historically observed within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.36.2.4 Biology and reproduction

The Collared delma feeds on insects and spiders, with small cockroaches the most common prey item. Some individuals have been captured in subterranean termite colonies (Davidson 1993; Porter 1998).

As with all members of the Pygopodidae family, the Collared delma produces two small white, elongated eggs in December. These then hatch in February to March (Peck & Hobson 2007).

9.36.3 Habitat

The Collared delma normally inhabits eucalypt-dominated woodlands and open-forests in Queensland Regional Ecosystem Land Zones (LZ) 3, 9 and 10 (Brigalow Belt Reptiles Workshop 2010).

The Collared delma has been recorded from rocky areas associated with dry open forests. This species occurs in open eucalypt and acacia woodland with an understorey of native grasses and loose rocks. The Collared delma has also been recorded from eucalypt woodland adjacent to semi-evergreen vine thicket. This species shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006).

The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993).

9.36.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been

used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The habitat assumptions for the Collared delma are presented below.

9.36.4.1 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Collared delma, all REs that contain a specimen backed record (from any data source), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.36.4.2 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.36.4.3 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

For the Collared delma, all areas that do not contain a specimen backed record, and do not fulfil the requirements of 'core' and 'essential habitat' are considered to be 'general habitat'.

9.36.4.4 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.36.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.36.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.36.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.37 Yakka skink

9.37.1 Status

EPBC Act – Vulnerable

9.37.2 Biology and ecology

9.37.2.1 Characteristics

The Yakka skink (*Egernia rugosa*) is a large, robustly built skink with a notably thick tail and grows to a total length of about 40 cm with short legs and claws. A broad, dark brown to black stripe extends along the back from the nape to the tail. Individual scales within this stripe can be variegated with dark and medium brown. This dark stripe is bordered on either side by a narrow, pale fawn stripe. The upper lips are whitish to reddish brown, contrasting with darker adjacent scales. The belly and ventral surfaces are cream to yellowish orange and the throat often with blackish flecks. Scales are in 26 to 30 rows at mid-body (Cogger 2000; DEHP 2012; Richardson 2006).



Plate 38: Yakka skink (Source: DSEWPaC 2011t)

9.37.2.2 Known distribution

Important Yakka skink populations occur where colonies are identified or are within 5 km of known records of the species. Any contiguous patch of vegetation which is suitable for the long-term persistence of a population, or for maintaining genetic diversity across the landscape, is important habitat for the species (Brigalow Belt Reptiles Workshop 2010).

The distribution of the Yakka skink is highly fragmented and spans from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. Included in this range are sections of the Brigalow Belt (North and South), Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet tropics and Cape York Peninsula Biogeographical Regions (DSEWPaC 2011t).

This species is known from Fairview and Arcadia CSG Fields and has been recorded from Arcadia Valley, Lonesome Holding and Mt. Hutton (DEHP 2012c; Queensland Museum 2011). The Yakka skink is also known from remnant vegetation communities which are contiguous with the communities within the gas fields, including Expedition National Park (URS 2009a), unprotected lands near the Dawson Highway and Leichardt Highway junction, a number of unprotected areas in Arcadia Valley and also from the Burnett Highway to the north of Biloela (Richardson 2006).

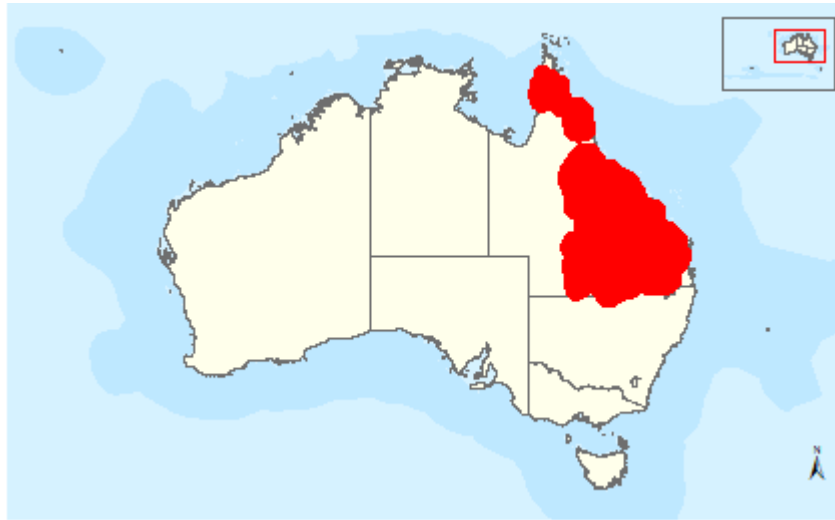


Figure 40: Mapped distribution range of Yakka skink (Source: DSEWPaC 2011t)

9.37.2.3 Known species populations within the CSG fields

This species has been historically observed within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.37.2.4 Biology and reproduction

The Yakka skink is a gregarious terrestrial species which is active during the morning, and from dusk through the early evening. The colony/group consists of both adults and juveniles and a wide variety of body sizes (Curtis *et al* 2012; DSEWPaC 2011t).

The species is omnivorous feeding on plant material (including fruits) and a wide variety of invertebrates (eg beetles, grasshoppers and spiders). The species also uses a regular defecation site and is known to retreat quickly to shelter (Curtis *et al* 2012; DSEWPaC 2011t).

The species shows a high site-fidelity and limited capacity to disperse from a colony site (DSEWPaC 2011t).

The Yakka skink produces live young and rarely bears more than six per litter. The breeding season for this poorly known species has not been recorded (DEHP 2012c; Richardson 2006).

9.37.3 Habitat

Yakka skink habitat is amongst dense ground vegetation, fallen timber or rock outcrops in open dry sclerophyll forest (ironbark) or woodland, Brigalow forest, open shrub land, and lancewood forest on coarse gritty soils in the vicinity of low ranges, foothills and undulating terrain with good drainage (Cogger 2000; DEHP 2012; Richardson 2006).

Important microhabitats for this species include rocky outcrops, hollow logs, animal burrows and ground cover (including perennial grass clumps, leaf litter, rocks, fallen timber etc) (Richardson 2006).

Colonies have been found in large hollow logs, cavities or burrows under large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes. However, the species is not generally found in trees or rocky habitats (DSEWPaC 2011t).

This species can occur in Brigalow communities as listed under the EPBC Act and also in habitats which also support the Brigalow scaly-foot (DSEWPaC 2011t).

9.37.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Yakka skink habitat assumptions are presented below.

9.37.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species has been observed to utilise the following six land zones: 3 - Alluvium (river and creek flats); 4 - Clay plains not associated with current alluvium; 5 - Old loamy and sandy plains; 7 - Ironstone jump-ups; 9 - Undulating country on fine-grained sedimentary rocks; and 10 - Sandstone ranges. (DSEWPaC 2011t)
- The species has been observed associating in habitats with the following flora species: Brigalow (*Acacia harpophylla*); Mulga (*Acacia aneura*); Bendee (*Acacia catenulata*); Lancewood (*Acacia shirleyi*); Belah (*Casuarina cristata*); Poplar box (*Eucalyptus populnea*); Ironbark (*Eucalyptus* spp.); and White cypress pine (*Callitris glaucophylla*) (DSEWPaC 2011t)

9.37.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Yakka skink, all REs that contain a specimen backed record (from any data source), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.37.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.37.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts

the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

For the Yakka skink, all areas that do not contain a specimen backed record, and do not fulfil the requirements of 'core' and 'essential habitat' are considered to be 'general habitat'. Areas identified as potential habitat for this species in the pre-clearance survey have been included into this habitat category.

9.37.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.37.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.37.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.37.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.38 Large-eared pied bat

9.38.1 Status

Vulnerable – listed 4 April 2001

9.38.2 Biology and ecology

9.38.2.1 Characteristics

The Large-eared pied bat (*Chalinolobus dwyeri*) is a medium-sized insectivorous bat measuring a total length of approximately 100 mm and weighing 7 to 12 g (DSEWPac 2011v). It has a shiny black coat with a white stripe on the flank (underside) of each wing. The ears are large and their facial lobes are located on the lower lip and between the corner of the mouth and the bottom of the ear (Hoye & Dwyer 1995, Ryan 1966). Its relatively short, broad wings suggest it flies slowly and with considerable manoeuvrability (DERM 2011a).



Plate 39: Large-eared pied bat (Source: Pennay 2006)

9.38.2.2 Known distribution

The former and current distribution of the Large-eared pied bat is poorly known (DSEWPac 2011v). Large declines since the species was first described in northern NSW during 1966 have been suggested however it is not possible to evaluate these declines (DSEWPac 2011v). Records for current distribution exist from Shoalwater Bay, north of Rockhampton in Queensland through to near Ulladulla in NSW. Despite this large range it is thought the species is uncommon and patchy within this area (DSEWPac 2011v). The majority of the known distribution exists in NSW with the largest populations found within the sandstone escarpments and northern slopes of the Sydney basin (DSEWPac 2011v).

Populations occur where suitable roosts are present. In particular, the populations in north-eastern NSW and south-east Queensland, Shoalwater Bay and Blackdown Tablelands are likely to be isolated with little interaction with their nearest populations (DSEWPac 2011v).

Important populations supporting higher numbers of individuals include those present in the sandstone escarpments of Carnarvon, Expedition Ranges and Blackdown Tablelands Queensland (DSEWPac

2011v). It is likely that these areas support a high proportion of the Queensland populations; however population estimates and distribution in these areas has not been established (DSEWPaC 2011v).

No maternity roost sites are known in Queensland (TSSC 2010)

The species extent of occurrence is approximately 570,000 km² based on the distribution range (Hoye and Dwyer 1995). The area of occupancy is approximately 9,120 km² (TSSC 2010).

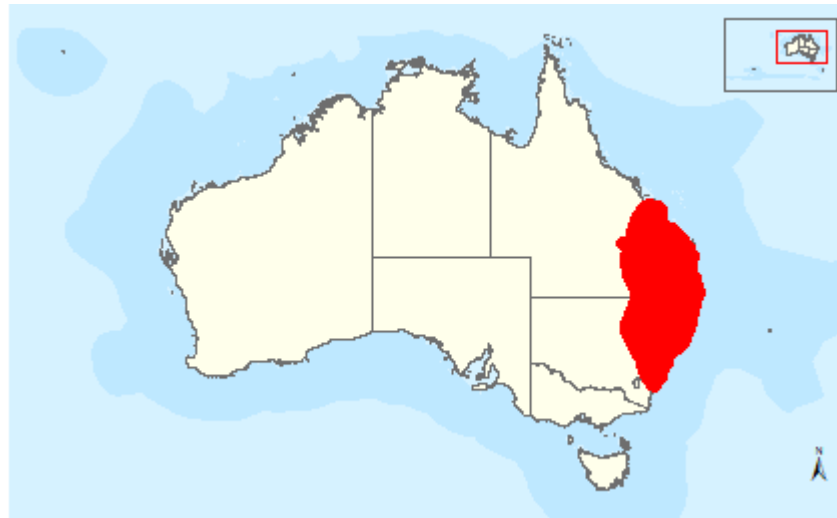


Figure 41: Mapped distribution range of Large-eared pied bat (Source: DSEWPaC 2011v)

9.38.2.3 Known species populations within the CSG fields

This species has been recorded in the Arcadia gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.38.2.4 Biology and reproduction

The diet and foraging behaviour of the Large-eared pied bat has not been well studied. The relatively short broad wings of this bat suggest that it is manoeuvrable and forages below the canopy (DERM 2011a). The species has been known to forage for insects at night around roost sites for a distance of up to several kilometres. However, it is not known if it targets particular groups of insects, such as moths (DERM 2011a).

Females can give birth at one year of age and males also appear capable of breeding at this age (DSEWPaC 2011v). Life expectancy and natural mortality have not been determined. Females have low fecundity giving birth to only one or two young per year (Hoye & Dwyer 1995).

Mating appears to occur in early winter. During autumn and early winter, males had enlarged testes and the muzzle glands of both sexes were swollen indicating that scent secreted from these glands may be a secondary sexual attractant during the mating period (Dwyer 1966). Females are pregnant in October and by early December they have all given birth and are lactating. Females most often have two young (average litter size of 1.8) with a juvenile sex ratio of males to females being 12:11. The nursery colony is established in September by both adult females and males with the majority of adult males leaving by the time the young are born in early summer. In late February and during March the juveniles have left the roost. The adult females leave the roost after the juveniles and the site is abandoned during the winter months (Dwyer 1966).

The generation life span has not been determined for the Large-eared pied bat. Based on the life expectancy of other bat species it is likely to be between two and ten years (DSEWPac 2011v).

9.38.3 Habitat

Natural roosts may depend heavily on sandstone outcrops/escarpments and this species has been observed in disused mine shafts, caves, overhangs and disused Fairy martin (*Hirundo ariel*) nests for shelter and to raise young. The species also possibly roosts in the hollows of trees, dry and wet sclerophyll forest, Cyprus-pine dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country. In South-east Queensland, the species has primarily been recorded from higher altitude among moist tall open forest adjacent to rainforest (DSEWPac 2011v).

Recent habitat modelling based on surveys in the southern Sydney region suggests that the Large-eared pied bat is largely restricted to the interface of sandstone escarpment for roost habitat and relatively fertile valleys for foraging habitat. Recent survey work in the Brigalow Belt South region of NSW supports this modelling (DSEWPac 2011v).

Almost all records have been found within several kilometres of cliff lines or rocky terrain (QLD DERM 2011a).

The majority of records are from canopied habitat, suggesting a sensitivity to clearing, although narrow connecting riparian strips in otherwise cleared habitat are sometimes quite heavily used (NSW DECC 2007).

It is considered that some populations of this species would rely in part on Brigalow (*Acacia harpophylla* dominant and co-dominant) communities (DSEWPac 2011v).

The Large-eared pied bat feeds on insects and usually flies at mid canopy level (6 to 10 m) from the ground but have also been documented flying low along creek lines (Curtis *et al* 2012).

9.38.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Large-eared pied bat habitat assumptions are presented below.

9.38.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat occurs within several kilometres of cliff lines or rocky terrain (QLD DERM 2011a)
- Narrow connecting riparian strips in otherwise cleared habitat are sometimes quite heavily used. As such, areas mapped as 'riverine', 'lacustrine' and 'palustrine' Wetland REs as well as 'riverine', 'lacustrine' and 'palustrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species
- Also occurs in dry and wet sclerophyll forest, Cyprus-pine dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland, sandstone outcrop country and moist tall open forest adjacent to rainforest (DSEWPac 2011v)

9.38.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Large-eared pied bat all REs that contain a specimen backed record, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.38.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

For the Large-eared pied bat, all REs that contain a specimen backed record have been mapped as 'essential habitat' in addition to the areas that have been validated during the pre-clearance surveys due to habitat and species recording. This mapping is restricted only to the relevant polygon in which the record falls (ie as per the DEHP certified RE mapping).

9.38.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records (ie forested areas adjacent to the identified 'essential habitat' area). 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based pre-clearance survey observations.

The range of these areas has been restricted to habitats that were identified during the pre-clearance surveys associated with either rocky outcrop terrains suitable for potential roosting sites or more complex structured habitat existing on fertile alluvial plains or sandy soils that provide a feeding and shelter resources consistent with those from habitats from which this species has been previously recorded.

9.38.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species such as simple structured and less fertile sedimentary rock, sandstone tableland associated habitats (ie that do not meet the habitat assumptions identified above).

9.38.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.38.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.38.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.39 South-eastern long-eared bat

9.39.1 Status

Vulnerable – listed 4 April 2001

9.39.2 Biology and ecology

9.39.2.1 Characteristics

The head and body length of the South-eastern long-eared bat (*Nyctophilus corbeni*) is approximately 50 to 75 mm in length and its tail length is approximately 35 to 50 mm. The weight varies between genders with females (14 to 21 g) being heavier than males (11 to 15 g).

The South-eastern long-eared bat is distinguishable from other long-eared bats by its larger size as well as a broader skull and jaw. It is also geographically separated from other long-eared bats (van Dyck & Strahan 2008).

It should be noted that most of the data on this species is from studies undertaken outside of Queensland (Curtis *et al* 2012).



Plate 40: South-eastern long-eared bat (Source: Murphy 2005)

9.39.2.2 Known distribution

The South-eastern long-eared bat has a limited distribution restricted to the Murray-Darling Basin in south-eastern Australia (DSEWPac 2011w). In Queensland, the majority of records for this species are from the Brigalow Belt South Bioregion, with the most easterly record from the Bunya Mountains National Park. The most northerly records are from the Expedition Range and Dawson River areas with the most westerly records from west of Bollon in the Mulga lands Bioregion (DSEWPac 2011w; Schulz & Lumdsen 2010). The nearest records to the Project footprint are from the Rundle Range, north of Gladstone and Expedition National Park on Melancholy Creek (DERM 2012; Atlas of Living Australia 2012).



Figure 42: Mapped distribution range of South-eastern long-eared bat (Source: DSEWPaC 2011w)

9.39.2.3 Known species populations within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.39.2.4 Biology and reproduction

There is little information currently available on this species reproductive biology, although it is thought that mating takes place during autumn and winter. Females are thought to store sperm until spring, when fertilisation and gestation occurs. Up to two young are born during late spring/early summer with young not fully weaned until mid-summer (DEC 2005a; Curtis *et al* 2012).

9.39.3 Habitat

Although commonly recorded in some areas such as the Brigalow Belt South and Nandewar Bioregions in north-eastern NSW, this species occurs in a range of inland woodland vegetation types, including box, ironbark, cypress pine, mallee, bull-oak, brigalow and belah woodlands/forests and will roost in tree hollows, crevices and under loose bark within these communities (DEC 2005a; DSEWPaC 2011w). The South-eastern long-eared bat forages within the understorey of the abovementioned communities, including the ground (DSEWPaC 2011xw; Schulz & Lumdsen 2010).

'Essential habitat' is generally associated with large tracts of vegetation (100s to 1,000s of ha), including open forest with open to dense u/storey (but also found in SEVT and brigalow/ belah); mixed *Eucalyptus/ Corymbial/ Angophora* +/- cypress/ bull-oak (pers comm. Greg Ford). 'General habitat' seems to be associated mainly with large tracts of relatively undisturbed woodland and forest, particularly on landzones 5, 7 and 10 (and landzone 3 within these), although it does venture into landzone 4 and 9 (pers comm. Greg Ford).

The species is known to fly large distances (>7 km in a night) from roosts to foraging areas. There is limited information on species habitat in Queensland, with data based on capture records only (Curtis *et al* 2012).

Limited information is available regarding the roosting ecology of this species, however surveys undertaken by others suggest that these bats may change roosting sites as frequently as each day (most roosts used for just a single day) and are likely to travel across large distances between

consecutive roosts (up to 2 km). No information is available on maternity roosts where larger groups may form (DSEWPaC 2011w; Schulz & Lumdsen 2010).

9.39.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The South-eastern long-eared bat habitat assumptions are presented below.

9.39.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands (DSEWPaC 2011w)
- Also occurs in Bull-oak woodland, Brigalow woodland, Belah woodland, Smooth-barked apple (*Angophora leiocarpa*), woodland; River red gum (*Eucalyptus camaldulensis*), forests lining watercourses and lakes, Black box (*Eucalyptus largiflorens*), woodland, dry sclerophyll forest (DSEWPaC 2011w)

9.39.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the South-eastern long-eared bat, all REs that are considered to be habitat for this species, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.39.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.39.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

For the South-eastern long-eared bat, all areas that contain REs that provide habitat as identified by DOTE are included within the 'general habitat' category.

9.39.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.39.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.39.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.39.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.40 Northern quoll

9.40.1 Status

Endangered – listed 12 April 2005

9.40.2 Biology and ecology

9.40.2.1 Characteristics

The Northern quoll (*Dasyurus hallucatus*) is the smallest of the four Australian quoll species. This species is the most arboreal and aggressive of the four quoll species (DSEWPaC 2011x). It has reddish brown fur dorsally, with cream coloured fur on its ventral surface. White spots are present on its back and rump although the tail is unspotted. The Northern quoll has a pointy snout. The Northern quoll is a solitary carnivorous marsupial that makes its dens in rock crevices, tree holes or occasionally termite mounds. This species is primarily nocturnal or may be crepuscular under certain situations.

The Northern quoll can weigh up to 1.2 kg, with the males being larger than the females (TSSC 2005). The body size for a male is approximately 270 to 370 mm and the female is approximately 249 to 310 mm (Van Dyck; Strahan 2008).



Plate 41: Northern quoll (Source: Ward 2010)

9.40.2.2 Known distribution

The Northern quoll was historically common across northern Australia, occurring almost continuously from the Pilbara, Western Australia, to near Brisbane, Queensland (Braithwaite & Griffiths 1994). The Northern quoll is now restricted to five regional populations across Queensland, the Northern Territory and Western Australia both on the mainland and on offshore islands.

Within Queensland, extant populations are highly fragmented and have experienced significant range reductions when compared to the species former distribution (DSEWPaC 2011x).

The Northern quoll is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, as far north as Cooktown in Queensland and extends as far west into central Queensland to the vicinity of Carnarvon Range National Park (Woinarski *et al* 2008). There are occasionally records as far south in Queensland as Maleny on the sunshine coast hinterland (DERM 2009).

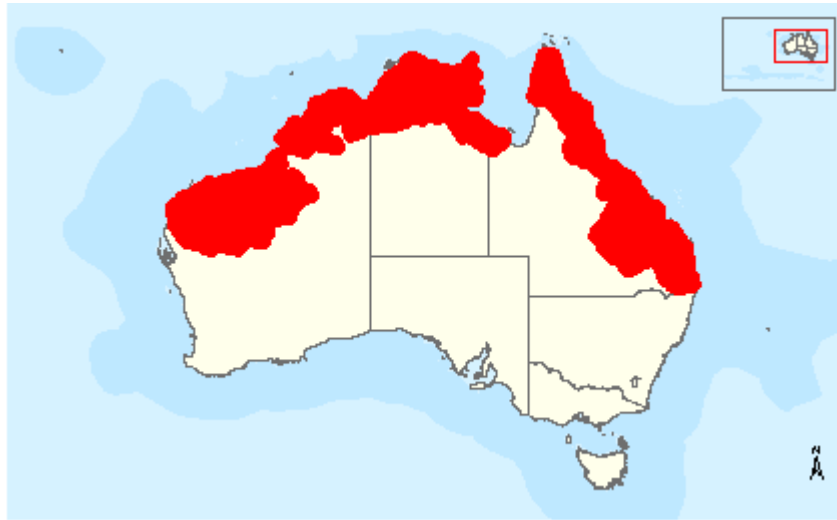


Figure 43: Mapped distribution range of Northern quoll (Source: DSEWPaC 2011x)

9.40.2.3 Known species populations within the CSG fields

This species has a moderate chance of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.40.2.4 Biology and reproduction

Northern quolls have short life spans, with males living for approximately one year and the oldest recorded female in the wild being three years of age (TSSC 2005).

Northern quolls breed once each year exhibiting synchronous reproduction within each year at each site (Nelson & Gemmell 2003, Oakwood 2008). Northern quolls produce on average seven young which are born after a gestation of 21 to 26 days. Females wean two to three young which become reproductively mature at 11 months (Oakwood 2008).

In the first year that females reproduce, the litters are larger and predominately male. If breeding occurs in the second year, litters are smaller and predominately female. As females rarely survive to reproduce in the third year, the breeding territory is probably inherited by one of her daughters, ensuring breeding success (Oakwood 2000).

Whilst still in the pouch, juveniles have a high rate of survival, but once they leave the pouch and are left in the den they are likely to suffer high mortality.

Young start to eat insects at four months old, and leave the den to forage at five months old, whilst still suckling from their mother. Juveniles are weaned at 6 months old, in November to early December. Once young are independent their survival is difficult to assess as they disperse to other areas. At this stage, they are in a size range that makes them vulnerable to a wide range of predators (Oakwood 2000).

The majority of male Northern quolls die after their first breeding season, which is unusual for a marsupial this large (Oakwood 2000).

The intense physical effort of male quolls (roving during the females onset of oestrus) appears to cause the physiological decline of males and subsequent die off at one year of age (Oakwood 2008). This male die-off in combination with the fact females usually breed only once makes local populations highly vulnerable to extinction.

9.40.3 Habitat

The Northern quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert (Threatened Species Scientific Committee 2005aq). Northern quoll are also known to occupy non rocky lowland habitats such as beachscrub communities in central Queensland. Northern quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Rocky habitats are usually of high relief, often rugged and dissected but can also include tor fields or caves in low lying areas such as in Western Australia. Eucalypt forest or woodland habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes. Dens are made in rock crevices, tree holes or occasionally termite mounds (Threatened Species Scientific Committee 2005aq). Northern quolls sometimes occur around human dwellings and campgrounds. Northern quolls appear to be most abundant in habitats within 150 km of the coast (Braithwaite & Begg 1995).

Recent surveys throughout Queensland have suggested Northern quolls are more likely to be present in high relief areas that have shallower soils, greater cover of boulders, less fire impact and were closer to permanent water (Woinarski *et al* 2008).

Rocky habitats support higher densities and/or longer lived individuals within the species range, due to more protection from predators, better nutrition and less exposure to agricultural practices (Burnett 1997; Oakwood 2000). Rocky habitats also supported a higher density of Northern Quoll dens (Oakwood 1997 in Oakwood 2000). Breeding success is higher in animals that have a den near a creek line (Braithwaite & Begg 1995).

9.40.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The habitat assumptions for the Northern quoll are presented below.

9.40.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, (DSEWPac 2011x)
- The Northern quoll is now only known from the most rugged and remote parts of its former range (Curtis *et al* 2012). This could be attributed to the reduced occurrence and accessibility of the poisonous cane toads within these areas which has partly led to a decline in the species
- Research indicates that the species is more likely to be present in high relief areas that have shallower soils, greater cover of vegetation, boulders, less fire impact and were closer to permanent water (Woinarski *et al* 2008)
- It can also be assumed that the Northern quoll habitat would not extend into the surrounding un-wooded grasslands based on its habitat requirements such as cover from predators, height relief areas with a greater cover of boulders, rocky outcrops and less fire impact (Woinarski *et al* 2008; DSEWPac 2011x; Curtis *et al* 2012)

9.40.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Northern quoll, all REs that contain a specimen backed record (from any data source), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.40.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.40.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

9.40.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.40.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.40.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.40.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.41 Bridled nail-tail wallaby

9.41.1 Status

Endangered – listed 16 July 2000

9.41.2 Biology and ecology

9.41.2.1 Characteristics

The Bridled nail-tail wallaby (*Onychogalea fraenata*) is a highly solitary, medium-sized macropod; up to 1 m tall and weighing up to 8 kg (males). The species has distinctive markings of a white 'bridle' line running from the centre of the neck, along the shoulder to behind the forearm on each side of the body. A black stripe runs the length of the body, and white cheek stripes are present on both sides of the head. A horny 'nail' occurs at the tip of the tail, is between 3 to 6 mm and is partly concealed by hair (Lundie-Jenkins 2001).

The species has a high level of sexual dimorphism and males may be up to twice as large as females (Sigg & Goldizen 2006).



Plate 42: Bridled nail-tail wallaby (*Onychogalea fraenata*) (Source: Reardon n.d)

9.41.2.2 Known distribution

The Bridled nail-tail wallaby is confined to Taunton National Park (Scientific) (an area of 11,000 ha) near the town of Dingo with some sightings within 10 km of the park (Davidson 1991; Lundie-Jenkins 2001). Population genetics and radio-tracking studies have shown that the populations at different localities within Taunton National Park (Scientific) are not isolated, but connected through frequent juvenile dispersal (Fisher 1999). One reintroduced population is confined to a smaller section of Idalia National Park in Western Queensland (Pople *et al* 2001), and another exists at Avocet Nature Refuge near Emerald, in Central Queensland (Lundie-Jenkins & Lowry 2005). Another population has been re-introduced at Scotia Sanctuary (64,000 ha), 150 km south of Broken Hill (Finlayson *et al* 2008).

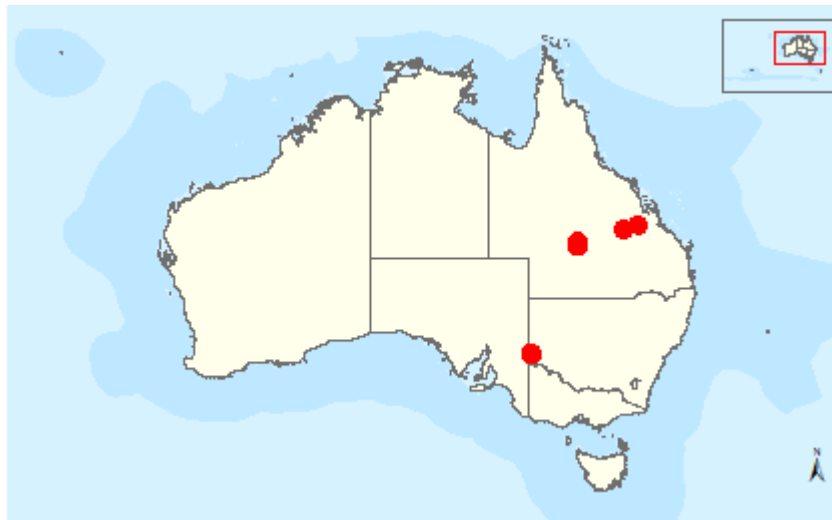


Figure 44: Mapped distribution range of the Bridled nail-tail wallaby (Source: DOTE 2014y)

9.41.2.3 Known species populations and their relationship within the CSG fields

This species has been historically observed within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.41.2.4 Biology and reproduction

A study at Taunton National Park (Scientific) found the diet of the Bridled nail-tail wallaby to be diverse, including herbaceous species (forbs), grasses and shrubs. Proportions of these different plant groups varied with season and availability. Bridled nail-tail wallabies prefer other foods to grass species in all seasons, particularly during the dry winter. At this time forbs (mostly chenopods) became the major dietary component, and feeding selectivity was high for the relatively rare food items such as sedges. There was strong selection for sedges during spring, when food resources were at their lowest abundance. They showed a preference for food items of relatively high nutritional value (leaf and reproductive parts such as seedheads) and selection against items of relatively high fibre content (grass stem and sheath). They also appeared to prefer younger stages of growth (which have less fibre) (Evans & Jarman 1999).

Bridled nail-tail wallabies breed all year round. Females conceive while they have a joey in the pouch, and the timing of development is such that the next young is born the day after the previous one leaves the pouch permanently (Fisher & Goldizen 2001; Johnson 1997).

Bridled nail-tail wallabies require areas of low, dense ground cover that is close to pasture to breed successfully. After young leave the pouch permanently at around 17 weeks old, juvenile Bridled nail-tail wallabies do not follow their mothers as larger kangaroos do. Rather, they spend the day concealed in dense cover, generally at the edge of a feeding area that is more than 200 m away from their mothers' daytime shelter (DOTE 2014x).

9.41.3 Habitat

The Bridled nail-tail wallaby occurs in woodland, particularly in Brigalow (*Acacia harpophylla*) scrub, preferring areas with the most fertile soil (Lundie-Jenkins 2001). During the day (when they are resting), Bridled nail-tail wallabies prefer habitat that consists of young Brigalow regrowth or contains fallen logs (Evans 1996). They shelter beneath shrubs, in large grass tussocks and inside hollow logs.

Adults prefer logs where available (Fisher & Goldizen 2001) but also used grass shelters as the biomass of grass increases after a drought, enabling them to shelter closer to feeding areas. They generally choose shelter sites with the densest cover of foliage and stems at Bridled nail-tail wallaby height (25 to 50 cm), and this type of shelter is concentrated at the edges of wooded areas such as Brigalow regrowth (Fisher 2000). At night (when they are feeding), they prefer the ecotone habitat containing both pasture and young Brigalow regrowth (Evans 1996). When feeding in open pasture, they prefer to stay close to the edge of shelter habitat (Evans 1996).

On the north-western section of Taunton National Park (Scientific), the Bridled nail-tail wallaby is found in all four of the major vegetation types; open grassy eucalypt woodland dominated by Poplar box (*Eucalyptus populnea*), dense *Acacia* forest dominated by Brigalow, transitional vegetation intermediate between the woodland and forest and in areas of very dense Brigalow regrowth (Tierney 1985). At Idalia National Park, reintroduced Bridled nail-tail wallabies use open woodland as well as Brigalow regrowth, and also use Wilga bushes (*Geijera parviflora*) as shelter habitat (Pople *et al* 2001).

9.41.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Bridled nail-tail wallaby habitat assessment assumptions are presented below.

9.41.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs in open grassy eucalypt woodland dominated by Poplar box (*Eucalyptus populnea*), dense *Acacia* forest dominated by Brigalow, transitional vegetation intermediate between the woodland and forest and in areas of very dense Brigalow regrowth (Tierney 1985)
- The species prefers the ecotone habitat containing both pasture and young Brigalow regrowth when feeding (Evans 1996)

9.41.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Bridled nail-tail wallaby, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.41.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.41.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Bridled nail-tail wallaby, all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'.

9.41.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.41.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.41.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.41.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.42 Brush-tailed rock-wallaby

9.42.1 Status

Vulnerable – listed 16 July 2000

9.42.2 Biology and ecology

9.42.2.1 Characteristics

The Brush-tailed rock-wallaby (*Petrogale penicillata*) is brown above, tending to be rufous on the rump and grey on the shoulders. The chest and belly is paler and in some individuals there is a white blaze on the chest. There is a white to buff cheek stripe and a black dorsal stripe from the forehead to the back of the head. The exterior of the ears is black, and inside the ears is buff. There is a black auxiliary patch often extending as a dark stripe to the margin of the hind-legs. There is a pale grey side-stripe sometimes present. The feet and paws are dark brown to black. The tail darkens distally with a prominent brush. The pelage is long and thick, particularly about the rump, flanks and base of the tail. Individuals from the north of the species range tend to be lighter and have a less prominent tail brush (Eldridge & Close 1998).

Males grow to 529 to 586 mm and females to 510 to 570 mm in head and body length. The tail length of the male is 510 to 700 mm and 500 to 630 mm for females. Males reach a weight of 5.5 to 10.9 kg and females a weight of 4.9 to 8.2 kg (Eldridge & Close 1998).



Plate 43: Brush-tailed rock-wallaby (*Petrogale penicillata*) (Source: Fergus 2004)

9.42.2.2 Known distribution

It is estimated that the total population size is between 15,000 and 30,000 individuals (DOTE 2014z). Gaining a more precise estimate of numbers is difficult due to inaccessibility of the species habitat, particularly to the north of its range where numbers are known to be greater (DEC 2005b). Seventeen percent of the total population occurs in south-eastern Queensland, 82% in New South Wales (including ACT), and fewer than 1% in Victoria. Up to 80% of the total population occurs in northern New South Wales alone (DEC 2005b).

The Brush-tailed rock-wallaby was once widespread and abundant in south-eastern Australia. It was formerly found along the Great Dividing Range from Nanango in south-east Queensland through to east Gippsland in Victoria (Connolly 1995; Eldridge & Close 1992; Short & Milkovits 1990). However, there has been a reduction in the species range and numbers with the decline being greatest in Victoria and southern New South Wales (DEC 2005b). Despite this range contraction, the Brush-tailed rock-wallaby is still the most widespread *Petrogale* in eastern Australia (Eldridge & Close 1992). The species is known from 962 nationally-recorded sites; 876 of these sites are in New South Wales (DEC 2005b).

Populations of the Brush-tailed rock-wallaby occur, or did occur, throughout the Great Dividing Range from the border with New South Wales to Nanango, 100 km northwest of Brisbane (where it forms a hybrid zone with *Petrogale herberti*) (Eldridge & Close 1992). Although there are no recent surveys published from Queensland, this species is considered to be declining and vulnerable (Clancy & Close 1997). It appears that the population in Lamington National Park is now extinct (Maxwell *et al* 1996).

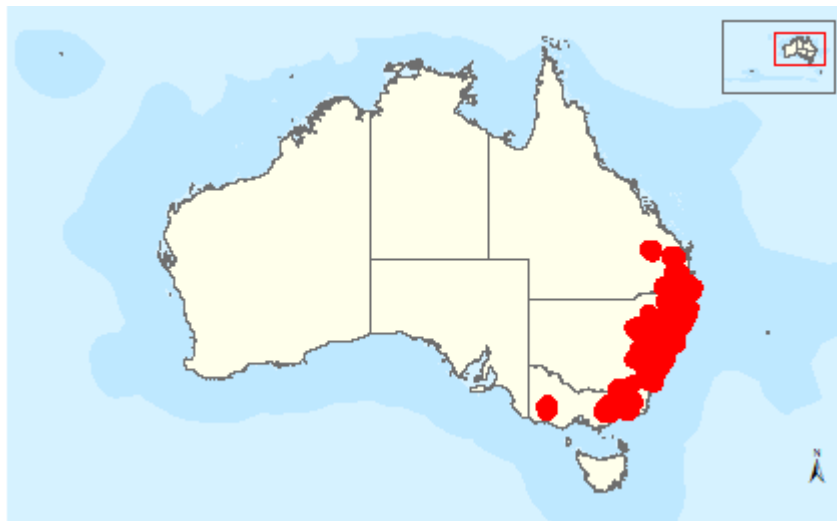


Figure 45: Mapped distribution range of the Bridled nail-tail wallaby (Source: DOTE 2014z)

9.42.2.3 Known species populations and their relationship within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.42.2.4 Biology and reproduction

The diet of the Brush-tailed rock-wallaby is primarily grasses (35 to 50%), forbs (25 to 40%) and "browse" (shrubs, trees and climbers) (12 to 30%) with ferns and sedges of very minor importance (Short 1989). It is also reported to eat *Themeda triandra* (Kangaroo grass) more than other grass species (Jarman & Phillips 1989). Rock-wallabies forage mostly at night (NPWS 2003).

Sexual maturation of females occurs at 18 months and males at 20 to 24 months (Lee & Ward 1989; DEC 2005b).

Brush-tailed rock-wallabies are polygamous and a dominant male will be found with up to four females. They appear to live in family groups of two to five adults and usually one or two juveniles and sub-adult individuals (Joblin 1983; Short 1980), but are also known to occur in male-female pairs (DEC 2005b).

A rocky habitat with an abundant supply of ledges, caves and potential pathways, plus a northerly aspect were found to be important for rock-wallabies to breed (Short 1982).

Females give birth to a single pouch young at a time, after a gestation period of approximately 30 days (Close 1993). The young remain in the pouch for six months. After it first emerges from the pouch, the joey spends a further seven to 20 days in and out of the pouch. The mother leaves the dependent young in small caves during the day between feeds. Weaning is believed to occur 86 days after leaving the pouch, when the joey is nine months old (Lee & Ward 1989).

9.42.3 Habitat

This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks (Murray *et al* 2008; Short 1982). It also utilises tree limbs (Maxwell *et al* 1996, Sharman & Maynes 1983). While it appears that most Brush-tailed rock-wallaby colonies are on north-facing slopes and cliff lines (Short 1982), colonies have been found on south-facing cliffs in Kangaroo Valley (Kutzner & Dodd 1996; Wong 1997), in the Macleay River Gorge (Bayne 1994), in the Warrumbungles and at Mt Kaputar (NPWS 2003), although usually in lower densities (DOTE 2014z).

Rocky outcrops appear crucial to current habitat selection by rock-wallabies, however, vegetation structure and composition is also considered to be an important factor (Bugg 1995; Lim & Giles 1987; Pearson 1992). In many parts of their range, including at the Warrumbungles, rock-wallabies are closely associated with dense arboreal cover, especially fig trees (NPWS 2003). The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases may provide some protection from predation (Wong 1993 & 1997). A range of vegetation types are associated with Brush-tailed rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (Murray *et al* 2008).

Brush-tailed rock-wallabies typically shelter during the day in rock crevices, caves and overhangs, yet often bask in exposed sunny spots (Sharman & Maynes 1983). Within their home range, rock-wallabies habitually use the same refuges, sunning spots, feeding areas and pathways (Joblin 1983) and these are often defended vigorously (Bayne 1994).

Brush-tailed rock-wallabies select foraging locations that tend to be more open and with more short green grasses and forbs than other locations nearby. Foraging Brush-tailed rock-wallabies do not favour areas that are concealed by tussocks or near to the cliffs (Carter & Goldizen 2003).

9.42.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Brush-tailed rock-wallaby habitat assessment assumptions are presented below.

9.42.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks (Murray *et al* 2008; Short 1982)
- Most Brush-tailed rock-wallaby colonies are on north-facing slopes and cliff lines and when present populations on south-facing slopes contain fewer individuals (Short 1982)

9.42.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Brush-tailed rock-wallaby, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.42.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.42.4.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Bridled nail-tail wallaby, all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'.

9.42.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.42.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.42.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.42.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.43 Grey-headed flying-fox

9.43.1 Status

Vulnerable – listed 6 December 2001

9.43.2 Biology and ecology

9.43.2.1 Characteristics

The Grey-headed flying-fox (*Pteropus poliocephalus*) is one of the largest bats in the world with a weight of 600 to 1,000 g and a head-body length of 230 to 289 mm (Eby & Lunney 2002; Tidemann 1998). It is the only Australian flying-fox that has a collar of orange/brown fully encircling its neck (Hall 1987). Thick leg fur extends to the ankle, in contrast to other *Pteropus* species in which it only reaches the knee (Hall 1987; Tidemann 1998). As its name implies, the head is covered by light grey fur (Hall 1987). The belly fur is grey, often with flecks of white and ginger. The fur on the back shows two morphs which could be related to age, moult or sub-population (Hall & Richards 2000). One morph has dark grey fur and the other has a pronounced silver or frosted appearance (Hall 1987). Winter fur is darker than summer fur with a pronounced moult occurring in June (Hall 1987).



Plate 44: Grey-headed flying fox (*Pteropus poliocephalus*) (Source: Welbergen 2009)

9.43.2.2 Known distribution

The Grey-headed flying-fox is Australia's only endemic flying-fox and occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria (Tidemann 1998). However, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years. At a local scale, the species is generally present intermittently

and irregularly (Eby & Lunney 2002). At a regional scale, broad trends in the distribution of plants with similar flowering and fruiting times support regular annual cycles of migration (Eby & Lunney 2002). Whilst Brisbane, Newcastle, Sydney and Melbourne are occupied continuously (Pallin 2000; Hall 2002; van der Ree *et al* 2006), elsewhere, during spring, Grey-headed flying-foxes are uncommon south of Nowra and widespread in other areas of their range. The species is widespread throughout their range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of New South Wales (associated with flowering Spotted gum (*Corymbia maculata*)) and on the north-west slopes (generally associated with flowering White box (*Eucalyptus albens*) or Mugga ionbark (*Eucalyptus sideroxylon*)) (NSW DECCW 2010).

The species sometimes ranges into South Australia (Hall & Richards 2000) and occasional individuals have been observed on Bass Strait islands (Tidemann 1998) and mainland Tasmania (Kempton 2010). It is infrequently found west of the Great Dividing Range (Tidemann 1998).

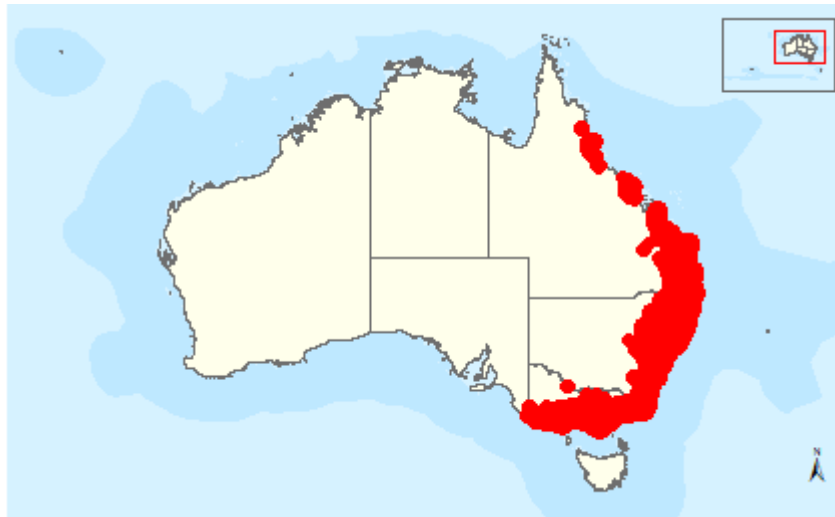


Figure 46: Mapped distribution range of the Grey-headed flying-fox (Source: DOTE 2014aa)

9.43.3 Known species populations and their relationship within the CSG fields

This species has historically been recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.43.3.1 Biology and reproduction

The Grey-headed flying-fox has a diverse native diet, which it supplements with introduced plants (Eby 1995, 1998; Hall & Richards 2000; Parry-Jones & Augee 1991). Nectar and pollen from the flowers of eucalypts (genera *Eucalyptus*, *Corymbia* and *Angophora*), melaleucas and banksias are the primary food for the species (Duncan *et al* 1999). Most eucalypts have regular seasonal flowering schedules but do not flower every year, and there are a few areas within the range of the Grey-headed flying-fox where nectar is available continuously (House 1997; Law *et al* 2000; Wilson & Bennett 1999).

Generally, females do not reach full sexual maturity until three years of age (Martin 2000).

Mating occurs in early autumn, after which time the larger camps begin to break up, reforming in late spring/early summer, as food resources become more abundant (Hall & Richards 2000). Males and females segregate in October when females usually give birth. Following six months of gestation,

females bear a single young each year. Lactation usually begins in October and continues for three to four months or sometimes longer (Nelson 1965).

For a period of four to five weeks after giving birth, the mother carries her single young with her to feeding sites. Young are carried on the ventral surface of their foraging mothers (Tidemann 1998). Once the young are completely furred, they are left in maternal camps and continue to be nursed until they are independent after around 12 weeks (Hall & Richards 2000).

9.43.4 Habitat

The Grey-headed flying-fox requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from *Eucalyptus* and related genera but in some areas it also utilises a wide range of rainforest fruits (Eby 1998).

The Grey-headed flying-fox roosts in aggregations of various sizes on exposed branches. Roost sites are typically located near water, such as lakes, rivers or the coast (van der Ree *et al* 2005). Roost vegetation includes rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation (Nelson 1965; Ratcliffe 1931), but colonies also use highly modified vegetation in urban and suburban areas (Birt *et al* 1998; Tidemann & Vardon 1997; van der Ree *et al* 2005). The species can maintain fidelity to roost sites for extended periods (Lunney & Moon 1997), although new sites have been colonised (Tidemann & Vardon 1997).

9.43.5 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' presented in this SSMP. The Grey-headed flying-fox habitat assessment assumptions are presented below.

9.43.5.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- This species utilises rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands, commercial fruit crops and introduced tree species in urban areas (Eby 1998)
- The primary food source is blossom from *Eucalyptus* and related genera (Eby 1998)
- The species utilises rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation typically located near water, such as lakes, rivers or the coast for roosting (Nelson 1965; Ratcliffe 1931)

9.43.5.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Grey-headed flying-fox, all areas identified in the habitat assumptions above, which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.43.5.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.43.5.4 General habitat

General habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential / core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters supported by literature and field based observation.

For the Grey-headed flying-fox, all areas that meet the habitat assumptions that are not contained within areas that overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'general habitat'.

9.43.5.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.43.6 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.43.7 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 100 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.43.8 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.44 Koala

9.44.1 Status

Vulnerable - listed 2 May 2012

9.44.2 Biology and ecology

9.44.2.1 Characteristics

The Koala (*Phascolarctos cinereus*) is an arboreal, herbivorous marsupial and is mostly nocturnal. However, unlike other arboreal mammals the Koala does not have a tail. They have a large round head, large round furry ears, a stout body, short legs and large feet. Both front and hind paws have long sharp claws. The Koala ranges between 67 to 74 cm in males and 64 to 73 cm in females. A male Koala on average weighs 6.5 kg, while a female Koala on average weighs 5.1 kg (Australian Koala Foundation 2012; Menkhorst & Knight 2004).



Plate 45: Koala (Source: Monkhouse 2005)

9.44.2.2 Known distribution

In Queensland, the Koala's distribution extends inland from the east coast: from the Wet Tropics interim biogeographic regionalisation of Australia (IBRA) bioregion, into the Einasleigh Uplands bioregion in the north of the state; from the Central Mackay Coast bioregion, through the Brigalow Belt North bioregion to the Desert Uplands and Mitchell Grass Downs bioregions, and from the Southeast Queensland bioregion, through the Brigalow Belt to the Mulga Lands and Channel Country bioregions in the south-west of the state (Patterson 1996; TSSC 2012).

The highest density of the Koala population occurs in south-east Queensland. Lower densities occur through central and eastern areas (Queensland EPA 2006).

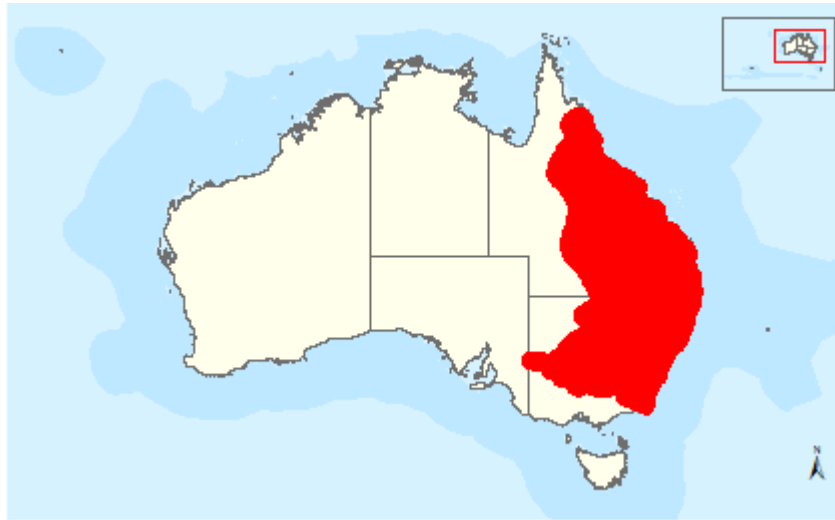


Figure 47: Mapped distribution range of Koala (Source: DOTE 2014a)

9.44.2.3 Known species populations within the CSG fields

This species has been observed within the CSG fields which are within the known distribution of the species and suitable habitat is present.

9.44.2.4 Biology and reproduction

Female Koalas can potentially produce one offspring each year with births occurring between October and May. The newly-born Koala lives in its mother's pouch for six to eight months and, after leaving the pouch, remains dependent on the mother, riding on her back. Young Koalas are independent from about 12 months of age (DOTE 2014a).

The Koala is a leaf-eating specialist that feeds primarily during dawn, dusk or night (Crowther *et al* 2013). Its diet is restricted mainly to foliage of *Eucalyptus* spp; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. The Koala may, at times, supplement its diet with other species, including *Leptospermum* spp. and *Melaleuca* spp. (Martin & Handasyde 1999; Moore & Foley 2000).

9.44.3 Habitat

Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species (Martin & Handasyde 1999).

Koala habitat can be broadly defined as any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. The distribution of this habitat is largely influenced by land elevation, annual temperature and rainfall patterns, soil types and the resultant soil moisture availability and fertility. Preferred food and shelter trees are naturally abundant on fertile clay soils.

Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by *Eucalyptus* species. In coastal lowlands in Queensland and New South Wales, Koalas are also found in vegetation communities dominated by *Melaleuca* or *Casuarina* species (TSSC 2012p).

On the western slopes, tablelands and plains in Queensland and New South Wales, Koalas are found in sub-humid *Eucalyptus*-dominated forests and woodlands in riparian and non-riparian environments, and some *Acacia*-dominated forests and woodlands in non-riparian environments (Melzer *et al* 2000).

In the dry, subtropical to semi-arid environments in the western parts of the species' range, Koalas inhabit *Eucalyptus*-dominated forests and woodlands, particularly in the vicinity of riparian environments, and *Acacia*-dominated forests, woodlands and shrublands (Melzer *et al* 2000; NSW DECC 2008; Sullivan *et al* 2003a).

Koalas are also known to occur in modified or regenerating native vegetation communities, as well as urban and rural landscapes where food trees or shelter trees may be highly scattered.

There is a growing body of evidence that identifies the importance of shelter (non-food) trees to koalas. Crowther and colleagues (2013) expand on this and suggest that shelter trees are equally important as food trees and should be weighted as such when assessing habitat suitability. Shelter trees play an essential role in thermoregulation and are likely to be selected based on height, canopy cover and elevation (ie trees occurring in gullies are preferable) (Crowther *et al* 2013). The difficulty in regards to shelter trees is that, unlike food trees, there is no identified sub-set of forest and woodland trees known to be shelter trees. The use of a particular tree species, or individual trees within a species is highly contextual and variable (Crowther *et al* 2013).

9.44.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The habitat assumptions for the Koala are presented below.

9.44.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Within the Brigalow-belt Region, the following eucalypt species are considered to provide a food source for this species: *Eucalyptus saligna*, *Eucalyptus camaldulensis*, *Eucalyptus tereticornis*, *Eucalyptus populnea*, *Eucalyptus siderophloia* and *Eucalyptus chloroclada* (Australian Koala Foundation 2012)

9.44.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Koala, all REs that contain a specimen backed record (from any data source), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.44.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either

migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.44.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

9.44.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.44.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.44.6 Unavoidable impact from the Project

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.44.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.45 Murray cod

9.45.1 Status

Vulnerable – listed 3 July 2003

9.45.2 Biology and ecology

9.45.2.1 Characteristics

The Murray cod (*Maccullochella peelii*) is the largest freshwater fish found in Australia, growing up to 1.8 m in length and weighing over 100 kg, although most commonly weighing 10 kg. It possesses a broad, depressed head with a rounded snout and a concave forehead profile. It has a large mouth and jaws that are approximately equal in length. The caudal fin is rounded and 65 to 81 scales are present in the lateral line. It is olive-green with small brown spots, rounded pectoral fins, creamy white undersides and sometimes with red on fin edges (DSEWPac 2011y).

This species is a long-lived predator that is highly territorial and will aggressively attack any fish entering its area. The species rate of growth varies probably due to temperature, habitat and food availability; however, it does not vary between sexes. Murray cod older than five years gain 1 to 1.5 kg per year in rivers and 2 to 2.5 kg per year in warm impoundments (DSEWPac 2011y).



Plate 46: Murray cod (Source: Schmida 2003)

9.45.2.2 Known distribution

The Murray cod is found extensively throughout the Murray-Darling Basin in the south-eastern region of Australia. Both hatchery-bred and wild caught fish have been translocated outside the natural range. The species has been introduced in the Cooper Creek system in Queensland and South Australia. In Queensland it has also been introduced to the Burnett and Fitzroy River systems (DSEWPac 2011y).

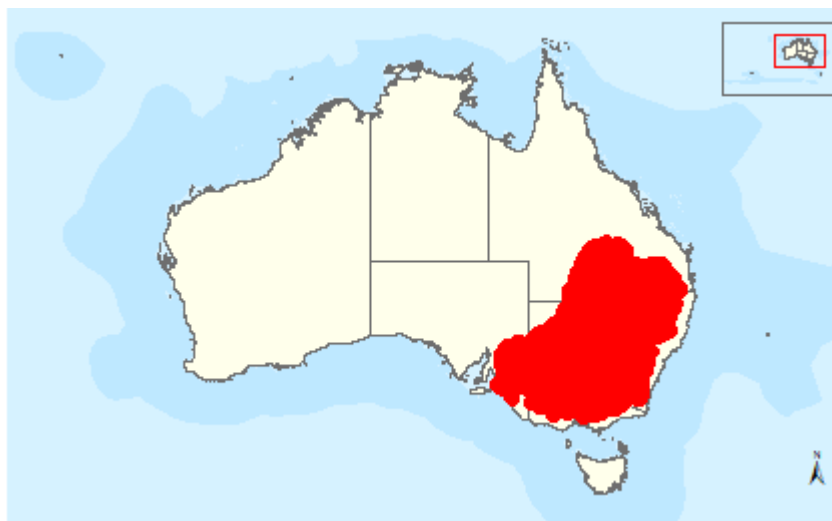


Figure 48: Mapped distribution range of Murray cod (Source: DSEWPac 2011y)

9.45.2.3 Known species populations within the CSG fields

This species has a moderate chance of occurring within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.45.2.4 Biology and reproduction

The Murray cod is the top predator of Australia's inland rivers. Cod are carnivorous and, at times, voracious feeders (McDowall 1996). The diet changes with age, with the typical adult diet consisting of spiny crayfish, yabbies and shrimps (National Murray Cod Recovery Team 2009). It also feeds on the following fish:

- Common carp (introduced)
- Goldfish and Redfin perch (introduced)
- Bony herring
- Catfish
- Golden perch
- Western carp gudgeon
- other Cod species

Other species found in the diet include ducks, cormorants, grebes, tortoises, water dragons, snakes, mice, frogs and mussels. Upon hatching, larvae are 5 to 8 mm long and within 8 to 10 days are able to feed on zooplankton. After reaching a length of 15 to 20 mm, they begin to feed on aquatic insects (Kearney & Kildea 2001; Native Fish 2004).

The Murray cod reaches sexual maturity at 4 to 5 years of age and at 2 to 3 kg in weight. The species has relatively low fertility compared to many other freshwater fish (Native Fish 2004). A female weighing around 3 kg can produce approximately 10,000 eggs whereas a female around 23 kg produces up to 90,000 eggs (Kearney & Kildea 2001).

The species migrates upstream prior to spawning in late spring and early summer when the water reaches a temperature of between 16 to 21°C. This change in temperature provides the stimulus for spawning (Kearney & Kildea 2001). Murray cod form pairs prior to breeding. A spawning site is

selected, usually a sunken red gum log in lowland rivers, or a submerged rock in upland streams, although Murray cod have been recorded excavating and laying eggs in depressions in clay banks as well. The female is believed to clean the breeding site with her tail before laying her large adhesive eggs as a large mat on the spawning surface. The male then squirts his milt over the eggs fertilising them (Native Fish 2004). Hatching usually occurs 5 to 7 days after fertilisation, and a batch of eggs takes 3 to 4 days to hatch (Kearney & Kildea 2001). The larvae then drift downriver, prior to the fry settling out in suitable protected habitat (TSSC 2003c).

9.45.3 Habitat

The Murray cod has the ability to live in a diverse range of habitats, including clear rocky streams to slow flowing, turbid rivers and billabongs. The Murray cod is considered a main channel specialist as it is frequently found in the main river channel and larger tributaries. It is found in floodplain channels when they contain water; although this usage appears limited. Juveniles are most commonly found in the main river channel until about one year of age, after which they branch out (National Murray Cod Recovery Team 2010).

The Murray cod is usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures (National Murray Cod Recovery Team 2010).

Essential microhabitat for the Murray cod includes intact waterway habitat with complex structural cover (large rocks, snags, overhanging vegetation), main channel or high flow areas that are known or highly likely to support natural populations of this species.

9.45.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The habitat assumptions for the Murray cod are presented below.

9.45.4.1 General assumptions

The following habitat assumption has been made based on current scientific knowledge of this species:

- The Murray cod is found in a wide range of warm water habitats, from clear, rocky streams to slow-flowing turbid rivers and billabongs in waters up to 5 m deep and in sheltered areas with cover from rocks, timber or overhanging banks (DSEWPaC 2011y)

9.45.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

9.45.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.45.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

9.45.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.45.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.45.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 500 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.45.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.46 Fitzroy river turtle

9.46.1 Status

Vulnerable – listed 16 July 2000

9.46.2 Biology and ecology

9.46.2.1 Characteristics

The Fitzroy river turtle (*Rheodytes leukops*) is a medium to dark brown turtle growing to 25 cm shell length (SL) with scattered darker spots and blotches on the upper shell surface (DSEWPaC 2011aa). It has a pale yellow or cream belly and dull olive-grey exposed fleshy parts. The shell is broadly oval and the neck is covered with large, pointed conical tubercles (Cogger 2000). The back edge of the shell on hatchlings is serrated (Cogger 2000; Latta & Latta 2005; Wilson & Swan 2003). The Fitzroy river turtle has distinctive eyes with black pupils surrounded by a narrow white inner ring (adults) or a metallic silvery-blue iris (hatchlings) (Cogger 2000; Limpus 2007). The Fitzroy river turtle has relatively long forelimbs with five long claws and a large cloacal bursae which has a respiratory function (Cogger 2000; Wilson & Swan 2003).



Plate 47: Fitzroy river turtle (Source: DERM 2007b)

9.46.2.2 Known distribution

The Fitzroy river turtle is only found in the drainage system of the Fitzroy River, Queensland (DSEWPaC 2011aa). It is estimated that this species occurs in a total area of less than 10,000 km² (Cogger *et al* 1993, McDonald *et al* 1991). Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek, and Gogango (Cogger *et al* 1993; Covacevich *et al* 1996; Tucker *et al* 2001; Venz 2002).

No population information is available for this species.

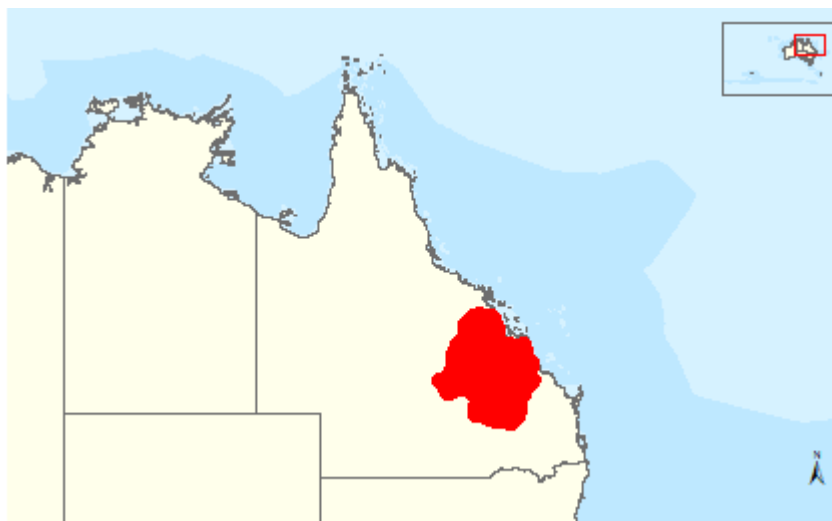


Figure 49: Mapped distribution range of Fitzroy river turtle (Source: DSEWPaC 2011aa)

9.46.2.3 Known species populations within the CSG fields

This species has been observed historically within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.46.2.4 Biology and reproduction

The Fitzroy river turtle forages on the river bottom (Cann 1998) and is known to consume a variety of foods, including Ribbonweed (*Vallisneria* sp.), freshwater sponge, aquatic insect larvae, algae, small snails, terrestrial insects and terrestrial plant material such as leaves and bark (Cann 1998; Tucker *et al* 2001).

Nesting occurs between September and October (Legler 1985). All located nests have been on river sandbanks 1 to 4 m above water level (Cann 1998; Cogger *et al* 1993). Nests have been found up to 15 m from water on flat sandbanks (Cann 1998).

Annual reproductive potential of females is 46 to 59 eggs laid in three to five clutches (Cann 1998). Eggs can take up to 90 days to hatch (Legler 1985). Eggs are deposited in nesting chambers 170 mm deep, containing between 12 and 20 eggs (Latta & Latta 2005). The eggs are approximately 29 mm long and 21 mm wide (Limpus 2007).

This species can take between 15 to 20 years to reach sexual maturity (Limpus 2007).

9.46.3 Habitat

The Fitzroy river turtle is found in rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (DSEWPaC 2011aa). Preferred areas have high water clarity, and are often associated with Ribbonweed (*Vallisneria* sp.) beds (Cogger *et al* 1993). Common riparian vegetation associated with the Fitzroy river turtle includes Blue gums (*Eucalyptus tereticornis*), River oaks (*Casuarina cunninghamiana*), Weeping bottlebrushes (*Callistemon viminalis*) and Paperbarks (*Melaleuca linariifolia*) (Tucker *et al* 2001).

Turtles often associate with logs in deeper water, and may sit on the downstream side or under rocks in fast flowing riffles (Cann 1998; Tucker *et al* 2001).

It is thought that the Fitzroy river turtle has an affinity for well-oxygenated riffle zones, moving into deeper pools as the riffle zones cease to flow (Tucker *et al* 2001). However, recent studies have captured several turtles from deep pools (Gordos *et al* 2003a; 2003b, 2004).

9.46.3.1 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The habitat assumptions for the Fitzroy river turtle are presented below.

9.46.3.2 General assumptions

The following habitat assumption has been made based on current scientific knowledge of this species:

- The Fitzroy river turtle is found in rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (DSEWPoC 2011aa)

9.46.3.3 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Fitzroy river turtle, all REs that contain a specimen backed record (from any data source), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

9.46.3.4 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.46.3.5 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation.

For the Fitzroy river turtle, all areas with the required habitat structure and composition that do not contain a specimen backed record, and do not fulfil the requirements of 'core' and 'essential habitat' are considered to be 'general habitat'.

9.46.3.6 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.46.4 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.46.5 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs, an exclusion zone of 500 m will be applied during the initial planning phase of the development.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.46.6 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.47 Great egret

9.47.1 Status

Marine and Migratory (CAMBA/JAMBA)

9.47.2 Biology and ecology

9.47.2.1 Characteristics

The Great egret (*Ardea alba* (syn. *Ardea modesta*)) is a moderately large bird (83 to 103 cm in length, 700 to 1,200 g in weight) with white plumage, a black or yellow bill and long reddish and black legs. During the breeding season the colour of the bare parts change (DSEWPac 2011ab).



Plate 48: Great egret (Source: Folini 2006)

9.47.2.2 Known distribution

The species is a widespread throughout southern and eastern Asia and Australasia. The species occur throughout the majority of Australia. There are no published estimates of the extent of occurrence of this species in Australia, however the area of occupancy is estimated at 408,400 km² (DSEWPac 2011ab).

It is estimated that there are between 25,000 and 100,000 individuals within Australia. The most important populations, based on the capacity for recruitment and abundance, are the breeding populations that occur at the Top End, in the Channel Country and in the Darling Riverine Plains and Riverina regions. It should be noted that minor breeding sites are scattered across this species range, including the central Queensland Coast (DSEWPac 2011ab). However, no known breeding sites have been documented within the Port Curtis area.

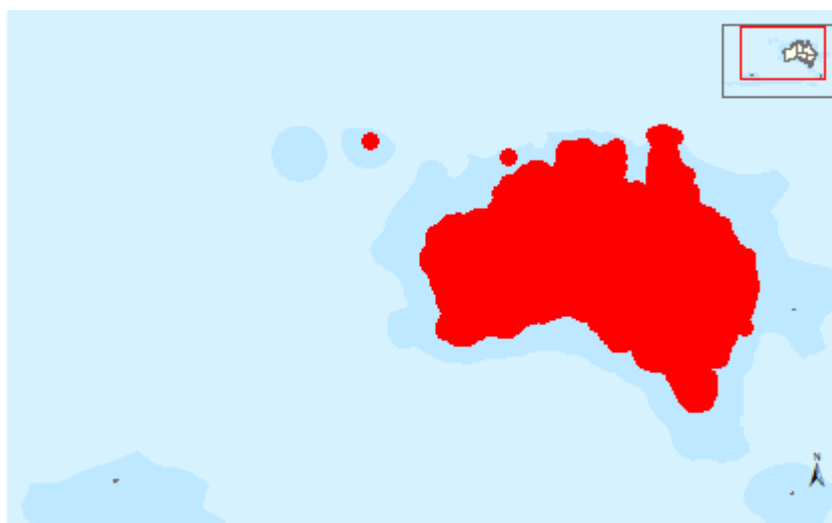


Figure 50: Mapped distribution range of Great egret (Source: DSEWPac 2011ab)

9.47.2.3 Known species populations within the CSG fields

This species is known to utilise habitats within and adjacent the CSG fields, including palustrine wetlands alongside roads, in wet gullies and farm dams.

9.47.2.4 Biology and reproduction

This species is dispersive and, in parts of its range, migratory and is often observed as a solitary individual, or in small groups when feeding. They roost in large flocks that may consist of hundreds of birds (DSEWPac 2011ab).

The species exhibits a diverse array of complex foraging behaviours, including foraging by wading through shallow to moderately deep water, by standing in water and capturing prey that wanders nearby, or by walking over shore or dry ground. Prey is taken from water and vegetation but not from sediments. Prey species include fish, insects, crustaceans, molluscs, frogs, lizards, snakes and small birds and mammals (DSEWPac 2011ab).

The breeding season is variable and depends to some extent on rainfall, but generally extends from November to April. The Great egret usually nests in colonies and builds its nest as a platform of sticks in treetops over water in swampy woodlands and mangrove communities (DSEWPac 2011ab; Pizzey & Knight 2007). These colonies can be mono-specific or more commonly mixed with other wader/waterbird species. Two to six, but usually three to five eggs are laid, with both parents incubating the eggs (23 to 29 days). Fledglings depart the nest or colony between 55 to 88 days of age (DSEWPac 2011ab).

9.47.3 Habitat

This species is a local migrant throughout Australia and inhabits shallow points of rivers, estuaries, mudflats, freshwater wetlands, irrigated pastures, dams and sewerage ponds (Pizzey & Knight 2007).

Refer to Figure 3.1 for habitat assessment process.

9.47.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Great egret habitat assumptions are presented below.

9.47.4.1 General assumption

The following general habitat assumption has been made based on current scientific knowledge of this species:

- Species is often associated with freshwater and/or saline wetlands (DSEWPaC 2011ab). As such, areas mapped as 'riverine', 'lacustrine' and 'pulstrine' Wetland REs as well as 'riverine', lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species along with permanent anthropogenic water sources such as farm dams

9.47.4.2 Core habitat

Core habitat consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As the Great egret is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'core habitat' exists for this species within the Project footprint.

9.47.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As the Great egret is a ubiquitous species with an extensive distribution both within and outside of Australia, it is not considered that 'essential habitat' exists for this species within the Project footprint. Pre-clearance surveys confirm this assumption.

9.47.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation. For the Great egret all areas that are mapped as 'riverine', 'lacustrine' and pulstrine' Wetland REs as well as 'marine', estuarine, 'riverine', lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands (Version 3.0) are considered to constitute 'general habitat' for this species.

9.47.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.47.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.47.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.47.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.48 Cattle egret

9.48.1 Status

Marine and Migratory (CAMBA/JAMBA)

9.48.2 Biology and ecology

9.48.2.1 Characteristics

The Cattle egret (*Ardea ibis*) is about 70 cm in length, while the wingspan and weight vary between sexes; males have a wingspan of 91 cm and weight of 390 g, while the females have a wingspan of 88 cm and weight of 340 g (DSEWPac 2011ac).

The species is small, stocky and mostly white with a short neck and stout yellow-red bill. During breeding and courtship the species has a heavy jowl, orange-buff crown, neck, breast and mantle. There is a marked seasonal variation in plumages during the breeding and non-breeding seasons. The juveniles are indistinguishable from non-breeding adults until the end of their first year when they may develop coloration during the breeding season (DSEWPac 2011ac).



Plate 49 Cattle egret (Source: Garg 2008a; Vaidyanathan 2007)

9.48.2.2 Known distribution

In Australia the species is a partial migrant. Two major distributions have been located: from north-east Western Australia to the Top End of the Northern Territory and around south-east Australia. The south-east distribution occurs from Bundaberg, inland to Roma, Thargominda, and then down through Inverell, Walgett, Nyngan, Cobar, Ivanhoe, Balranald to Swan Hill, and then west to Pinnaroo and Port Augusta (DSEWPac 2011ac).

It is estimated that there are over 100,000 individuals inhabiting Australia, New Zealand.

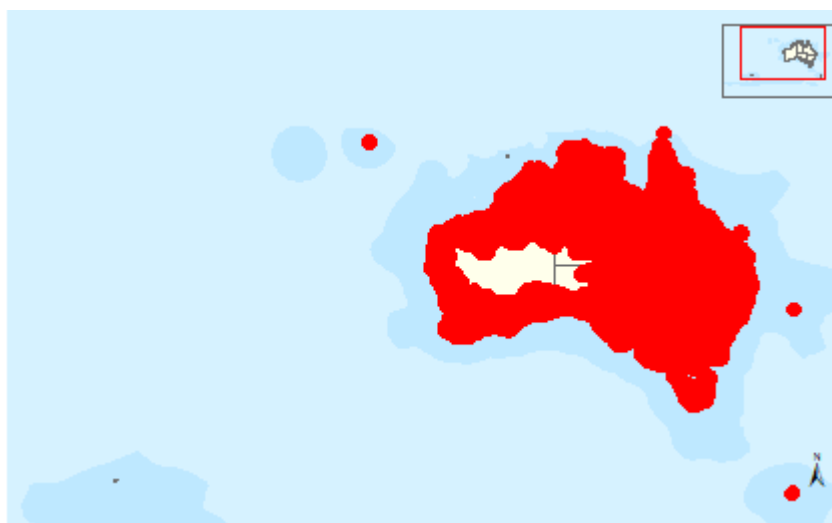


Figure 51: Mapped distribution range of Cattle egret (Source: DSEWPaC 2011ac)

9.48.2.3 Known species populations within the CSG fields

This species has been recorded within the RSGPA. However, this species is a rare vagrant to the area and specific measures are not required.

9.48.2.4 Biology and reproduction

The Cattle egret derives its name from its habit of associating with cattle (eg eating ticks and flies off the backs of livestock). The species also preys on other insects, frogs, lizards, snakes and small mammals (DSEWPaC 2011ac). Foraging normally occurs away from water on low lying grasslands, improved pastures and croplands (DSEWPaC 2011ac).

Breeding in the eastern colonies usually occurs in a well-defined period from October to January, occasionally extending by a month either side. Breeding generally occurs close to the coast from Bundaberg south (DSEWPaC 2011ac). The Cattle egret usually nests in colonies and builds its nest as a small, untidy platform of sticks in foliage in swampy woodlands (Pizzey & Knight 2007). Nests are sited usually in middle to upper branches (DSEWPaC 2011ac).

9.48.3 Habitat

This species is a local migrant throughout Australia and inhabits paddocks, pastures, croplands, garbage tips, wetlands, mudflats and drainage areas and is frequently associated with cattle (Pizzey & Knight 2007).

The species breeds in colonies in wooded swamps such as mangrove forests (eg the lower Adelaide River, Northern Territory), *Melaleuca* swamps (eg Shortland, NSW) and the eucalypt/lignum swamps of the Murray-Darling Basin. They may breed in artificial situations or close to urban areas; generally the nesting trees are inundated except where breeding on small islands (DSEWPaC 2011ac).

Refer to Figure 3.1 for habitat assessment process.

9.48.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance surveys have been used to

define a set of assumptions used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Cattle egret habitat assumptions are presented below.

9.48.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is often associated with freshwater wetlands. As such, areas mapped as 'riverine', 'lacustrine' and 'palustrine' Wetland REs as well as 'riverine', 'lacustrine' and 'palustrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species along with permanent anthropogenic water sources such as farm dams
- The species has been identified as utilising low-lying grasslands, improved pasture and cropland as foraging habitat (DSEWPac 2011ac). As a result of this, areas mapped as 'non-remnant' contained within 3 km of a wetland are considered habitat for this species

9.48.4.2 Core habitat

Core habitat consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As the Cattle egret is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'core habitat' exists for this species within the Project footprint.

9.48.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As the Cattle egret is a ubiquitous species with a distribution both within and outside of Australia, it is not considered that 'essential habitat' exists for this species within the Project footprint. Pre-clearance surveys confirm this assumption.

9.48.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species.

For the Cattle egret 'riverine', 'lacustrine' and 'pulstrine' Wetland REs as well as 'riverine', 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) and the associated buffer are considered to constitute 'general habitat' for this species.

9.48.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.48.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.48.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.48.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.49 Fork-tailed swift

9.49.1 Status

Marine and Migratory (CAMBA/JAMBA/ROKAMBA)

9.49.2 Biology and ecology

9.49.2.1 Characteristics

The Fork-tailed swift (*Apus pacificus*) is a medium-sized Swift with a length of 18 to 21 cm, a wingspan of 40 to 42 cm and weighs around 30 to 40 g. The body is slim, with long scythe-shaped wings that taper to finely pointed tips. It is characterised by a long and deeply forked tail. The species is mainly blackish with a white band across the rump and a white patch on the chin and throat. The sexes are alike, with juveniles also indistinguishable in the field (DOTE 2014ac).



Plate 50: Fork-tailed swift (Source: Francksan n.d.)

9.49.2.2 Known distribution

This species occurs throughout the majority of Australian except for south-eastern Western Australian and western South Australia.

Within Queensland this species is normally found in higher abundance west of the Great Dividing Range, while east of the range records are more scattered. There is limited information on the population size (DOTE 2014ac).

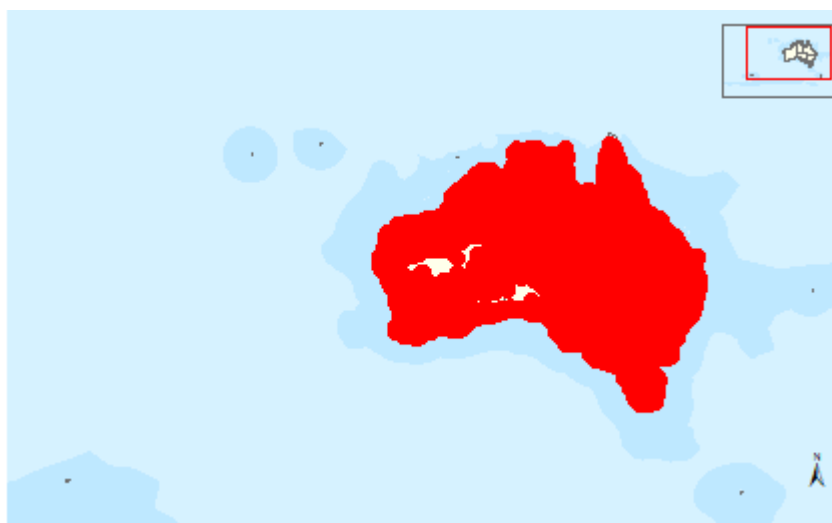


Figure 52: Mapped distribution range of the Fork-tailed swift (Source: DOTE 2014ac)

9.49.2.3 Known species populations and their relationship within the CSG fields

This species has been recorded within the Arcadia gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.49.2.4 Biology and reproduction

This species flies anywhere between 1 and 300 m above the ground, with the species highly mobile in Australia. The species forages for insects generally in flocks (10 to 1,000) along the edge of low pressure.

The Fork-tailed swift is a non-breeding migrant to Australia usually in the summer (October to April) (DOTE 2014ac, Pizzey & Knight 2007).

Table 17: Migration period to Australia (Pizzey & Knight 2007)

Australian Migrants	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Apus pacificus</i> (Fork-tailed swift)												

9.49.3 Habitat

This species is usually observed flying over open country (from semi-arid to coastal zones and islands), however occasionally observed flying over forests and cities (Pizzey & Knight 2007).

In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. The sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines (Higgins 1999).

9.49.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Fork-tailed swift habitat assumptions are presented below.

9.49.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is aerial and hunts and courts in flight. Is reported to roost on cliffs and large trees, but also known to sleep whilst in flight (Pizzey & Knight 1997)
- This species does not breed in Australia. Breeding occurs in Siberia and the Himalayas (Pizzey & Knight 1997)

9.49.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As the Fork-tailed swift is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'core habitat' exists for this species within the Project footprint.

9.49.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As the Fork-tailed swift is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'essential habitat' exists for this species within the Project footprint.

9.49.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species.

As the Fork-tailed swift is highly mobile, there is potential for it to utilise airspace above the entire CSG fields area. However, as this species does not utilise terrestrial based habitats, it is considered that no general 'land based' habitat occurs within the Project footprint.

9.49.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.49.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.49.6 Unavoidable impact from the Project

No unavoidable impacts are expected for this species.

9.49.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.50 Sharp-tailed sandpiper

9.50.1 EPBC Act legal status

Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

9.50.2 Biology and ecology

9.50.2.1 Characteristics

The Sharp-tailed sandpiper (*Calidris acuminata*) is a small to medium wader. The bird has a length of 17 to 22 cm, a wingspan of 36 to 43 cm and a weight of 65 g. It is a portly sandpiper with a flat back, pot belly and somewhat drawn-out rear end. It has a small flat head on a short neck with a short and slightly decurved bill. The species has medium length legs. At rest, the primaries are level with or slightly short of the tip of the tail. The primary projection is short in adults and moderately long in juveniles. The sexes are similar and there is marked seasonal variation (Higgins & Davies 1996).



Plate 51: Sharp-tailed sandpiper (Source: Alnus 2007)

9.50.2.2 Known distribution

The Sharp-tailed sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (Cramp 1985; Higgins & Davies 1996).

In Queensland, they are recorded in most regions, being widespread along much of the coast and are very sparsely scattered inland, particularly in central and south-western regions (Higgins & Davies 1996).

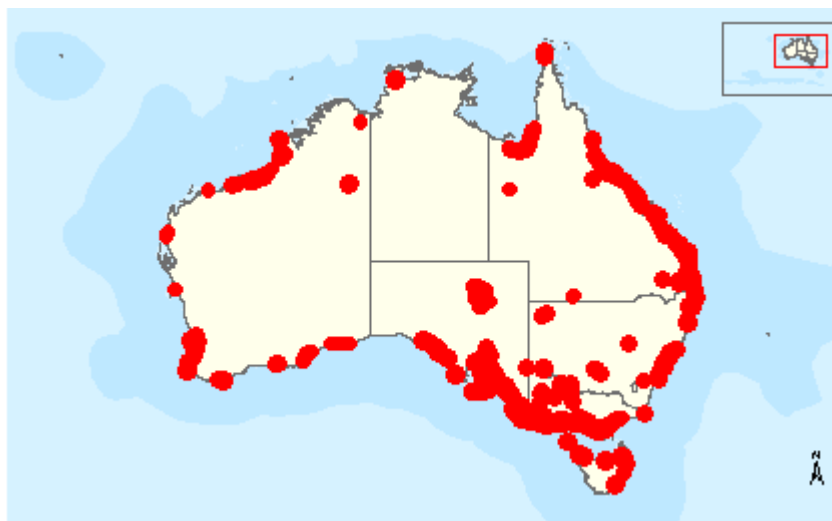


Figure 53: Distribution range of the Sharp-tailed sandpiper (Source: DOTE 2014ab)

9.50.3 Known species populations and their relationship within the CSG fields

This species has been recorded within the Roma gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.50.3.1 Biology and reproduction

The Sharp-tailed sandpiper forages on seeds, worms, molluscs, crustaceans and insects (Higgins & Davies 1996).

The Sharp-tailed sandpiper is recorded to eat *Paspalum* spp.; Clover (*Trifolium* spp.); *Medicago* sp., Lucerne (*Medicago sativa*); *Ruppia* spp.; Goosefoot (*Chenopodium* spp.) and Knotweed (*Polygonum* spp.) plant seeds (Higgins & Davies 1996).

The Sharp-tailed sandpiper has been recorded eating various insects, including the larvae, and molluscs and crustaceans. They also ingest grit, sand and charcoal. They are also reported to eat arachnids and dead fish (Barker & Vestjens 1989; Higgins & Davies 1996).

This species does not breed in Australia (DOTE 2014ab).

9.50.4 Habitat

In Australasia, the Sharp-tailed sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgeland and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season. They may be attracted to mats of algae and water weed either floating or washed up around terrestrial wetlands, and coastal areas with much beachcast seaweed. Sometimes they occur on rocky shores and rarely on exposed reefs (Higgins & Davies 1996).

9.50.5 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Sharp-tailed sandpiper habitat assumptions are presented below.

9.50.5.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species is associated with shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation (Higgins & Davies 1996)
- Species is also associated with non-remnant areas such as saltworks, sewage farms, dams and flooded paddocks (Higgins & Davies 1996)

9.50.5.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.50.5.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.50.5.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For these species, all areas that meet the habitat assumptions presented above are considered to constitute 'general habitat'.

9.50.5.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.50.6 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined Section 6.0.

9.50.7 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.50.8 Management Practices and Methods

Management measures for this species are outlined in Section 7.0.

9.51 Latham's snipe

9.51.1 Status

Marine and Migratory (CAMBA/JAMBA/ROCKAMBA/Bonn)

9.51.2 Biology and ecology

9.51.2.1 Characteristics

Latham's snipe (*Gallinago hardwickii*) is a medium sized wader, and the largest snipe in Australia, with a length of 29 to 33 cm, a wingspan of 50 to 54 cm and a mass of 150 to 230 g. It has a long straight bill, rather short broad pointed wings, a long tail and short legs (Higgins & Davies 1996). The cryptic plumage is intricately marked with barring and chevrons of buff, black and various shades of brown, with blackish-brown stripes across the crown and cream streaks down the back. The belly and parts of the head are white, and the tail is rufous with a white tip. The eyes are large and blackish-brown in colour (Higgins & Davies 1996; Pizzey & Knight 1997). The colour of the bill varies from pale-brown to olive, becoming blackish at the distal third and olive-yellow at the base. The legs and feet are olive-grey to olive in colour. The sexes are similar in appearance, and there is no seasonal variation in the plumage. Juveniles in fresh plumage differ only slightly from adults, but can be distinguished by slight differences in the patterning on the upperwing. Adults and juveniles are indistinguishable after early November (Higgins & Davies 1996).



Plate 52: Latham's snipe (Source: Birds in Backyards 2010)

9.51.2.2 Known distribution

Latham's snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia (ie it travels through northern Australia to reach non-breeding areas located further south) (Higgins & Davies 1996). The species has been recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia (including the Adelaide plains and Mount Lofty Ranges, and the Eyre Peninsula). The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales (Barrett et al 2003; Blakers et al 1984; Frith et al 1977).

The extent of occurrence is estimated at 3,000,000 km² and the area of occupancy is estimated at 3,000 km² (Garnett & Crowley 2000).

The distribution of Latham's snipe is naturally fragmented (although, because of the mobility of the species, this is unlikely to have any effect on survival) (DSEWPaC 2011ad).

The size of the Latham's snipe population that visits Australia is estimated at 25,000 to 100,000 birds (Wetlands International 2002).

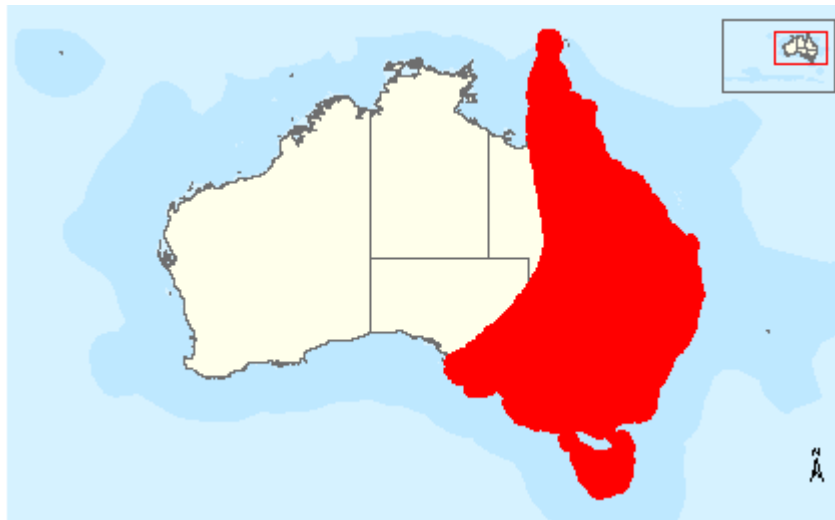


Figure 54: Mapped distribution range of Latham's snipe (Source: DSEWPaC 2011ad)

9.51.2.3 Known species populations within the CSG fields

This species has been recorded within the Roma gas fields and the Scotia gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.51.2.4 Biology and reproduction

Latham's snipe is an omnivorous species that feeds on seeds and other plant material (mainly from species in families such as Cyperaceae, Poaceae, Juncaceae, Polygonaceae, Ranunculaceae and Fabaceae), and on invertebrates including insects (mainly flies and beetles), earthworms and spiders and occasionally molluscs, isopods and centipedes (Frith *et al* 1977; Todd 2000).

Latham's snipe does not breed in Australia; instead it breeds in Japan and eastern Russia (DSEWPaC 2011ad).

9.51.3 Habitat

In Australia, Latham's snipe occurs in permanent and ephemeral wetlands up to 2,000 m above sea-level (Chapman 1969; Naarding 1981). They usually inhabit open, freshwater wetlands with low, dense vegetation (eg swamps, flooded grasslands or heathlands, around bogs and other water bodies) (Frith *et al* 1977; Naarding 1983; DSEWPaC 2011ad). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity (Frith *et al* 1977; Naarding 1983).

Latham's snipe occurs in temperate and tropical regions of Australia (Driscoll 1993). Its altitudinal range extends from sea-level (ie the coast) to approximately 2,000 m above sea-level (Chapman 1969; Driscoll 1993).

In Australia, Latham's snipe occurs in a wide variety of permanent and ephemeral wetlands (Naarding 1981). They usually occur in open, freshwater wetlands that have some form of shelter (usually low and dense vegetation) nearby (Frith et al 1977; Naarding 1983; DSEWPaC 2011ad). They generally occupy flooded meadows, seasonal or semi-permanent swamps, or open waters (Frith et al 1977; Naarding 1983), but various other freshwater habitats can be used including bogs, waterholes, billabongs, lagoons, lakes, creek or river margins, river pools and floodplains (Frith et al 1977; Naarding 1981 & 1983). The structure and composition of the vegetation that occurs around these wetlands is not important in determining the suitability of habitat (Naarding 1983). As such, snipe may be found in a variety of vegetation types or communities including tussock grasslands with rushes, reeds and sedges, coastal and alpine heathlands, lignum or tea-tree scrub, button-grass plains, alpine herbfields and open forest (Chapman 1969; Frith 1970; Frith et al 1977; Naarding 1983; Wall 1990).

Latham's snipe sometimes occur in habitats that have saline or brackish water, such as saltmarsh, mangrove creeks, around bays and beaches, and at tidal rivers (Frith et al 1977; Naarding 1983; Patterson 1991). These habitats are most commonly used when the birds are on migration (Frith et al 1977). They are regularly recorded in or around modified or artificial habitats including pasture, ploughed paddocks, irrigation channels and drainage ditches, ricefields, orchards, saltworks, and sewage and dairy farms (Fielding 1979; Frith et al 1977; Lane & Jessop 1985; Naarding 1982 & 1983). They can also occur in various sites close to humans or human activity (eg near roads, railways, airfields, commercial or industrial complexes) (Frith et al 1977; Naarding 1983).

The foraging habitats of Latham's snipe are characterised by areas of mud (either exposed or beneath a very shallow covering of water) and some form of cover (eg low, dense vegetation) (Frith et al 1977; Todd 2000). The snipe roost on the ground near (or sometimes in) their foraging areas, usually in sites that provide some degree of shelter, eg beside or under clumps of vegetation, among dense tea-tree, in forests, in drainage ditches or plough marks, among boulders, or in shallow water if cover is unavailable (Frith et al 1977; Naarding 1982 & 1983).

Latham's snipe could potentially occur in Bluegrass (*Dichanthium*) dominant grasslands of the Brigalow Belt Bioregions (North and South) if this community is subject to flooding (DSEWPaC 2011ad).

9.51.4 Habitat assessment

Information obtained from expert advice, data from pre clearing surveys and site based species records has been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. Latham's snipe habitat assumptions are presented below.

9.51.4.1 General assumptions

The following general habitat assumptions have been made based on current scientific knowledge of Latham's snipe:

- Species are associated with freshwater, brackish and marine riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of tidal or stream order 3 or greater waterways within 5 km of the HAT
- Species are often associated with freshwater and/or saline wetlands (DSEWPaC 2011ad). As such, areas mapped as but not limited to estuarine, 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species

9.51.4.2 Core habitat

Core habitat consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations). 'Essential habitat' also contains potential breeding habitat for resident species or areas that are identified as important for migratory species during migration (eg wetlands used for building fat reserves). Also included within this category are populations that are limited geographically within the region.

9.51.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

9.51.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. General habitat may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'General habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature that field based observation.

9.51.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.51.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.51.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.51.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.52 White-bellied sea-eagle

9.52.1 Status

Marine and Migratory (CAMBA)

9.52.2 Biology and ecology

9.52.2.1 Characteristics

The White-bellied sea-eagle (*Haliaeetus leucogaster*) is a large raptor that has long, broad wings and a short, wedge-shaped tail. The species measures 75 to 85 cm in length, and has a wingspan of 180 to 220 cm (DSEWPac 2011ae).

The plumage of adult birds is predominantly white and grey. The head, breast and belly, and the feathering on the legs, are white, while the back and upper surfaces of the wings are grey, with black tips. The undersides of the wings are greyish-black around the distal edges, with a smaller area of white along the leading edge. The tail is grey at the base, and has a white tip.

Juveniles differ from the adults in appearance, with juveniles having predominantly dark brown plumage on the upper parts, except for the creamy colouring on the head, and creamy markings over the rest of the upper parts. The underside of the body is a similar colour to the upper parts, but becomes paler with wear. The underside of the wing is patterned with a mixture of orange-buff, white, dark brown and dark grey. There is a gradual transition (several moults over several years) from the brown and cream plumage of juvenile birds to the white and grey plumage of the adults (DSEWPac 2011ae).



Plate 53: White-bellied sea-eagle (Source: Issadeen 2009)

9.52.2.2 Known distribution

The species is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. The species also occurs inland along some of the larger waterways, especially in eastern Australia. Analysis indicates that distribution may shift in response to climatic conditions, with an apparent decreased occupancy of inland sites (and increased occupancy of coastal sites) during drought conditions (DSEWPaC 2011ae).

The total population size of is estimated at more than 500 pairs (DSEWPaC 2011ae). No specific information is available on the number of subpopulations. Some populations are geographically isolated, for example, the Tasmanian population; however such populations are not genetically isolated. No specific populations have been identified as being critical to the long-term survival and recovery of the species (DSEWPaC 2011ae). There is limited published data available on the population dynamics of the central Queensland populations.

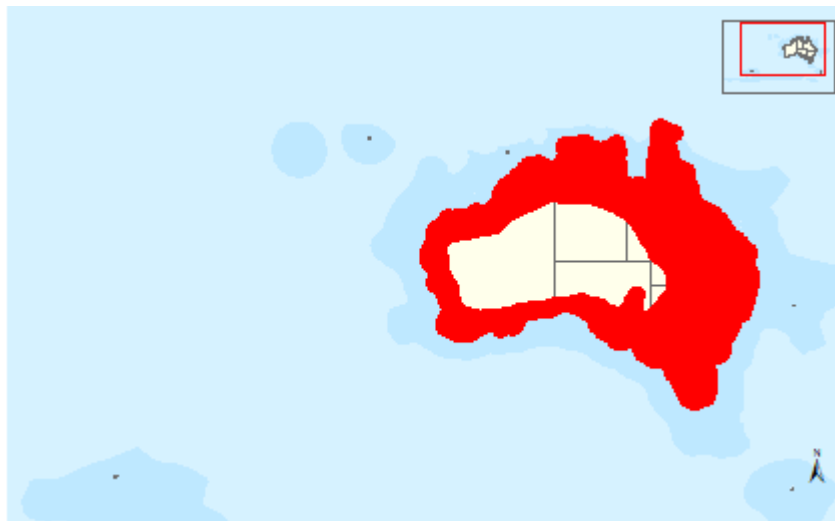


Figure 55: Mapped distribution range of White-bellied sea-eagle (Source: DSEWPaC 2011ae)

9.52.2.3 Known species populations within the CSG fields

This species has historically been recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.52.2.4 Biology and reproduction

The White-bellied sea-eagle is described as a breeding resident throughout much of its distribution. The species home range, which is generally close to bodies water can be up to 100 km² (DSEWPaC 2011ae).

The White-bellied sea-eagle is generally seen singularly or in pairs, though it may occasionally congregate around sites where food is abundant. The White-bellied sea-eagle hunts its prey from a perch or whilst in flight, including fish, birds, reptiles, mammals and crustaceans. This species also feeds on carrion and offal feeds (DSEWPaC 2011ae).

The species first breeds at approximately six years old, with a high mortality rate in newly-independent young birds. If juveniles survive to breeding age they may live for up to 30 years (DSEWPaC 2011ae).

Breeding has been recorded from only a relatively small area of the total distribution, with patchy distribution along the coastline, and especially the eastern coast. However, the species could potentially breed throughout much of its range (DSEWPac 2011ae).

The start of nesting season is when the species is most vulnerable, with a risk that a breeding pair could desert the nest. This species is a breeding resident throughout much of its range, with breeding adult birds generally sedentary and monogamous (DSEWPac 2011ae). In Northern Australia, the breeding period for this species is between May and August. The nest of the White-bellied sea-eagle is quite large and often found in tall trees near water, remote coastal cliffs or on the ground on islands, bushes, mangroves, rocky outcrops, caves, crevices, on the ground and on artificial structures (Pizzey & Knight 2007; DSEWPac 2011ae).

Table 18: Breeding period (Orange indicates breeding period) (Pizzey & Knight 2003)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Clutches for this species usually consist of two eggs, with the eggs incubated for approximately six weeks. The nestlings remain in the nest for 65 to 70 days or more, while the fledged young may be fed by the adults for up to three months after leaving the nest. Fledglings are driven out of their parents breeding territory approximately four months after fledging (DSEWPac 2011ae).

9.52.2.5 Habitat

This species is a local migrant throughout Australia and inhabits coastal areas, islands, estuaries, inlets, rivers and inland lakes. The species will overfly a variety of terrestrial habitats (such as coastal dunes, tidal flats, grasslands, heathlands, woodland, eucalypt forests, rainforests and urban areas) but will also forage over wide expanses of open water (DSEWPac 2011ae).

Refer to Figure 3.1 for habitat assessment process.

9.52.2.6 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The White-bellied sea-eagle habitat assessment assumptions are presented below.

9.52.2.7 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Species is associated with freshwater and/or saline wetlands (DSEWPac 2011ae). As such, areas mapped as 'marine', 'estuarine' and 'lacustrine' Wetland Regional Ecosystems as well as 'lacustrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered to contain the required habitat attributes for this species

9.52.2.8 Core habitat

Core habitat consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As the White-bellied sea-eagle is a ubiquitous species with an extensive distribution within Australia, it is not considered that 'core habitat' exists for this species within the Project footprint.

9.52.2.9 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As the White-bellied sea-eagle is a ubiquitous species with an extensive distribution within Australia, it is not considered that 'essential habitat' exists for this species within the Project footprint. Pre-clearance surveys confirm this assumption.

9.52.2.10 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species.

For the White-bellied sea-eagle all areas that are mapped as 'marine', estuarine', 'lacustrine' and pulstrine' Wetland Regional Ecosystems as well as 'lacustrine' waterbodies on the Queensland Wetland Mapping wetlands (Version 3.0) and areas with a 'stream order' of '4' and above as indicated on DERM's watercourse mapping (Version 2.1) are considered to constitute 'general habitat' for this species.

9.52.2.11 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.52.3 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.52.4 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.52.5 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.53 White-throated needletail

9.53.1 Status

Marine and Migratory (CAMBA/JAMBA/ROKAMBA)

9.53.2 Biology and ecology

9.53.2.1 Characteristics

This large swift has long curved wings and white markings. The plumage of the White-throated needletail (*Hirundapus caudactus*) is predominantly grey-brown, glossed with green and the wings are long and pointed. The tail is short and square, with the protruding feather shafts giving a spiky appearance. The throat and undertail are white (Birds in Backyards 2006).



Plate 54: White-throated needletail (Source: Bridger 2010)

9.53.2.2 Known distribution

The White-throated needletail is usually a summer migrant to Australia and is widespread in eastern Queensland. Migration usually occurs from the breeding grounds of the Northern Hemisphere (Pizzey & Knight 2007).

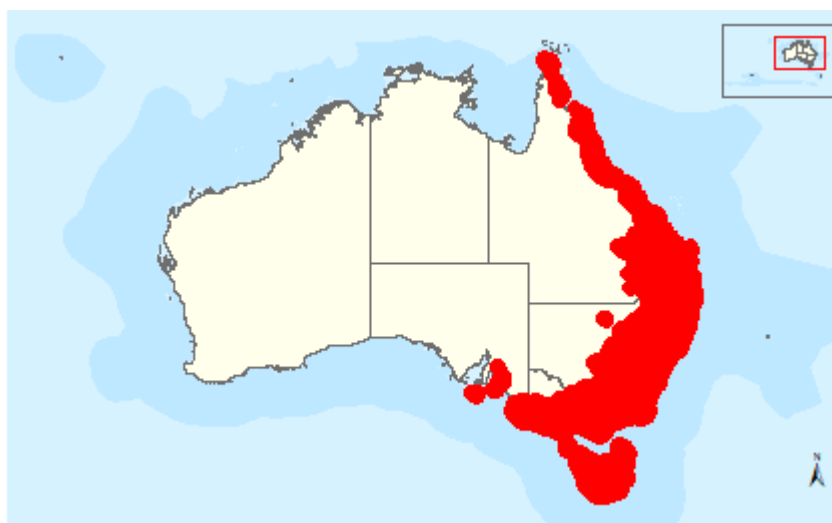


Figure 56: Mapped distribution range of White-throated needletail (Source: DSEWPac 2011ah)

9.53.2.3 Known species populations within the CSG fields

This species has been recorded within the Arcadia gas fields and the Roma gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.53.2.4 Biology and reproduction

During the non-breeding season in Australia, the White-throated needletail has been recorded eating a wide variety of insects, including beetles, cicadas, flying ants, bees, wasps, flies, termites, moths, locusts and grasshoppers (DSEWPac 2011ah).

White-throated needletails are non-breeding migrants in Australia. Breeding takes place in northern Asia. The eggs are laid on a platform of sticks placed in a hollow or similar crevice high in a tall conifer. Little else is known of the breeding behaviour of this species except that courtship displays consist of a series of vertical flights and that copulation is believed to take place in flight (Birds in Backyards 2006).

9.53.3 Habitat

This species is regularly observed flying over forests, woodlands, pastoral areas, floodplains, lakes and coastlines (Pizzey & Knight 2007). Indicative habitat also includes near margins of wetlands and human settlements.

This species occurs over most types of habitat, as described above and may also fly between trees or in clearings, below the canopy, but are less commonly recorded flying above woodland (DSEWPac 2011ah).

Essential microhabitat is defined as forests, woodlands, lakes, coastlines and active nesting sites.

Refer to Figure 3.1 for habitat assessment process.

9.53.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent

with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The White-throated needletail habitat assumptions are presented below.

9.53.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Although the White-throated needletail is almost exclusively aerial, it is probably recorded most often above wooded areas, including open forest and rainforest, heathland and may also fly between trees or in clearings, below the canopy (DSEWPac 2011ah)

9.53.4.2 Core habitat

Core habitat consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As the White-throated needletail is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'core habitat' exists for this species within the Project footprint.

9.53.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As the White-throated needletail is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'essential habitat' exists for this species within the Project footprint. Pre-clearance surveys confirm this assumption.

9.53.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. 'General habitat' also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'general habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field based observation. As the White-throated needletail is highly mobile, there is potential for it to utilise airspace above the entire Project footprint. However, as this species does not utilise terrestrial based habitats, it is considered that no general 'land based' habitat occurs within the Project footprint.

9.53.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.53.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.53.6 Unavoidable impact from the Project

No unavoidable impacts are expected for this species.

9.53.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.54 Rainbow bee-eater

9.54.1 Status

Marine and Migratory (JAMBA)

9.54.2 Biology and ecology

9.54.2.1 Characteristics

The Rainbow bee-eater (*Merops ornatus*) is the only species of bee-eater in Australia. The males measure 25 cm in length and the females 22 cm, including the central tail-streamers, which project 2 to 6 cm beyond the rest of the tail in the male and 1 to 2 cm in the female. The wingspan is 34 cm in the male and 31 cm in the female (DSEWPac 2011g).

Rainbow bee-eaters have a long, slender and decurved black bill, a red iris, dark grey skin around the eye and blackish legs and feet. The adults have green or blue-green colouring on the forehead and chestnut on the back of the head. There is a bold black stripe across the eye that is bordered below by a narrower blue stripe and bright yellow colouring on the chin and cheeks that changes to chestnut around the throat and that is bordered by a conspicuous, crescent-shaped black patch on the front of the neck. The upper part of the back is bright green, merging to light blue on the lower part of the back to the base of the tail. There is bright green and light blue colouring on the upper surface of the wings, with chestnut colouring on the secondary feathers and dark brown primary feathers, light green colouring on the breast that becomes paler on the belly and that changes to light or pale blue from the lower belly to the base of the tail (DSEWPac 2011g).

The tail is black with blue edging on the upper surface and two long, wire-like central feathers (termed streamers) that project beyond the tip of the tail. There is some slight seasonal variation in the appearance of the plumage (DSEWPac 2011g).



Plate 55: Rainbow bee-eater (Source: Aviceda 2007)

9.54.2.2 Known distribution

It is not known if the total population of the Rainbow bee-eater is divided into a series of discrete sub-populations. Analyses have indicated that there has been little or no change in the total population size of the Rainbow bee-eater, but that there have been shifts in local abundances and, possibly, in local distributions. The mobility of the species suggests that it is unlikely that any local or regional population would be genetically isolated from the remainder of the Australian population (DSEWPaC 2011ag).

The Rainbow bee-eater can be found throughout much of mainland Australia and near-shore islands. The occurrence and occupancy of the species within Australia have not been estimated (DSEWPaC 2011ag).



Figure 57: Mapped distribution range of Rainbow bee-eater (Source: DSEWPaC 2011ag)

9.54.2.3 Known species populations within the CSG fields

This species has been recorded within the Arcadia gas fields, Roma gas fields and the Scotia gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.54.2.4 Biology and reproduction

The movement patterns of the Rainbow bee-eater are complex, and are not fully understood. Populations that breed in southern Australia are migratory (ie after breeding, they move north and remain there for the winter). However, populations that breed in northern Australia are considered to be resident, and in many northern localities the Rainbow bee-eater is present throughout the year (DSEWPaC 2011ag).

The Rainbow bee-eater is primarily insectivorous usually foraging from open perches. The species may also feed on the ground, preying on worms and tadpoles (DSEWPaC 2011ag).

The Rainbow bee-eater is capable of living for up to 24 years; however there is no information on the ages of sexual maturity. The breeding season extends from August to January. Nests are located in a chamber at the end of a burrow or tunnel in flat or sloping ground, in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel or cliff faces (DSEWPaC 2011ag).

The species breeds in socially monogamous pairs that are sometimes assisted by a varying number of auxiliary birds or 'helpers'. The female lays a clutch of two to eight, but normally four or five, eggs which are incubated by both sexes. Incubation is for a period of 22 to 31 days. The young remain in their burrows for a period of 23 to 36 days and will continue to be fed by the adults for another two to four weeks after their first departure from the nest (DSEWPac 2011ag).

Table 19: Breeding periods (Orange indicates breeding period) (Pizzey & Knight 2003)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

9.54.3 Habitat

This species inhabits open woodlands with sandy/loamy soils, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforest communities. On migration, the Rainbow bee-eater may also fly over the top of non-preferred habitats such as rainforest or treeless plains (DSEWPac 2011ag; Pizzey & Knight 1997).

9.54.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Rainbow bee-eater habitat assumptions are presented below.

9.54.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Occurs mainly in open forests and woodlands, shrub lands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (DSEWPac 2011ag). These areas are considered to constitute habitat for this species
- It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water (DSEWPac 2011ag). It is assumed that areas that are located within but not necessarily limited to 3 km of a stream-order 3 or greater watercourse (as indicated on DEHP's mapping) provide potential habitat for this species

9.54.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

For the Rainbow bee-eater, all REs that contain a specimen backed record (from any data source), which overlap with areas identified in the BPA mapping that have been identified as containing a 'State' or 'Regional' 'Corridor' (J-Rating) and/or 'Core Habitat' (H-Rating) and/or 'Habitat for EVR Taxa' (A-Rating) have been mapped as 'core habitat'.

As the Rainbow bee-eater is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'core habitat' exists for this species within the Project footprint.

9.54.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As the Rainbow bee-eater is a ubiquitous species with an extensive distribution both within, and outside of Australia, it is not considered that 'essential habitat' exists for this species within the Project footprint.

9.54.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species.

For the Rainbow bee-eater, all areas that meet the assumptions presented above are included within the 'general habitat' category.

9.54.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.54.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.54.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.54.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.55 Black-faced monarch

9.55.1 Status

Marine and Migratory (Bonn)

9.55.2 Biology and ecology

9.55.2.1 Characteristics

The Black-faced monarch (*Monarcha melanopsis*) ranges in size from 16 to 19 cm and has a distinctive black face that does not extend across the eyes. The dorsal parts, wings and upper breast are grey and with a rufous coloured belly. The blue-grey bill is hooked at the tip and eye is dark in colour. Young birds are similar but lack the black face, have a black bill and tend to have a brownish body and wings. The Black-faced monarch is one of the monarch flycatchers, a forest and woodland-dwelling group of small insect-eating birds, and is strictly arboreal (Pizzey & Knight 1997).



Plate 56: Black-faced monarch (Source: Armbrust 1998)

9.55.2.2 Known distribution

The Black-faced monarch occurs along the east coast of Australia. This species is located primarily on the eastern side of the Great Dividing Range, between Cape York Peninsular (Queensland) to Glendale National Park in eastern Victoria. This species is more abundant within the northern portion of its range (Pizzey & Knight 1997).



Figure 58: Mapped distribution range of Black-faced monarch (Source: DSEWPaC 2011ai)

9.55.2.3 Known species populations within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.55.2.4 Biology and reproduction

The Black-faced monarch is a resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter (Pizzey & Knight 1997).

The Black-faced monarch forages for insects among foliage, or catches flying insects on the wing (Pizzey & Knight 1997).

The Black-faced monarch builds a deep cup nest of Casuarina needles, bark, roots, moss and spider web in the fork of a tree, about 3 to 6 m above the ground. Only the female builds the nest, but both sexes incubate the eggs and feed the young. Clutch size ranges from two to three and reproduction occurs between October and January (Pizzey & Knight 1997).

9.55.3 Habitat

The Black-faced monarch mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest (DSEWPaC 2011ai).

The species also occurs in selectively logged and 20 to 30 years old regrowth rainforest (Laurance *et al* 1996). It is also sometimes found in nearby open eucalypt forests (mainly wet sclerophyll forests), especially in gullies with a dense, shrubby understorey as well as in dry sclerophyll forests and woodlands, often with a patchy understorey. The species especially occurs in 'marginal' habitats during winter or during passage (migration) (DSEWPaC 2011ai).

Other areas in which the Black-faced monarch may be found include gullies in mountain areas or coastal foothills (DSEWPaC 2011ai), softwood scrub dominated by Brigalow (*Acacia harpophylla*) (Leach 1995), coastal scrub dominated by Coast banksia (*Banksia integrifolia*) and Southern

mahogany (*Eucalyptus botryoides*) (Smith 1984), occasionally among mangroves (Draffan *et al* 1983; Storr 1984c; Diamond & Bishop 1994) and sometimes in suburban parks and gardens (Taylor & COG 1992).

9.55.4 Habitat assessment

Information obtained from Brigalow Belt South Fauna Expert Panel Report, South-east Queensland Biodiversity Planning Assessment (EPA 2006) together with expert advice, site based species records and pre-clearance survey data has been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Black-faced monarch habitat assumptions are presented below.

9.55.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is known to inhabit rainforests, eucalypt-dominated woodlands and forests and coastal scrubs in addition to damp gullies in rainforests and eucalypt forests (Pizzey & Knight 1997)

9.55.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.55.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed alignment.

9.55.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as 'essential habitat' or 'core habitat'. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'General habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature that field based observation.

For these species, all areas that meet the habitat assumptions presented above are considered to constitute 'general habitat'.

9.55.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.55.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.55.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.55.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.56 Spectacled monarch

9.56.1 Status

Marine and Migratory (Bonn)

9.56.2 Biology and ecology

9.56.2.1 Characteristics

The Spectacled monarch (*Monarcha trivirgatus*) ranges in size from 14 to 16 cm. This species is blue-grey above, with a black face mask that extends across both eyes. The breast is rufous in colour and the underparts are white. The tail is black with white outer tips. Immature birds lack the black face and have a grey throat. The north Queensland subspecies *albiventris* has a rufous upper breast sharply defined from more extensive white underparts (Pizzey & Knight 1997).



Plate 57: Spectacled monarch (Source: Armbrust 1998)

9.56.2.2 Known distribution

The Spectacled monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. It is also found in Papua New Guinea, the Moluccas and Timor (Blakers *et al* 1984; Pizzey & Knight 1997).

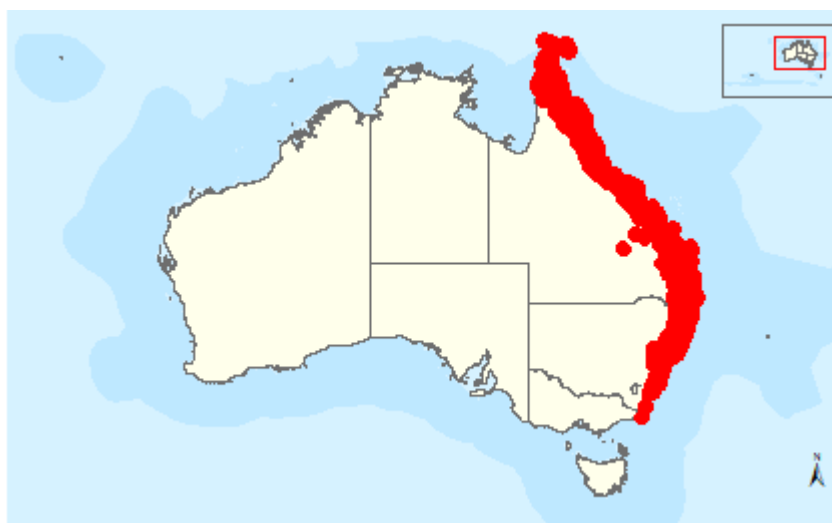


Figure 59: Mapped distribution range of Spectacled monarch (Source: DSEWPac 2011aj)

9.56.2.3 Known species populations within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.56.2.4 Biology and reproduction

The Spectacled monarch is a resident in the north of its range (ie from Rockhampton in QLD northward), but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter (Pizzey & Knight 1997).

The Spectacled monarch forages for insects among foliage, or catches flying insects on the wing (Pizzey & Knight 1997).

The Spectacled monarch builds a small cup nest of fine bark, plant fibres, moss and spider web in a tree fork or in hanging vines 1 to 6 m above the ground, often near water. Only the female builds the nest, but both sexes incubate the eggs and feed the young. Clutch size consists of two eggs. Reproduction occurs between October and February (Pizzey & Knight 1997).

9.56.3 Habitat

The Spectacled monarch inhabit both dense low vegetation and habitats with fairly open understoreys (Bravery 1970; Huggett 2000) and prefers understorey of mountain and lowland rainforests, thickly wooded gullies and waterside vegetation; mostly well below the canopy (Pizzey & Knight 1997).

The spectacled monarch forages at most levels in the forest, though most often at low or middle levels, within 6 m of the ground (Crome 1978; Hughes & Hughes 1980).

9.56.4 Habitat assessment

Information obtained from Brigalow Belt South Fauna Expert Panel Report, South-east Queensland Biodiversity Planning Assessment (EPA 2006) together with expert advice, site based species records and pre-clearance survey data has been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and

'general habitat' that have been presented in this SSMP. The Spectacled monarch habitat assumptions are presented below.

9.56.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is known to inhabit both dense low vegetation and habitats with fairly open understoreys, mountain and lowland rainforest understorey, thickly wooded gullies and waterside vegetation (Pizzey & Knight 1997)

9.56.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.56.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed alignment.

9.56.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as 'essential habitat' or 'core habitat'. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'General habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature that field based observation.

For these species, all areas that meet the habitat assumptions presented above are considered to constitute 'general habitat'.

9.56.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.56.5 Anticipated threats and potential impacts

Threats affecting this species from gas field development are outlined in Section 6.0.

9.56.6 Unavoidable impact from Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.56.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.57 Satin flycatcher

9.57.1 Status

Marine and Migratory (Bonn)

9.57.2 Biology and ecology

9.57.2.1 Characteristics

The Satin flycatcher (*Myiagra cyanoleuca*) ranges in size from 15 to 17 cm. This species is blue-black and white bird with a small crest. The sexes are dimorphic. Males are glossy blue-black dorsally, with a blue-black chest and white below. Females are dusky blue-black dorsally, with an orange-red chin, throat and breast, and white underparts and pale-edged wing and tail feathers. Young birds are dark brown-grey above, with pale streaks and buff edges to the wing feathers, and a mottled brown-orange throat and chest (Pizzey & Knight 1997).



Plate 58: Satin flycatcher female (left) and male (right) (Source: Birds Australia 2010)

9.57.2.2 Known distribution

The Satin flycatcher occurs along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. It is also found in New Guinea. The Satin flycatcher is not a commonly seen species, especially in the far south of its range, where it is a summer breeding migrant (Birdlife Australia 2012f).

The Satin flycatcher is a migratory species, moving northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring (Pizzey & Knight 1997).

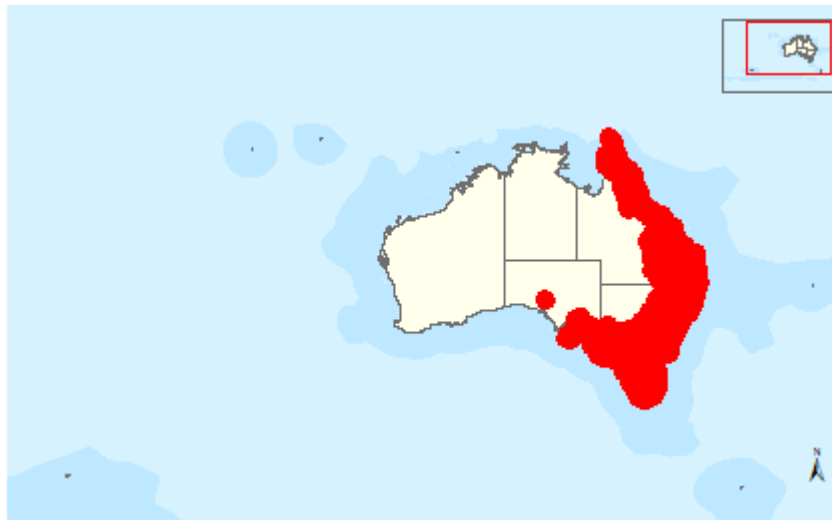


Figure 60: Mapped distribution range of Satin flycatcher (Source: DSEWPaC 2011ak)

9.57.2.3 Known species populations within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.57.2.4 Biology and reproduction

The Satin flycatcher is a resident in the north of its range, but is a migrant to coastal south-eastern Australia, arriving in August to October and returning northwards in February to April (Pizzey & Knight 1997).

The Satin flycatcher forages for insects among foliage, or catches flying insects on the wing (Pizzey & Knight 1997).

The Satin flycatcher builds a neat cup of bark strips, moss, spiders webs on a horizontal dead branch located 5 to 25 m above the ground under living foliage (Pizzey & Knight 1997). This species has been reported to nest in loose groups with each individual pair spaced between 20 to 50 m apart. Both sexes build the nest, incubate the eggs and feed the young (Pizzey & Knight 1997).

Clutch size ranges from two to three eggs and breeding occurs between October and February (Pizzey & Knight 1997).

9.57.3 Habitat

The Satin flycatcher is found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests (Birdlife Australia 2012f).

- This species is known to inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands (cited in DSEWPaC 2011ak) usually above the shrub layer (Pizzey & Knight 1997)
- On migration, this species occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (Blakers *et al* 1984; Emison *et al* 1987; Officer 1969) as well as trees in open country and gardens (Pizzey & Knight 1997)

9.57.4 Habitat assessment

Information obtained from Brigalow Belt South Fauna Expert Panel Report, South-east Queensland Biodiversity Planning Assessment (EPA 2006) together with expert advice, site based species records and pre-clearance survey data has been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Satin flycatcher habitat assumptions are presented below.

9.57.4.1 General assumptions

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is known to inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands near wetlands or watercourses (Pizzey & Knight 1997)

9.57.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.57.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed alignment.

9.57.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as 'essential habitat' or 'core habitat'. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species. As potential habitat for many species contained within this SSMP may include most of the regional ecosystems of the Brigalow Belt Bioregion, the 'General habitat' category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature that field based observation.

For these species, all areas that meet the habitat assumptions presented above are considered to constitute 'general habitat'.

9.57.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.

9.57.5 Anticipated threats and potential impacts

Threats affecting this species from gas field development are outlined in Section 6.0.

9.57.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.57.7 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.58 Eastern osprey

9.58.1 EPBC Act legal status

Marine and Migratory (Bonn)

9.58.2 Biology and ecology

9.58.2.1 Characteristics

The Eastern osprey (*Pandion cristatus*) is a medium-sized raptor (length 50 to 65 cm, wingspan 145 to 170 cm, weight 1.0 to 1.1 kg in adult males and 1.2 to 1.9 kg in adult females) (DOTE 2014ad). Adults are mainly dark-brown to blackish-brown above and white below with a white head and neck, streaked blackish-brown, a dark-brown to blackish-brown crest, a black stripe across the eye and ear, a band of reddish-brown, brown or dark-brown streaking across the breast (sparse or absent in males), a white and pale greyish-brown underwing with black carpal patches and black trim, a white to pale greyish-brown undertail, yellow irides, a black bill and white to pale grey legs and feet (Johnstone & Storr 1998; Marchant & Higgins 1993). The sexes are similar in appearance but can be distinguished when together by differences in size and plumage (females are typically larger than males and usually have darker and more distinct streaking on the breast). Juveniles are similar in appearance to adults, but can be distinguished by multiple differences in plumage and their darker, yellow-orange irides (Marchant & Higgins 1993).



Plate 59: Eastern osprey (Source: Psylexic 2007)

9.58.2.2 Known distribution

The total range (breeding plus non-breeding) around the northern coast is more widespread, extending from Esperance in Western Australia to NSW, where records become scarcer towards the south, and

into Victoria and Tasmania, where the species is a rare vagrant (Barrett *et al* 2003; Blakers *et al* 1984; Johnstone & Storr 1998; Marchant & Higgins 1993; Morris *et al* 1981). The distribution of the species around the northern coast (south-western Western Australia to south-eastern NSW) appears continuous except for a possible gap at Eighty Mile Beach (Barrett *et al* 2003; Blakers *et al* 1984).

There are no published estimates of the extent of occurrence of the Eastern osprey within Australia (DOTE 2014ad) although the area of occupancy for this species in Australia is estimated at 117,400 km² (DOTE 2014ad).

The Eastern osprey is considered to be moderately common in Australia (Olsen 1998). The species is most abundant in northern Australia, where high population densities occur in remote areas (Garnett 1992; Johnstone & Storr 1998).

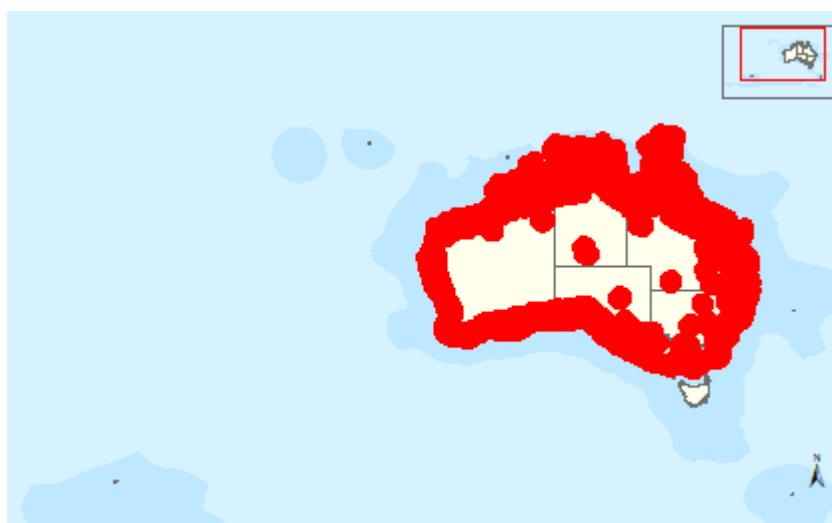


Figure 10.1 Distribution range of the Eastern osprey (Source: DOTE 2014ad)

9.58.2.3 Known species populations and their relationship within the CSG fields

This species has a moderate likelihood of occurring within the CSG fields area. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.58.2.4 Biology and reproduction

In Australia, Eastern ospreys mainly feed on fish, especially mullet where available, and rarely take molluscs, crustaceans, insects, reptiles, birds and mammals (DOTE 2014ad).

Eastern ospreys typically breed in monogamous pairs (Marchant & Higgins 1993; Olsen 1995). The Eastern osprey breeds from April to February in Australia (DOTE 2014ad).

Eastern osprey nests vary in size and shape but they are generally large and are mostly composed of sticks (Bischoff 2001; Clancy 2006; Johnstone & Storr 1998; Kennard & Kennard 2006; Marchant & Higgins 1993; Rose 2000). They are constructed in a variety of natural and artificial sites including in dead or partly dead trees or bushes, on cliffs, rocks, rock stacks or islets, on the ground on rocky headlands, coral cays, deserted beaches, sandhills or saltmarshes and on artificial nest platforms, pylons, jetties, lighthouses, navigation towers, cranes, exposed shipwrecks and offshore drilling rigs (Bischoff 2001; Clancy 2006; Dennis 2007a; Dennis & Baxter 2006; Johnstone & Storr 1998; Marchant & Higgins 1993; Olsen 1995; Rose 2000). Nest sites may be used over many years by one or more pairs (DOTE 2014ad).

Females lay clutches of one to four (but typically two or three) eggs (Hollands 2003; Johnstone & Storr 1998; Marchant & Higgins 1993; Olsen 1995). The eggs are white to buff with brownish (and sometimes also underlying purple or grey) spots and blotches (Hollands 2003; Johnstone & Storr 1998; North 1912). They are incubated by both sexes, but mainly by the female, for a period of 33 to 38 days (Clancy 2006; Hollands 2003; Johnstone & Storr 1998; Kennard & Kennard 2006; Rose 2000).

The nestlings are brooded by the female and by the male when the female is absent from the nest. To begin with they are mainly fed by the female on food delivered by the male, but later both parents gather and supply food (Hollands 2003; Kennard & Kennard 2006; Marchant & Higgins 1993; Rose 2000). The young fledge approximately seven to eleven weeks after hatching (Dennis 2007b; Holsworth 1965; Kennard & Kennard 2006; Maciejewski 1993; Rose 2000) but continue to return to the nest for some time thereafter to be fed. The period of post-fledging dependence probably ranges from about one to two months in duration (Dennis 2007b; Hollands 2003; Kennard & Kennard 2006; Marchant & Higgins 1993; Rose 2000). Pairs usually rear one brood but are capable of rearing two broods per season (Clancy 2006; Marchant & Higgins 1993). Pairs tend not to breed each year; breeding attempts may be separated by periods of up to three years (Dennis 2007a).

9.58.3 Habitat

Eastern ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia (Johnstone & Storr 1998; Marchant & Higgins 1993; Olsen 1995). They require extensive areas of open fresh, brackish or saline water for foraging (Marchant & Higgins 1993). They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes (DOTE 2014ad). They exhibit a preference for coastal cliffs and elevated islands in some parts of their range (Boekel 1976; Domm 1977), but may also occur on low sandy, muddy or rocky shores and over coral cays (Marchant & Higgins 1993). They may occur over atypical habitats such as heath, woodland or forest when travelling to and from foraging sites (DOTE 2014ad).

Eastern ospreys occur sympatrically and sometimes interact with White-bellied sea-eagles (Barrett et al 2003; Clancy 2006; Dennis & Baxter 2006; Kennard & Kennard 2006), which is also listed as Marine and Migratory under the EPBC Act.

9.58.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Eastern osprey habitat assumptions are presented below.

9.58.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species inhabits coasts, estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks (Pizzey & Knight 1997)
- The species also ventures far inland and ascends larger rivers, large permanent waterbodies (such as larger farm dams) (Pizzey & Knight 1997)

9.58.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.58.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.58.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For the Eastern osprey all areas that are mapped as 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'lacustrine' waterbodies, on the Queensland Wetland Mapping wetlands (Version 3.0) and areas with a 'stream order' of '4' and above as indicated on DERM's watercourse mapping (Version 2.1) are considered to constitute 'general habitat' for this species along with other permanent water resources with suitable feeding attributes.

9.58.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.58.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.58.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.58.7 Specific management requirements

Management measures for this species are outlined in Section 7.0.

9.59 Glossy ibis

9.59.1 EPBC Act legal status

Marine and Migratory (CAMBA/Bonn)

9.59.2 Biology and ecology

9.59.2.1 Characteristics

The Glossy ibis (*Plegadis falcinellus*) is the smallest ibis known in Australia. The neck is reddish-brown and the body is a bronze-brown with a metallic iridescent sheen on the wings. The Glossy ibis has a distinctive long, downwards curved bill that is olive-brown in colour (DOTE 2014b). The facial skin is blue-grey with a white line that extends around the eyes. The eyes, legs and feet are brown (Birds Australia 2010). Sexes are similar in plumage, but the male is larger in size. The average length of a Glossy Ibis is 55 to 65 cm, with a wingspan of 80 to 95 cm, and weight of approximately 500 to 800 grams (Hancock *et al* 1992; Marchant & Higgins 1990).

During the breeding season, plumage colour intensifies to a rich chestnut on the neck, mantle, shoulders and under parts. A purple-green sheen occurs on the head, upperparts, tail and wings. The facial skin turns pale blue with courtship, and fades to dark purple after the courting period (Hancock *et al* 1992).

Juveniles have similar dark plumage to adults. Nestlings have a pink bill which gradually turns olive-brown starting from the tip (Hancock *et al* 1992).



Plate 60: Glossy ibis (Source: Karatay 2007)

9.59.2.2 Known distribution

Within Australia, the Glossy ibis is generally located east of the Kimberley in Western Australia and Eyre Peninsula in South Australia. The species is also known to be patchily distributed in the rest of

Western Australia. The species is rare or a vagrant in Tasmania (Beehler *et al* 1986; Coates & Bishop 1997; Marchant & Higgins 1990).



Figure 61: Distribution range of the Glossy ibis (Source: BirdLife International 2014c)

9.59.2.3 Known species populations within the CSG fields

This species has been recorded within the Arcadia gas fields, Roma gas fields and Scotia gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.59.2.4 Biology and reproduction

Glossy Ibis feed mainly on aquatic invertebrates/insects such as freshwater snails, mussels, crabs and crayfish. The species will also, however, eat fish, frogs and tadpoles, dryland invertebrates (such as beetles and grasshoppers), lizards, small snakes and nestling birds (del Hoyo *et al* 1992; Gowland 1988; Marchant & Higgins 1990; Vestjens 1977).

Glossy ibis breed from mid spring to the end of summer (DOTE 2014b). Reproduction may extend to September to April if there are persistent food resources at breeding sites. In some areas, breeding is said to coincide with annual rains (del Hoyo *et al* 1992).

Three to six eggs are laid. Both adults care for young who fledge in approximately 25 to 28 days (Hancock *et al* 1992). Chicks will interact with chicks from nearby nests from approximately ten days of age. Once fledged, adults remain feeding young for several weeks (Marchant & Higgins 1990).

The nest is a platform of twigs and vegetation usually positioned less than one metre above water (occasionally up to 7 m) in tall dense stands of emergent vegetation (e.g. reeds or rushes), low trees or bushes (del Hoyo *et al* 1992). The nest is often lined with aquatic vegetation (Birds Australia 2010).

9.59.3 Habitat

The Glossy ibis' preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. The species is occasionally found in coastal locations such as

estuaries, deltas, saltmarshes and coastal lagoons (del Hoyo *et al* 1992; Hancock *et al* 1992; Marchant & Higgins 1990).

Within Australia, the largest contiguous areas of prime habitat is inland and northern floodplains. The Glossy Ibis is commonly in largest numbers in drying Top End grass/sedge swamps and Channel Country grass/forb meadows. The species is sometimes recorded in wooded swamps, artificial wetlands (such as irrigated fields), and in mangroves for breeding (Chatto 2000; Marchant & Higgins 1990). The species may retreat to permanent wetlands and/or coastal areas (including tidal wetlands) during drought (Marchant & Higgins 1990).

Glossy ibis roost in trees or shrubs usually near, but sometimes far, from water bodies (Brown *et al* 1982; Marchant & Higgins 1990).

Australian breeding habitat types include wooded and shrubby swamps in the semi-arid and arid regions of the Northern Territory and Queensland. This includes Cooba (*Acacia stenophylla*), Eucalyptus/lignum swamps (*Muehlenbeckia florulenta*) of the Murray-Darling Basin and in Melaleuca/reed swamps at near-coastal breeding colonies in the south. Breeding has once been recorded in mangroves in the Northern Territory (Marchant & Higgins 1990).

9.59.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Glossy ibis habitat assumptions are presented below.

9.59.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species is often associated with freshwater wetlands. As such, areas mapped as 'riverine', 'lacustrine' and 'pulstrine' wetland REs as well as 'riverine', lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species

9.59.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.59.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.59.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For these species, all areas that meet the habitat assumptions presented above are considered to constitute 'general habitat'.

9.59.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.59.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.59.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.59.7 Specific management requirements

Management measures for this species are outlined in Section 7.0.

9.60 Cotton pygmy-goose

9.60.1 EPBC Act legal status

Migratory – Bonn (Family Anatidae)

9.60.2 Biology and ecology

9.60.2.1 Characteristics

The Cotton pygmy-goose (*Nettapus coromandelianus*) is a tiny duck with a small, dark, goose-like bill. The male has a white head, neck and underparts with a glossy green back that appears black in dull light (NPWS 1999).

In the breeding season, the male has a black band around the base of the neck. The female is predominately brown with darker plumage on the wings. Both sexes have dark plumage on the forehead and crown (Marchant & Higgins 1990).



Plate 61: Cotton pygmy-goose (Source: Fergus 2006)

9.60.2.2 Known distribution

The Cotton pygmy-goose is a rare vagrant in the southern part of its range on the north coast of NSW. However, the species is relatively common on lily-covered lagoons, dams and ponds in north-eastern Queensland (Marchant & Higgins 1990; Blakers *et al* 1984).

The Cotton pygmy-goose is more restricted in range than any other Australian native duck and its numbers are relatively few (NPWS 1999).

Major centres of population are Dawson, Fitzroy, Burdekin and Barron River catchments (Blakers *et al* 1984). The Cotton pygmy-goose is locally common in suitable habitat near Brisbane (Beruldsen 1977) and is now vagrant outside Queensland (Marchant & Higgins 1990). The largest recent counts were 300 individuals on Ross River Dam near Townsville (Garnett & Cox 1987) and 350 individuals at Lake Powlathanga near Charters Towers in 1990. There are no recent estimates of total population size and the frequency of sightings near Rockhampton has apparently declined (Longmore 1978).

The extent of occurrence is estimated to be 400,000 km² and this estimate is considered to be of high reliability.

The population of this subspecies seems small, and appears to have declined in density over at least the southern half of its historical range (Garnett & Crowley 2000).



Figure 62: Distribution range of the Cotton pygmy-goose (Source: BirdLife International 2014d)

9.60.2.3 Known species populations within the CSG fields

This species has been recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.60.2.4 Biology and reproduction

The Cotton pygmy-goose feeds almost entirely on aquatic vegetation, particularly *hydrilla* and Pondweed. Foraging is undertaken by dabbling and picking at the water surface or by stripping seeds and flowers from aquatic plants. Individuals flatten their head and neck on the water surface and rapidly filter water through their bill while swimming fast, swallowing food with an upward jerk of the head (Marchant & Higgins 1990). Aquatic insects are also eaten (McAllan 1992).

The species requires dead trees with hollows near water for nesting and roosting sites (Beruldsen 1977).

The species is likely to be monogamous with clutch sizes thought to range from six to 16 (Frith 1982). The type of parental care is unknown (Marchant & Higgins 1990).

9.60.3 Habitat

The Cotton pygmy-goose is an almost entirely aquatic species. Preferred habitat is deep freshwater lagoons, swamps and dams, particularly those with waterlilies or other floating vegetation, such as *hydrilla*, *ceratophyllum*, *vallisneria*, *najas*, *lemna* and *chara* (Marchant & Higgins 1990). The species tends to avoid running water where deep-water vegetation cannot grow (Beruldsen 1977).

The species requires dead trees with hollows near water for nesting and roosting sites (Beruldsen 1977).

9.60.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Cotton pygmy-goose habitat assumptions are presented below.

9.60.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species is often associated with freshwater and/or saline wetlands. As such, areas mapped as 'riverine' 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'riverine', 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species along with permanent anthropogenic water sources such as farm dams
- The species has also been observed (GPS based data from known records) within two 'non-remnant areas within 1 km of a 'riverine' 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'riverine', 'lacustrine' and 'pulstrine' waterbodies as indicated on the Queensland Wetland Mapping (Version 3.0)'

9.60.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.60.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.60.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For the Cotton pygmy-goose all areas that are mapped as areas mapped as 'riverine' 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems as well as 'riverine', 'lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered to constitute 'General habitat' for this species.

9.60.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.60.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.60.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.60.7 Specific management requirements

Management measures for this species are outlined in Section 7.0.

9.61 Common greenshank

9.61.1 EPBC Act legal status

Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

9.61.2 Biology and ecology

9.61.2.1 Characteristics

The Common greenshank (*Tringa nebularia*) is a heavily built, elegant wader, 30 to 35 cm in length, with a wingspan of 55 to 65 cm and weight up to 190 g for both males and females. The bill is long and slightly upturned and the legs are long and yellowish-green. In flight, all plumages show uniformly dark upperwing and contrasting white rump extending in a white wedge up the back, whitish tail and tips of toes projecting slightly beyond the tip of the tail. The sexes are alike (Higgins & Davies 1996).

The head and neck are white with heavy black streaking, the interwing coverts are mostly brownish-grey with white fringes. The underbody is white with fine black streaks on chin and throat and there are bold black chevrons on breast and flank. The underwing is white with faint brownish barring on covers and the bill is bluish grey or greenish grey, legs and feet are pale greyish-green (Higgins & Davies 1996).

The juveniles are like non-breeding adults but head and neck are slightly darker with heavier, darker streaking. Bare parts are similar to the adult, but juvenile legs and feet are occasionally bright pale-yellow, dull yellow or dull slate-grey (Higgins & Davies 1996).



Plate 62: Eastern osprey (Source: Aviceda 2009)

9.61.2.2 Known distribution

The Common greenshank does not breed in Australia, however, the species occurs in all types of wetlands and has the widest distribution of any shorebird in Australia (Higgins & Davies 1996).

In Queensland, the species is widespread in the Gulf country and eastern Gulf of Carpentaria. It has been recorded in most coastal regions, possibly with a gap between north Cape York Peninsula and Cooktown. Inland, there have been a few records south of a line from near Dalby to Mt Guide, and sparsely scattered records elsewhere (Higgins & Davies 1996).

The global population is estimated to be 440,000 to 1,500,000 (BirdLife International 2009). The East Asian-Australasian Flyway population of the Common greenshank is thought to be approximately 60,000, of which 18,000 to 19,000 spend the non-breeding season in Australia (Bamford et al 2008; Clemens et al 2008).



Figure 63: Distribution range of the Common greenshank (Source: Atlas of Living Australia 2014)

9.61.2.3 Known species populations and their relationship within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.61.2.4 Biology and reproduction

The Common greenshank is carnivorous. In Australia it has been recorded eating molluscs, crustaceans, insects, and occasionally fish and frogs. Elsewhere, it has also been recorded eating annelids, lizards, and rodents (Higgins & Davies 1996).

The Common greenshank does not breed in Australia (DOTE 2014ae).

9.61.3 Habitat

The Common greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. The edges of the wetlands used are generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, mangroves, thickets of rushes,

and dead or live trees. It was once recorded with Black-winged stilts (*Himantopus himantopus*) in pasture, but are generally not found in dry grassland (Higgins & Davies 1996).

The species is known to forage at edges of wetlands, in soft mud on mudflats, in channels, or in shallows around the edges of water often among pneumatophores of mangroves or other sparse, emergent or fringing vegetation, such as sedges or saltmarsh. It will occasionally feed on exposed seagrass beds (Higgins & Davies 1996).

The Common greenshank roosts and loafs round wetlands, in shallow pools and puddles, or slightly elevated on rocks, sandbanks or small muddy islets. Occasionally the species will perch and roost on stakes (Higgins & Davies 1996).

9.61.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Common greenshank habitat assumptions are presented below.

9.61.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways
- Species are often associated with freshwater wetlands (DOTE 2014ae). As such, areas mapped as but not limited to 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species
- All areas identified as shorebird habitat by 'Shorebird 2020' are considered 'essential habitat' for these species

9.61.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.61.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.61.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For the Common greenshank, general habitat includes, but is not necessarily limited to, all areas identified above and areas associated with the banks of waterways are considered to constitute 'general habitat'.

9.61.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.61.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.61.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.61.7 Specific management requirements

Management measures for this species are outlined in Section 7.0.

9.62 Marsh sandpiper

9.62.1 EPBC Act legal status

Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

9.62.2 Biology and ecology

9.62.2.1 Characteristics

The Marsh sandpiper (*Tringa stagnatilis*) is a medium sized member of the Tringinae family. It has a length of 22 to 26 cm, a wingspan of 40 to 45 cm and a weight of 70 g. In all plumages the species shows a contrasting outerwing, a very pale whitish tail and a bold white wedge up the back (Higgins & Davies 1996).



Plate 63: Marsh sandpiper (Source: Psylexic 2007)

9.62.2.2 Known distribution

The Marsh sandpiper is found on coastal and inland wetlands throughout Australia. The species is widespread in coastal Queensland, but few records exist north of Cooktown (DOTE 2014af).

In Queensland, the south-east Gulf of Carpentaria is an internationally important site, while sites of national importance in Queensland include Buffalo Lake area in Normanton, Lake Namulla in Cunnamulla and Alva Beach in Ayr (Watkins 1993).

The Marsh sandpiper has an estimated East Asian-Australasian Flyway population of 100,000 to 1,000,000. The global population is estimated at 186,000 to 1,242,000 (Bamford et al 2008).

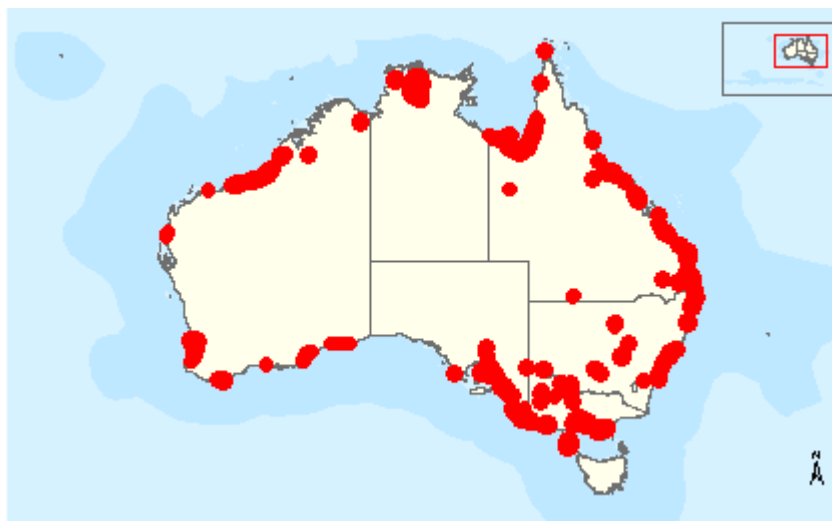


Figure 64: Distribution range of the Marsh sandpiper (Source: DOTE 2014af)

9.62.2.3 Known species populations and their relationship within the CSG fields

This species has been recorded within the Roma gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.62.2.4 Biology and reproduction

The Marsh sandpiper is carnivorous and has been recorded eating insects, molluscs and (internationally) crustaceans. Plant material has been found in stomachs but this may have been ingested incidentally (Higgins & Davies 1996).

The Marsh sandpiper does not breed in Australia (DOTE 2014af).

9.62.3 Habitat

The Marsh sandpiper lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, salt pans, saltmarshes, estuaries, pools on inundated floodplains and intertidal mudflats and also regularly at sewage farms and saltworks (DOTE 2014af). They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes (Pizzey & Knight 1997). They are found infrequently around mangroves (Higgins & Davies 1996).

The Marsh sandpiper usually forages in shallow water at the edge of wetlands. They probe wet mud of mudflats or feed among marshy vegetation (Higgins & Davies 1996).

The Marsh sandpiper has been recorded roosting or loafing on tidal mudflats, near low saltmarsh, and around inland swamps (Higgins & Davies 1996).

9.62.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Marsh sandpiper habitat assumptions are presented below.

9.62.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways
- Species are often associated with freshwater wetlands (DOTE 2014ae). As such, areas mapped as but not limited to 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species
- All areas identified as shorebird habitat by 'Shorebird 2020' are considered 'essential habitat' for these species

9.62.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.62.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.62.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For the Marsh sandpiper, general habitat includes, but is not necessarily limited to, all areas identified above and areas associated with the banks of waterways are considered to constitute 'general habitat'.

9.62.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.62.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.62.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.62.7 Management Practices and Methods

Management measures for this species are outlined in Section 7.0.

9.63 Pacific golden plover

9.63.1 EPBC Act legal status

Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

9.63.2 Biology and ecology

9.63.2.1 Characteristics

The Pacific golden plover (*Pluvialis fulva*) is a medium-sized (length 23 to 26 cm, weight 120 to 175 g) plover with long legs and an upright stance. Sexes are generally inseparable, but juveniles are separable from adults in the field (DOTE 2014ag).

In breeding plumage, adults have bold golden spots on the crown and hindneck; a white forehead, which extends as a broad supercilium that curves behind the ear coverts to the sides of the neck; and the rest of the face is black. The upperparts are blackish, boldly spotted with gold, with the tail dark brown with golden-buff bars. The underparts are black, with a broad white stripe (which continues from the sides of the neck) extending down along the sides of the breast to the flanks, where they are spotted black. The underwings are uniform brownish-grey. The bill is black, the eyes are dark brown, and the legs and feet are greyish black (Marchant & Higgins 1993).

In non-breeding plumage, the crown is dark brown with golden streaks; the nape and hindneck are similar, though slightly paler; the forehead, lores, supercilium, chin, throat and sides of the head are all golden or creamy buff. The upperparts are dark brown, heavily marked with bright golden scaly-shaped spots, while the secondary coverts are spotted white, which contrasts with the golden spots of the mantle and scapulars. The foreneck and breast are golden-buff, with grey-brown streaks, and the belly, flanks and undertail are all white with a buff tinge, and the flanks have fine grey-brown streaks. The underwings appear uniform brownish-grey (Marchant & Higgins 1993).

Juvenile birds are similar to non-breeding birds, but the patterning is neater, bolder and more even, with more golden-buff tones to the face and underparts, distinct streaking on the foreneck and barring or marbling on the breast and flanks (Marchant & Higgins 1993).



Plate 64: Pacific golden plover (Source: Harrison 2013)

9.63.2.2 Known distribution

Within Australia, the Pacific golden plover is widespread in coastal regions, though there are also a number of inland records (in all states), sometimes far inland and usually along major river systems, especially the Murray and Darling Rivers and their tributaries. Most Pacific golden plovers occur along the east coast, and are especially widespread along the Queensland and NSW coastlines (DOTE 2014ag).

There are no published estimates of the extent of occurrence of the Pacific golden plover in Australia. The estimated global extent of occurrence is 100,000 to 1,000,000 km² (Birdlife International 2007). The area of occupancy of the Pacific golden plover in Australia has been estimated at 46,700 km² (DOTE 2014ag).

The distribution of the Pacific golden plover is not fragmented, either in its breeding grounds or in its non-breeding areas (DOTE 2014ag).

The world population of Pacific golden plover has been estimated at about 209,500 (Wiersma 1996) or 170,000 to 220,000 (Birdlife International 2007).

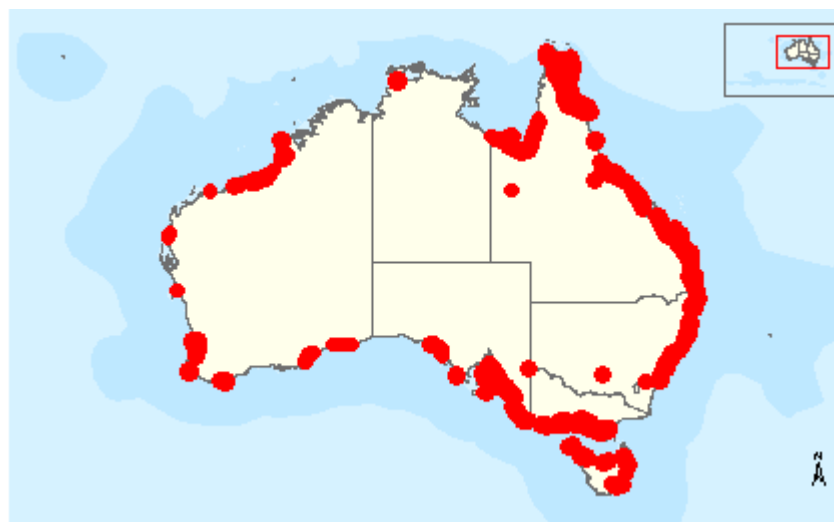


Figure 65: Distribution range of the Pacific golden plover (Source: DOTE 2014ag)

9.63.2.3 Known species populations and their relationship within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.63.2.4 Biology and reproduction

During the non-breeding season, Pacific golden plovers mainly eat molluscs, polychaete worms, insects and insect larvae, spiders and crustaceans (Domm & Recher 1973; Evans 1975; Frith & Calaby 1974; Vestjens 1977c). They are also said to very occasionally eat seeds, leaves, lizards, birds eggs and small fish (Marchant & Higgins 1993).

The species does not breed in Australia (Marchant & Higgins 1993; Wiersma 1996).

9.63.3 Habitat

In non-breeding grounds in Australia this species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Pacific golden plovers usually occur on beaches, mudflats and sandflats (sometimes in vegetation such as mangroves, low saltmarsh such as *Sarcocornia* or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in saltworks. The species is also sometimes recorded on islands, sand and coral cays and exposed reefs and rocks. They are less often recorded in terrestrial habitats, usually wetlands such as fresh, brackish or saline lakes, billabongs, pools, swamps and wet claypans, especially those with muddy margins and often with submerged vegetation or short emergent grass. Other terrestrial habitats inhabited include short (or, occasionally, long) grass in paddocks, crops or airstrips, sewage ponds, sports fields or ploughed or recently burnt areas, and they are very occasionally recorded well away from water (Marchant & Higgins 1993; Pizzey & Knight 1997).

This species usually forages on sandy or muddy shores (including mudflats and sandflats) or margins of sheltered areas such as estuaries and lagoons, though it also feeds on rocky shores, islands or reefs. In addition, Pacific golden plovers occasionally forage among vegetation, such as saltmarsh, mangroves or in pasture or crops (Bransbury 1985; Evans 1975; Ewart 1973; Pegler 1983; Smith 1966; Thomas 1968).

They usually roost near foraging areas, on sandy beaches and spits or rocky points, islets or exposed reefs, occasionally among or beneath vegetation including mangroves or low saltmarsh, or among beachcast seaweed. They sometimes also roost on levee banks and islands in evaporation ponds in saltworks (Bransbury 1985; Ewart 1973; Smith 1966; Thomas 1968; Patterson 1982; Pegler 1983; Prendergast *et al* 1985).

9.63.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Pacific golden plover habitat assumptions are presented below.

9.63.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways
- Species are often associated with freshwater wetlands (DOTE 2014ag). As such, areas mapped as but not limited to 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species

9.63.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.63.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.63.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For the Pacific golden plover, general habitat includes, but is not necessarily limited to, all areas identified above and areas associated with the banks of waterways are considered to constitute 'general habitat'.

9.63.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.63.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.63.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.63.7 Management Practices and Methods

Management measures for this species are outlined in Section 7.0.

9.64 Wood sandpiper

9.64.1 EPBC Act legal status

Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

9.64.2 Biology and ecology

9.64.2.1 Characteristics

The Wood sandpiper (*Tringa glareola*) is a small thin wader and member of the Tringinae family. The species has a length of 19 to 23 cm, a wingspan of 56 to 57 cm and a weight of 55 g. The species has a short straight bill and long legs. It is similar in size to the Sharp-tailed sandpiper (*Calidris acuminata*), however has a longer neck and slimmer build, slightly longer, straighter bill and longer legs. The species is a dark grey-brown or plain brown above and spotted pailer and white below with a greyish wash on the breast. It has dark streaking on the foreneck and breasts as well as some barring on the fore-flanks. In all plumages the species shows a white supercilium, extending well behind the eye with greenish or yellow legs (Higgins & Davies 1996).



Plate 65: Wood sandpiper (Source: Harrison 2011)

9.64.2.2 Known distribution

The Wood sandpiper has its largest numbers recorded in north-west Australia, with all areas of national importance located in Western-Australia (Watkins 1993).

In Queensland there are sparsely scattered records, generally south of 17° S, but also around Cairns (DOTE 2014ah).

An estimated 100,000 to 1,000,000 Wood sandpipers occupy the East Asian-Australasian Flyway (Bamford *et al* 2008).

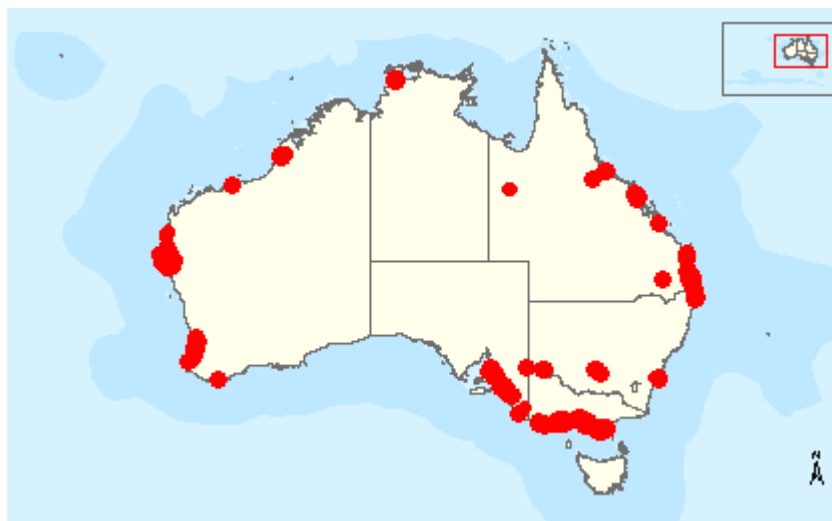


Figure 66: Distribution range of the Wood sandpiper (Source: DOTE 2014ah)

9.64.2.3 Known species populations and their relationship within the CSG fields

This species has been recorded within the Roma gas fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.64.2.4 Biology and reproduction

The Wood sandpiper is carnivorous, eating mainly insects and molluscs in Australia (Higgins & Davies 1996). Elsewhere the species also eats seeds, algae, worms, crustaceans, arachnids, fish and frogs (Cramp & Simmonds 1983).

The Wood sandpiper does not breed in Australia (DOTE 2014ah).

9.64.3 Habitat

The Wood sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially *Melaleuca* and River red gums (*Eucalyptus camaldulensis*) and often with fallen timber. They also frequent inundated grasslands, short herbage or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops. They are also found at some small wetlands only when they are drying. They are rarely found using brackish wetlands, or dry stunted saltmarsh. Typically they do not use coastal flats, but are occasionally recorded in stony wetlands. This species uses artificial wetlands, including open sewage ponds, reservoirs, large farm dams, and bore drains (Higgins & Davies 1996).

The Wood sandpiper forages on moist or dry mud at the edges of wetlands, either along shores, among open scattered aquatic vegetation, or in clear shallow water (Higgins & Davies 1996).

The species has been recorded loafing on a low, grassy hillock in a flooded meadow. It has also been recorded perched low in trees and on fences (Higgins & Davies 1996).

9.64.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Wood sandpiper habitat assumptions are presented below.

9.64.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways
- Species are often associated with freshwater wetlands (DOTE 2014ah). As such, areas mapped as but not limited to 'riverine', 'lacustrine' and 'pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species

9.64.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.64.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.64.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For the Wood sandpiper, general habitat includes, but is not necessarily limited to, all areas identified above and areas associated with the banks of waterways are considered to constitute 'general habitat'.

9.64.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.64.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.64.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.64.7 Management Practices and Methods

Management measures for this species are outlined in Section 7.0.

9.65 Caspian tern

9.65.1 EPBC Act legal status

Marine and Migratory (CAMBA/JAMBA)

9.65.2 Biology and ecology

9.65.2.1 Characteristics

The largest tern in Australia, the Caspian tern (*Hydroprogne caspia*) has long, slender backswept wings and a slightly forked tail. The heavy bill is red with a dusky tip. The sexes are similar, with a body length between 53 and 60 cm long, and an average weight of 680 g (Higgins & Davies 1996).

The Caspian tern has a white body, with a black and white streaked crown from bill to nape and a short shaggy crest. The mantle and upperwings are grey and the flight feathers are darker. The eye is dark brown and legs are black (Higgins & Davis 1996). When breeding, the crown is black. Immature birds are similar to non-breeding adults. Younger birds are mottled grey and brown (Birds Australia 2010b).



Plate 66: Caspian tern (Source: Mdf 2007)

9.65.2.2 Known distribution

Within Australia, the Caspian tern has a widespread occurrence and can be found in both coastal and inland habitat (Higgins & Davies 1996).

In Queensland, the Caspian tern is widespread in coastal regions from the southern Gulf of Carpentaria to the Torres Strait, and along the eastern coast. The species has been recorded in the western districts, especially the Lake Eyre Drainage Basin, north-west to the Gulf Country north of Mt Isa and Cloncurry, there are also scattered records for central Queensland (Higgins & Davies 1996).

Breeding occurs on the Wellesley Islands in the south-east Gulf of Carpentaria, islands off the far north coast from Bird Island south to Three Isles and from islands around Shoalwater Bay including Pelican

Rock south to Fairfax Island. Inland breeding records occur at Lake Bindegolly and Lake Moondarra (Chatto 2001; Higgins & Davies 1996).

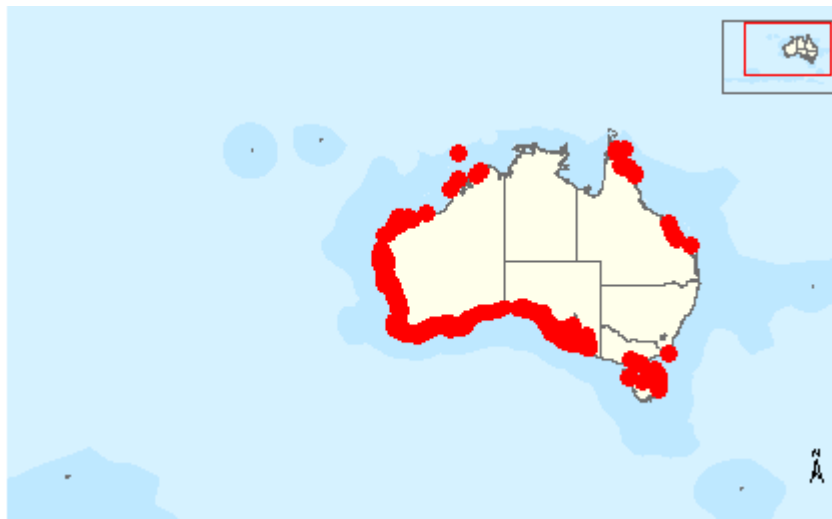


Figure 67: Distribution range of the Caspian tern (Source: DOTE 2014ai)

9.65.2.3 Known species populations and their relationship within the CSG fields

This species has been historically recorded within the CSG fields. The CSG fields are within the known distribution of the species and suitable habitat is present.

9.65.2.4 Biology and reproduction

The Caspian tern's diet consists predominantly of fish (5 to 25 cm in length) as well as the eggs and young of other birds, carrion, aquatic invertebrates (eg crayfish), flying insects and earthworms (Birdlife International 2010c).

The age of first breeding is four years old, or occasionally three years old (Barlow 1991). Caspian terns return to their natal areas to breed (Birds Australia 2010). The species breeds between September and December in the southern Hemisphere, though timing varies in different areas (Higgins & Davies 1996).

The nest is a deep scrape on the ground, usually unlined, but occasionally sparsely ringed with debris or scraps of local vegetation such as saltbush or Pigface (*Carpobrotus rossii*). Both sexes share nest-building, incubation and care of the young (Higgins & Davies 1996). Laying is asynchronous within colonies, with eggs and young at all stages being present in a colony at the one time (Higgins & Davies 1996). Colonies of Caspian terns can be large, dense and monospecific, or single pairs or small groups (two to three pairs) in large colonies of other bird species (Birdlife International 2010c; Chatto 2001; Fuller *et al* 1994).

The clutch size is one to three eggs, usually two, incubation takes 22 days and chicks fledge in approximately 35 days (Birds Australia 2010b).

9.65.3 Habitat

The Caspian tern is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including

ephemeral lakes), waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks. In offshore areas the species prefers sheltered situations, particularly near islands, and is rarely seen beyond reefs (Higgins & Davies 1996).

Large numbers may shelter along the coast, behind coastal sand-dunes or coastal lakes during rough weather, and have been recorded inland after storms (Higgins & Davies 1996).

The Caspian tern usually forages in open wetlands, including lakes and rivers. They often prefer sheltered shallow water near the margins, but can also be found in open coastal waters. In coastal inlets they may prefer to forage in tidal channels, or over submerged mudbanks (Higgins & Davies 1996).

The Caspian tern breeds on variable types of sites including low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks. Nests may be in the open, or among low or sparse vegetation, including herbfield, tussocks, samphire or other prostrate sand-binding plants. They sometimes nest near bushes or other shelter such as large sticks, driftwood and piles of beachcast seagrass. Generally roosting occurs on bare exposed sand or shell spits, banks or shores of coasts, lakes, estuaries, coastal lagoons and inlets. Occasionally they nest among beachcast debris above the high-water mark or at artificial sites, including islands in reservoirs, or on dredge-spoil (Higgins & Davies 1996).

Refer to Figure 3.1 for the habitat assessment process.

9.65.4 Habitat assessment

Information obtained from BPA (ie Brigalow Belt South Fauna Expert Panel Report (EPA 2006)), together with expert advice, site based species records and pre-clearance survey data have been used to define a set of assumptions that have been used to identify areas of habitat that are consistent with the definitions of 'core habitat', 'essential habitat' and 'general habitat' that have been presented in this SSMP. The Caspian tern habitat assumptions are presented below.

9.65.4.1 General assumptions

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with coastal and offshore waters, bays, inlets, saline or brackish lakes, saltfields, sewage ponds near the coast (Pizzey & Knight 1997)
- Species inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches (DOTE 2014ai)

9.65.4.2 Core habitat

'Core habitat' consists of 'essential habitat' in which the species is known and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.

As this species is ubiquitous with extensive distributions within Australia, 'core habitat' is not considered to exist for this species within the proposed Project footprint.

9.65.4.3 Essential habitat

'Essential habitat' is an area containing resources that are considered essential for the maintenance of populations of the species (eg potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). 'Essential habitat' is defined from known records and/or expert advice (including the findings of pre-clearance surveys).

As this species is ubiquitous with extensive distributions within Australia, 'essential habitat' is not considered to exist for this species within the proposed Project footprint.

9.65.4.4 General habitat

'General habitat' consists of areas or locations that are used by transient individuals or where species have been recorded but there is insufficient information to assess the area as essential/core habitat. 'General habitat' may be defined from known records or habitat that is considered to potential support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. 'General habitat' may include areas of suboptimal habitat for species

For the Caspian tern, general habitat includes, but is not necessarily limited to, all areas identified above and areas associated with the banks of waterways are considered to constitute 'general habitat'.

9.65.4.5 Unlikely habitat

'Unlikely habitat' areas are those areas that do not contain records of the particular species and do not contain sufficient habitat features to support the species (ie areas that do not meet the habitat assumptions identified above).

9.65.5 Anticipated threats and potential impacts from the Project

Threats affecting this species from gas field development are outlined in Section 6.0.

9.65.6 Unavoidable impact from the Project

Where an identified active breeding place for this species occurs during the initial planning phase of the development, an exclusion zone of 100 m will be applied. In addition, restricted zones of 50 m are to be established around breeding places that have become active after construction has commenced, as per Section 7.0.

Where disturbance is proposed within habitat for this species, the Santos management hierarchy will be applied (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation), as per the Protocol (refer Section 7.0).

Pre-clearance surveys will confirm the presence and quality of habitat and the likelihood that it is suitable to support a population of the species.

9.65.7 Management Practices and Methods

Management measures for this species are outlined in Section 7.0.

9.66 Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin

9.66.1 Status

Endangered – listed 7 January 2009



Plate 67: Natural grasslands community (Source: DSEWPac 2012a)

9.66.2 Ecology

9.66.2.1 Characteristics

The Natural Grasslands are typically composed of perennial native grasses on soils that are fine textured (often cracking clays) derived from either basalt or fine-grained sedimentary rocks, on flat or gently undulating rises. These grasslands occur in areas with relatively high summer rainfall. The tree canopy is usually absent however where trees persist, the projective crown cover is less than 10%. Tree species that may be present as scattered individuals include *Corymbia erythrophloia* (Gum-topped bloodwood), *Eucalyptus coolabah* (Coolibah), *Eucalyptus crebra* (Narrow-leaved ironbark), *Eucalyptus melanophloia* (Silver-leaved ironbark), *Eucalyptus orgadophila* (Mountain coolibah), *Eucalyptus populnea* (Poplar box) and *Melaleuca bracteata* (Black tea-tree).

The ground layer is typically dominated by perennial native grasses and contains at least three of the following indicator species: *Aristida latifolia* (Feather-top wiregrass), *Aristida leptopoda* (White speargrass), *Astrebla elymoides* (Hoop mitchell grass), *Astrebla lappacea* (Curly mitchell grass), *Astrebla squarrosa* (Bull mitchell grass), *Bothriochloa erianthoides* (Satin-top grass), *Dichanthium queenslandicum* (King bluegrass), *Dichanthium sericeum* (Queensland bluegrass), *Eriochloa crebra* (Cup grass), *Panicum decompositum* (Native millet), *Panicum queenslandicum* (Yabila grass), *Paspalidium globoideum* (Shot grass) and/or *Thellungia advena* (Coolibah grass). In a poor season

(hot summer or drought), the only visible evidence of natural grassland may be scattered tussocks that are difficult to identify. Identification and assessment of the community should therefore be made during a good season. If it can be demonstrated beyond reasonable doubt, that the grassland was derived from cleared woodland, then it is not considered a part of this TEC (DSEWPaC 2011an).

Within Queensland, eight REs have been identified as being analogous to the Natural Grasslands TEC (DSEWPaC 2011an). Table 1.1 lists these REs and provides a brief description of each RE type. Figure 1 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 20: REs analogous with Natural Grasslands TECs in Queensland

RE	RE Description
11.3.21	<i>Dichanthium sericeum</i> and/or <i>Astrebla</i> spp. grassland on alluvial plains. Cracking clay soils
11.4.4	<i>Dichanthium</i> spp., <i>Astrebla</i> spp. grassland on Cainozoic clay plains
11.4.11	<i>Dichanthium sericeum</i> , <i>Astrebla</i> spp. and patchy <i>Acacia harpophylla</i> , <i>Eucalyptus coolabah</i> on Cainozoic clay plains
11.8.11	<i>Dichanthium sericeum</i> grassland on Cainozoic igneous rocks
11.9.3	<i>Dichanthium</i> spp., <i>Astrebla</i> spp. Grassland on fine-grained sedimentary rocks
11.9.3a	<i>Dichanthium</i> spp., <i>Astrebla</i> spp. Grassland on fine-grained sedimentary rocks
11.9.12	<i>Dichanthium sericeum</i> grassland with clumps of <i>Acacia harpophylla</i> on fine-grained sedimentary rocks
11.11.17	<i>Dichanthium sericeum</i> grassland on old sedimentary rocks with varying degrees of metamorphism and folding

9.66.2.2 Known distribution

This ecological community is endemic to Queensland. It occurs where the Fitzroy River Basin and the Brigalow Belt North coincide, extending from Collinsville in the north to Carnarvon National Park in the south, bounded to the south by the Expedition, Carnarvon, Great Dividing, Drummond and Narrien ranges; and to the north by the Clark, Denham, Connors and Broadsound ranges (DSEWPaC 2011an). It occurs within IBRA subregions 6, 9, 10, 11, 12 and 13 of the Brigalow Belt North and subregions 1 and 9 of the Brigalow Belt South subregions.

9.66.2.3 Biology and reproduction

Climatic factors can cause large and seasonal fluctuations in species dominance and cover in grassland communities (Wilson *et al* 2002). For example in Bluegrass communities, the extent of seedling recruitment of Mitchell grasses and Queensland bluegrass is affected by previous climatic conditions (Austin & Williams 1988). Curly mitchell grass requires a high rainfall event in spring (at least 100 mm) followed by a similar rainfall in autumn and suitable rain the following winter to establish large numbers of seedlings. Queensland bluegrass germinates and establishes in dense populations under warm-season rainfall and will out-compete Curly mitchell grass seedlings and attain dominance in the grasslands during favourable seasonal conditions. Because of these differing requirements, in some years plants of the shorter-lived Queensland bluegrass may be almost or totally absent from Bluegrass communities and the vegetation dominated by Mitchell grasses. Winter rainfall also results

in the germination of a large suite of 'cool-season' forb species whereas summer rains favour annual grass species such as *Iseilema membranaceum* (Small flinders grass) (Austin & Williams 1988).

9.66.3 Known TEC populations and their relationship with the CSG Fields

Grasslands are present in ATP 745.

Mapping will be updated on the completion of pre-clearance surveys.

9.66.4 Anticipated threats and potential impacts as a result of the Project

Threats affecting this TEC from gas field development are outlined in Section 6.0.

9.66.5 Unavoidable impact from the Project

If the TEC cannot be avoided, EPBC approval conditions and the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be complied with.

Unavoidable clearing will be within the disturbance limits stipulated under the EPBC Approval and in accordance with the Protocol.

9.66.6 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.67 Brigalow (*Acacia harpophylla* dominant and co-dominant)

9.67.1 Status

Endangered – listed 4 April 2001



Plate 68: Brigalow TEC community (Source: DEHP 2013)

9.67.2 Ecology

9.67.2.1 Characteristics

The Brigalow 'threatened ecological community' (TEC) is characterised by either the dominance or co-dominance of *Acacia harpophylla* (Brigalow) as a canopy or sub-canopy species. Other canopy species that may be associated with this TEC include *Casuarina cristata* (Belah), other *Acacia* species and/or *Eucalypt* species. Structurally, the community may exist in a variety of forms from low open woodlands to open forests with dominant tree layers ranging between 9 m in height (in low rainfall regions) through to 25 m in height (in higher rainfall areas) (DSEWPaC 2011ao).

The Brigalow TEC is commonly associated with heavy clay soils (ie deep gilgaied clays, sedentary clays, alluvial clays, miscellaneous deep clays and loamy), are relatively fertile and tend to have a high salt content. In Queensland, the soils are primarily cracking clays, but texture contrast soils are common where *Eucalyptus* species are co-dominant. 85% of listed Brigalow community remnants in Queensland occur on flat to gently undulating Cainozoic clay plains not associated with current alluvium, and on gently undulating landscapes. About 10% of remnants are associated with river and creek flats and the remainder are found on old loamy and sandy plains, basalt plains and hills or hills lowlands on metamorphic or granitic rocks. Cracking clay soils, which are characteristic of Brigalow TEC soils, provide shelter for various mammals and reptiles. Woody debris and other litter on the ground also provides important habitat for some faunal species, especially reptiles (cited in DSEWPaC 2011ao).

Within Queensland, 16 REs have been identified as being analogous to the Brigalow TEC (DSEWPaC 2011ao). Table 2.1 lists these REs and provides a brief description of each RE type. Figure 2 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 21: REs analogous with Brigalow TECs in Queensland from DSEWPac (2011ao)

RE	Description
6.4.2	<i>Casuarina cristata</i> +/- <i>Acacia harpophylla</i> open forest on clay plains
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains
11.4.3	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> shrubby open forest on Cainozoic clay plains
11.4.7	Open forest of <i>Eucalyptus populnea</i> with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on Cainozoic clay plains
11.4.8	<i>Eucalyptus cambageana</i> open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains
11.4.9	<i>Acacia harpophylla</i> shrubby open forest with <i>Terminalia oblongata</i> on Cainozoic clay plains
11.4.10	<i>Eucalyptus populnea</i> or <i>E. pilligaensis</i> , <i>Acacia harpophylla</i> , <i>Casuarina cristata</i> open forest on margins of Cainozoic clay plains
11.5.16	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest in depressions on Cainozoic sand plains/remnant surfaces
11.9.1	<i>Acacia harpophylla</i> , <i>Eucalyptus cambageana</i> open forest on Cainozoic fine grained sedimentary rocks
11.9.5	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on Cainozoic fine grained sedimentary rocks
11.9.6	<i>Acacia melvillei</i> ± <i>A. harpophylla</i> open forest on Cainozoic fine grained sedimentary rocks
11.11.14	<i>Acacia harpophylla</i> open forest on deformed and metamorphosed sediments and interbedded volcanics
11.12.21	<i>Acacia harpophylla</i> open forest on igneous rocks; colluvial lower slopes
12.8.23	<i>Acacia harpophylla</i> open forest on Cainozoic igneous rocks
12.9-10.6	<i>Acacia harpophylla</i> open forest on sedimentary rocks
12.12.26	<i>Acacia harpophylla</i> open forest on Mesozoic to Proterozoic igneous rocks

9.67.2.2 Known distribution

The Brigalow TEC extends from south of Charters Towers in Queensland, in a broad swathe east of Blackall, Charleville and Cunnamulla and south to northern New South Wales near Narrabri and Bourke (DSEWPac 2011ao). Figure 2 outlines an indicative distribution of Brigalow TEC in Queensland.

In Queensland, it occurs predominantly within the Brigalow Belt North, Brigalow Belt South, Darling Riverine Plains and Southeast Queensland bioregions. It also occurs to a lesser extent in the Mitchell Grass Downs, Mulga Lands and Einasleigh Uplands bioregions. The original extent of the Brigalow ecological community in Queensland was estimated to be more than 7.3 million hectares. By 2003 about eight percent remained. Core areas of remnants are located in the Northern Bowen Basin, Belyando Downs, Issac-Comet Downs and Claude River Downs subregions of the Brigalow Belt North bioregion and in the Southern Downs and Moonie River-Commoroon Creek Floodout subregions of the Brigalow Belt South Bioregion (cited in DSEWPac 2011ao).

9.67.2.3 Biology and reproduction

Acacia harpophylla and *Casuarina cristata* are generally the dominant species within most of the REs analogous to the Brigalow TEC. Therefore, the overall biology of the Brigalow TEC reflects patterns of seasonal growth and flowering as determined by these species. Brigalow flowers between April and October with the production of viable seed requiring cross-pollination between trees. Seeds normally mature in late spring, early summer and generally remain viable for less than a year. In Queensland germination and establishment require good rainfall following seed set. Where Brigalow has been initially cleared without further treatment, it will sucker from the root systems of the original plants, with this regrowth growing faster than Brigalow seedlings (cited in DSEWPac 2011ao). These areas of Brigalow regrowth have the ability to provide suitable offsets for the clearing of Brigalow TECs where these areas do not currently fulfil the definition of the Brigalow TEC.

9.67.3 Known TEC populations and their relationship with the CSG Fields

Brigalow is located within all GFD project tenements.

The identified Brigalow is variable in condition from small low quality patches with considerable weed invasion to very large good quality patches with little evidence of disturbance. 'Endangered' HVR vegetation has potential to be included within this community

Mapping will be updated on the completion of pre-clearance surveys.

9.67.4 Anticipated threats and potential impacts as a result of the Project

Threats affecting this TEC from gas field development are outlined in Section 6.0.

9.67.5 Unavoidable impact from the Project

If the TEC cannot be avoided, EPBC approval conditions and the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be complied with.

Unavoidable clearing will be within the disturbance limits stipulated under the EPBC Approval and in accordance with the Protocol.

9.67.6 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.68 Semi-evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions

9.68.1 Status

Endangered – listed 4 April 2001

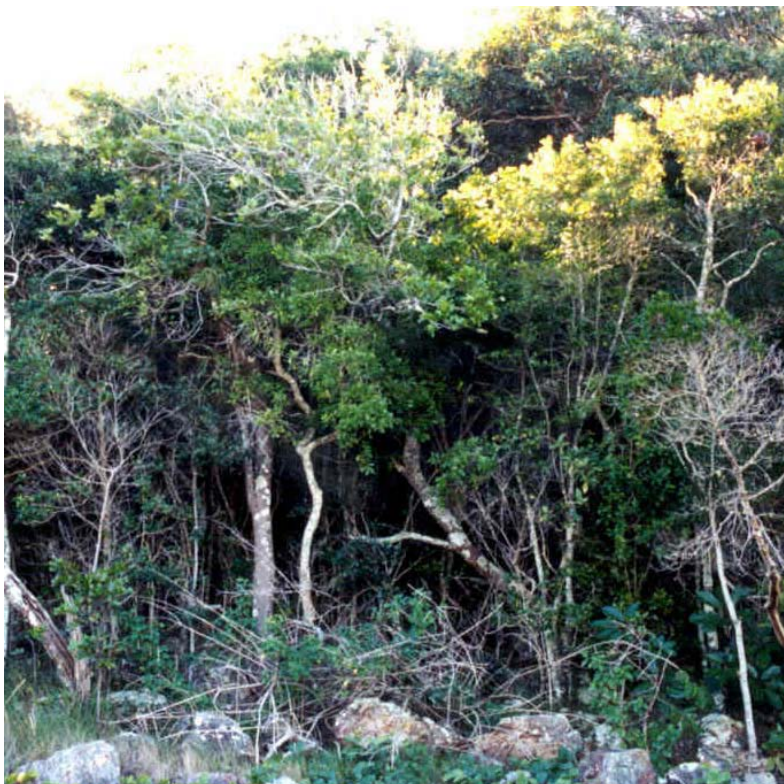


Plate 69: SEVT TEC community (Source: EPA 2007)

9.68.2 Ecology

9.68.2.1 Characteristics

The Central Semi-evergreen Vine Thicket (SEVT) 'threatened ecological community' (TEC) is also known as softwood scrub or bottle tree scrub. This TEC is characterised by a floristically diverse and heterogeneous assemblage of species, especially in the canopy and shrub layers (DSEWPac 2011ap). Typically, one patch of SEVT may contain over 40 vascular plant species, although the number of tree species is highly variable, ranging from 1 to 19 species (DSEWPac 2011ap).

Emergent species are composed of a range of evergreen, semi-evergreen and deciduous species, including *Brachychiton rupestris* (Narrow-leaved bottle tree) which is generally present within SEVT areas. Other species that may be locally present as emergent include *Acacia harpophylla* (Brigalow), *Brachychiton australis* (Broad-leaved bottle tree) and *Casuarina cristata* (Belah), or less often *Acacia fasciculifera*, *Archidendropsis thozetiana* (Grey Boxwood), *Cadellia pentastylis* (Ooline), *Euroschinus falcata*, *Flindersia australis* (Crow's ash) and *Ventilago viminalis* (Vine tree) (DSEWPac 2011ap).

A wide range of species are generally present within the canopy stratum and generally include *Backhousia angustifolia*, *Backhousia kingii*, *Croton insularis*, *Denhamia oleaster*, *Ehretia*

membranifolia, *Geijera parviflora*, *Macropteranthes leichhardtii*, *Notelaea microcarpa* and *Pouteria cotinifolia* (DSEWPac 2011ap).

A dense shrub understorey may be present. However where the canopy is very dense, shrubs may be absent as a result of competitive exclusion. Species common in the shrub layer include *Acalypha eremorum*, *Alectryon diversifolius*, *Everistia vacciniifolia*, *Carissa ovata*, *Croton phebaloides*, *Exocarpos latifolius*, *Geijera parviflora*, *Pittosporum spinescens* and *Triflorensia ixoroides* (DSEWPac 2011ap).

Within Queensland, 10 REs have been identified as being analogous to the SEVT TEC (DSEWPac 2011ap). Table 3.1 lists these REs and provides a brief description of each RE type. Figure 3 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 22: REs analogous with SEVT TECs in Queensland from DSEWPac (2011ap)

RE	Description
11.2.3	Microphyll vine forest ("beach scrub") on sandy beach ridges
11.3.11	Semi-evergreen vine thicket on alluvial plains
11.4.1	Semi-evergreen vine thicket ± <i>Casuarina cristata</i> on Cainozoic clay plains
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains/remnant surfaces
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks
11.8.6	<i>Macropteranthes leichhardtii</i> thicket on Cainozoic igneous rocks
11.8.13	Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks
11.9.4	Semi-evergreen vine thicket on Cainozoic fine-grained sedimentary rocks
11.9.8	<i>Macropteranthes leichhardtii</i> thicket on Cainozoic fine-grained sedimentary rocks
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding

9.68.2.2 Known distribution

The SEVT TEC extends from Townsville in Queensland south into northern New South Wales (NSW). It is primarily located within the Brigalow Belt Bioregion (ie Bioregion 11). Figure 3 outlines an indicative distribution of Brigalow TEC in Queensland based on current DEHP certified RE mapping.

In Queensland the remnant SEVT areas are scattered from coastal dunes and river deltas in the vicinity of Townsville and Ayr, through to the northern and central parts of the Brigalow Belt Bioregion and south into its south-eastern parts between Jandowae and Killarney on the Queensland/New South Wales border (Queensland Herbarium 2002a). In NSW, remnants usually occur as isolated patches scattered in other shrubby vegetation (Curran 2003) and are located on the North West Slopes east of Moree and north from the Liverpool Plains, with major occurrences in the vicinity of Gunnedah, Bingara and Narrabri (Benson *et al* 1996, Williams 1999, Curran 2003, Keith 2004).

The SEVT TEC occurs in the Brigalow Belt North, Brigalow Belt South and Nandewar bioregions (Threatened Species Scientific Committee 2001). In Queensland, more than 50% of remnants occur in the Arcadia, Buckland Basalts, Claude River Downs, Dawson River Downs, Northern Bowen Basin and Southern Downs sub regions (McDonald 2007).

9.68.2.3 Biology and reproduction

The SEVT TEC usually occurs as discrete patch within other vegetation types, including *Acacia harpophylla* forest. These TECs occupy the drier portion of the natural range of closed canopy vegetation communities, and the gradient from humid to sub-humid environments is reflected in the reduction of both canopy height and structural and floristic complexity. In rocky locations the canopy tends to be lower and more open. Adaptations to drier environments include smaller, thicker leaves, swollen roots and stems, and an optional deciduous habit.

SEVT TECs are generally fire sensitive and often rely on *Acacia harpophylla*, and other vegetation, to serve as a buffer to prevent the incursion of fires into the SEVT community.

SEVT ecosystems rely on a variety of dispersal modes for regeneration and recruitment.

The seeds of many canopy emergent species are dispersed by wind, while some seeds of the lower canopy and ground layer species are dispersed by frugivores (fruit-eating animals). SEVT ecosystems are known to be important habitat for numerous bird species and they provide a refuge for wildlife in times of fire and climate change (EPA 2007).

9.68.3 Known TEC populations and their relationship with the CSG Fields

SEVT is prevalent in ATP 803 and is also present in ATP 745.

The identified SEVT is variable in condition from small low quality patches with considerable weed invasion to very large good quality patches with little evidence of disturbance

It should be noted that RE mapping is not sufficiently robust to capture all the area of this community (ie RE mapping is based on a minimum area of 2 ha, community characteristics) and that this community may occur in areas mapped as regrowth and non-remnant under DERM's mapping.

9.68.4 Anticipated threats and potential impacts as a result of the Project

Threats affecting this TEC from gas field development are outlined in Section 6.0.

9.68.5 Unavoidable impact from the Project

If the TEC cannot be avoided, EPBC approval conditions and the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be complied with.

Unavoidable clearing will be within the disturbance limits stipulated under the EPBC Approval and in accordance with the Protocol.

9.68.6 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.69 The Community of Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin

9.69.1 Status

Endangered – listed 4 April 2001



Plate 70: Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin
TEC community (Source: EPA 2005)

9.69.2 Ecology

9.69.2.1 Characteristics

The Great Artesian Basin (GAB) is a hydrogeological basin that underlies an area of about 1.7 million square kilometres, primarily beneath arid and semi-arid regions of Queensland, New South Wales, South Australia and the Northern Territory (Cox & Barron 1998). The groundwater comes to the surface at points within Great Artesian Basin discharge areas which are the natural surface discharge points of aquifers. The discharge points and their associated wetland areas are variously called springs, artesian springs, mound springs, mud springs, boggomoss springs (springs with raised mounds of organic matter), spring pools and groundwater seeps (TSSC 2001). The size of discharge spring wetlands in Queensland range from 100 cm² to 3 ha, with most spring wetlands less than 0.05 ha in area (Fensham & Fairfax 2003).

The native species that comprise the ecological community are assemblages of plant and animal taxa associated with and dependent on the springs and wetland areas located at points where the Great Artesian Basin groundwater is discharged naturally. The species include plants and animals that are endemic to one or more springs/wetlands and species that occur more widely in the Great Artesian Basin (TSSC 2001) or beyond it. Springs in South Australia and New South Wales appear to be floristically similar, but distinct from those in Queensland. Species in common include *Cyperus laevigatus*, *Phragmites australis* and *Eriocaulon carsonii*. Species apparently restricted to Great Artesian Basin discharge spring wetlands in Queensland include *Eragrostis fenshamii* (previously known as *Eragrostis* sp.), *Myriophyllum artesium*, *Pennisetum alopecuroides*, *Schoenus falcatus* and *Sporobolus pamela* (Fensham et al 2004).

Within Queensland, six REs have been identified as being analogous to the SEVT TEC (DSEWPaC 2011aq). Table 4.1 lists these REs and provides a brief description of each RE type. Figure 4 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 23: REs analogous with SEVT TECs in Queensland from DSEWPaC (2011aq)

RE	Description
2.3.39	Springs on recent alluvium
4.3.22	Springs on recent alluvia and fine-grained sedimentary rock
5.3.23	Springs on recent alluvia and fine-grained sedimentary rocks
6.3.23	Springs on recent alluvia, ancient alluvia and fine-grained sedimentary rock
10.3.31	Artesian springs emerging on alluvial plains
11.3.22	Springs associated with recent alluvia, but also including those on fine-grained sedimentary rocks, basalt, ancient alluvia and metamorphic rocks

9.69.2.2 Known distribution

The Great Artesian Basin underlies an area approximately 1.7 million square kilometres primarily beneath arid and semi-arid regions of Queensland, New South Wales, South Australia and the Northern Territory (Cox & Barron 1998).

The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin TEC is associated with 12 spring supergroups located in discharge areas on the northern, western and southern margins of the Great Artesian Basin in Queensland, New South Wales and South Australia (Fensham *et al* 2010).

9.69.2.3 Biology and reproduction

Spring wetlands may form vegetated swamps or vegetation may be absent if there is no water seepage (Fensham *et al* 2010). The vegetated area can vary with spring flow, water salinity level, stock grazing and trampling, sediment deposition or removal (by flood or wind), minor diversion of spring tails, surface and near-surface water subsidies in a wet period, and the establishment of root or rhizome caps on small vents (DSEWPaC 2011aq).

Vegetation patterns, including micro-patterning, vegetation height and species present, may be related partly to variations in substrate, water chemistry, water depth and water flow rate. Water chemistry can determine whether some species are present or not (DSEWPaC 2011aq).

Springs are highly dynamic biological systems on a time-scale in the order of years to decades. Floristic composition and diversity vary with the physical location of springs, the number of springs in a spring-group or spring-complex, water salinity, the presence/absence of grazing by domestic stock, flooding following major rainfall events, and short-term and long-term changes in spring water flow (DSEWPaC 2011aq).

9.69.3 Known TEC populations and their relationship with the CSG Fields

This community does not occur in the project area, or locality, although a number of springs occur outside of the GFD Project area.

9.69.4 Anticipated threats and potential impacts as a result of the Project

Threats affecting this TEC from gas field development are outlined in Section 6.0.

9.69.5 Unavoidable impact from the Project

No disturbance of this community is allowable.

9.69.6 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.70 Weeping Myall Woodlands

9.70.1 Status

Endangered – listed 7 January 2009



Plate 71: Weeping Myall Woodlands TEC community (Source: NSW Catchment Management Authority 2013)

9.70.2 Ecology

9.70.2.1 Characteristics

Weeping myall woodlands occur in a range of forms, including woodlands and open-woodlands, or as a shrubby or grassy woodland. While Weeping myall (*Acacia pendula*) must be the dominant overstorey species, other tree species may also occur in the canopy layer. This community often includes Western rosewood (*Alectryon oleifolius* subs. *Elongates*), Poplar box (*Eucalyptus populnea*), and Black box (*Eucalyptus largiflorens*). Grey mistletoe (*Amyema quandang*) regularly occurs within Weeping myall communities.

The structure of this community varies throughout its range. Within the CSG fields, the community is restricted to sparse or scattered stands along floodplains or minor depressions. It generally occurs in areas with a flat topography, shallow depressions or gilgais on raised alluvial plains. Generally these areas are not associated with active drainage channels. This community is associated with black, bow, red-brown or grey clay and clay-loam soils.

Within Queensland, six REs have been identified as being analogous to the Weeping myall TEC (DSEWPaC 2011ar). Table 5.1 lists these REs and provides a brief description of each RE type. Figure 5 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 24: REs analogous with Weeping myall woodland TECs in Queensland from DSEWPaC (2011ar)

RE	Description
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RE	Description
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains
11.3.28	<i>Casuarina cristata</i> +/- <i>Eucalyptus coolabah</i> open woodland on alluvial plains

9.70.2.2 Known distribution

In Queensland, Weeping myall woodlands occur on the inland alluvial plains west of the Great Dividing Range in Queensland, within the Brigalow Belt South and Nandewar bioregions (DEWHA 2009),

The extent of Weeping myall woodlands in Queensland is thought to have declined by approximately 75% (DEWHA 2009).

9.70.2.3 Biology and reproduction

Weeping myall woodlands can vary in structure throughout its range. In higher rainfall areas it typically forms an open woodland. As rainfall decreases the ecological community becomes increasingly restricted, tending to sparse or scattered stands of woodland occurring in discrete bands fringing better-watered country. It can also occur as relatively narrow strips on the margins of floodplain woodland or on minor depressions or run-on areas adjacent to sandhills (White *et al* 2002).

Weeping myall flowers from March to May but the intensity and timing is variable between years (Santos 2007)

9.70.3 Known TEC populations and their relationship with the CSG Fields

Only scattered individuals or small clumps of *Acacia pendula* have been found in the GFD Project area. However, this community may still occur as a component of RE 11.3.2 in all project tenements.

This community is most likely to occur in ATP 708.

9.70.4 Anticipated threats and potential impacts as a result of the Project

Threats affecting this TEC from gas field development are outlined in Section 6.0.

9.70.5 Unavoidable impact from the Project

If the TEC cannot be avoided, EPBC approval conditions and the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be complied with.

Unavoidable clearing will be within the disturbance limits stipulated under the EPBC Approval and in accordance with the Protocol.

9.70.6 Management practices and methods

Management measures for this species are outlined in Section 7.0.

9.71 Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions

9.71.1 Status

Endangered – listed 1 March 2011



Plate 72: Coolibah – Black Box Woodlands TEC community (Source: Ausecology 2012)

9.71.2 Ecology

9.71.2.1 Characteristics

The Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (Coolibah – Black box) 'threatened ecological community' (TEC) is characterised by occurrences of one type of semi-arid to humid subtropical woodland where *Eucalyptus coolabah* subsp. *coolabah* (Coolibah) and/or *Eucalyptus largiflorens* (Black box) are the dominant canopy species and where the understorey tends to be grassy. The ecological community is associated with the floodplains and drainage areas of the Darling Riverine Plains and the Brigalow Belt South bioregions (Threatened Species Scientific Committee (TSSC) 2011c).

The Coolibah – Black box TECs are found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees (NSW Scientific Committee 2009). The TEC occurs on a landscape of flat to low relief where small changes in slope and height can influence the species composition. Parts of the TEC associated with drainage depressions and gilgai, or areas of lower floodplain, remain inundated for longer periods than parts of the TEC associated with higher floodplain areas of the distribution (TSSC 2011c).

The structure of the TEC may vary from tall woodland in riparian zones to very open woodland with a sparse mid layer of shrubs and saplings and a grassy ground layer (TSSC 2011c).

Typically the TEC forms mosaics with grasslands, shrublands and wetlands (NSW Scientific Committee 2009). The structure and composition varies depending on topography and flooding or disturbance history. Some species vary in abundance in an east-west direction across the range of the community, although the overall floristic character of the community is maintained across its range (NSW Scientific Committee & Mackenzie 2008).

The TEC naturally exists in a range of states, reflected by differences in vegetation structure partly in response to natural influences such as flooding history and seed bank availability, but also due to disturbances through human activities. States in which Coolibah – Black box woodlands exist include (TSSC 2011c):

- Structurally intact old growth with mature trees and native ground layer (very rare mature woodland)
- Structurally intact mature stands (thinned stands where trees may have been naturally thinned or ringbarked and coppiced approximately 50 to 100 years ago)
- Dense regrowth, with or without mature trees, with intact native groundcover (typically after flood events)
- Tree canopy removed but native groundcover intact (derived native grassland)
- Isolated paddock trees with relictual groundcover (degraded grassland)
- Native trees and ground cover removed or almost so (cropland, improved pasture)

Canopy species are composed of *Eucalyptus coolabah* subsp. *coolabah* (Coolibah) which must be present and is typically a dominant or subdominant tree species. Where Coolibah is not the dominant tree species present on its own, then Coolibah together with *E. largiflorens* (Black box) make up the dominant tree species in the canopy (TSSC 2011c).

Other tree species may occur in the tree canopy but are not dominant in the ecological community, except as small localised stands within patches of the ecological community. These include *Acacia salicina* (Cooba), *Acacia stenophylla* (River cooba), *Casuarina cristata* (Belah), *Eremophila bignoniiflora* (Eurah), *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus populnea* (Poplar box) (TSSC 2011c).

Medium to tall shrubs are typically sparse to absent in many areas of this TEC. Where a mid-layer is present it may include one or more of the following species: *Alectryon oleifolius* subsp. *elongatus* (Western rosewood), *Alstonia constricta* (Bitterbark), *Chenopodium nitrariaceum* (Nitre goosefoot), *Eremophila mitchellii* (Budda), *Geijera parviflora* (Wilga), *Muehlenbeckia florulenta* (Lignum) and *Rhagodia spinescens* (Spiny saltbush) (Benson *et al* 2006, Benson 2008, NSW Scientific Committee 2009). *Exocarpos aphyllus* (Leafless ballart) may be a common component of the shrub layer in localised areas of NSW and southern Queensland. *Acacia cambagei* (Gidgee) and Lignum may be common shrubs on lower floodplain areas such as stream channels and in depressions (TSSC 2011c).

On higher floodplain areas and over much of the community Western rosewood, *Apophyllum anomalum* (Warrior bush) and *Capparis mitchellii* (Wild orange) commonly tend to form a sparse mid layer (TSSC 2011c).

The ground layer is dominated by native graminoids, other herbs, chenopods and other small shrubs. The native species present may include the graminoids: *Astrebla lappacea* (Curly mitchell grass), *Cyperus victoriensis* (Yelka), *Dactyloctenium radulans* (Button grass), *Dichanthium sericeum* (Queensland bluegrass), *Eleocharis* spp. (Spike-rushes), *Eragrostis setifolia* (Neverfail), *Panicum decompositum* (Native millet), *Paspalidium distans* and *Paspalidium jubiflorum* (Warrego summer grass); and the herbs: *Daucus glochidiatus* (Native Carrot), *Marsilea drummondii* (Common nardoo), *Plantago cunninghamii* (Sagoweed), *Portulaca oleracea* (Pigweed), *Pycnosorus globosus* (Drumsticks), *Tetragonia tetragonioides* (New Zealand spinach) and *Tribulus* spp. (Caltrop). Chenopods include *Atriplex* spp., *Einadia nutans* subsp. *nutans* (Climbing Saltbush) and *Sclerolaena* spp. (TSSC 2011c).

Within Queensland, five REs have been identified as forming part of or aligning with the Coolibah – Black box TEC. Table 3.1 lists these REs and provides a brief description of these RE types. Figure 6 is a map showing the distribution of this RE using DEHP's RE mapping.

Table 25: REs analogous with Coolibah – Black box woodlands TEC in Queensland (TSSC 2011c)

RE	Description
11.3.3	<i>Eucalyptus coolabah</i> woodland on alluvial plains
11.3.15	<i>Eucalyptus coolabah</i> , <i>Acacia stenophylla</i> , <i>Muehlenbeckia florulenta</i> fringing woodland on alluvial plains
11.3.16	<i>Eucalyptus largiflorens</i> , +/- <i>Acacia cambagei</i> +/- <i>Acacia harpophylla</i> woodland to low open woodland on alluvial plains
11.3.28	<i>Eucalyptus coolabah</i> +/- <i>Casuarina cristata</i> open woodland on alluvial plains
11.3.37	<i>Eucalyptus coolabah</i> fringing woodland on alluvial plains

There may be some variants recognised within these REs that are not part of the TEC. For instance RE 11.3.15a *Muehlenbeckia florulenta* low shrubland +/- scattered *Eucalyptus coolabah* trees is excluded because the vegetation mainly comprises a lignum shrubland without Coolibah (TSSC 2011c).

Elements of the Coolibah – Black box TEC may extend into other REs, such as parts of RE 11.3.27 Freshwater Wetlands, where the wetlands are associated with fringing woodland, sometimes with Coolibah (TSSC 2011c).

9.71.2.2 Known distribution

The Coolibah – Black box TEC is a floodplain ecological community situated within the upper reaches of the Murray-Darling Basin and southern part of the Fitzroy River system and is limited to the Darling Riverine Plains and Brigalow Belt South bioregions (IBRA V6.1), situated in northern NSW and southern Queensland (TSSC 2011c).

The southern limit of the TEC is the southern boundary of the Darling Riverine Plains bioregion in NSW. The northern limit is the northern boundary of the Brigalow Belt South bioregion in Queensland (TSSC 2011c).

The TEC is likely to occur in the Catchment Management Authorities / Natural Resource Management Regions of Border Rivers Maranoa-Balonne, Condamine, Desert Channels, Fitzroy and South-West Queensland in Queensland (TSSC 2011c).

The TEC is likely to occur in the Local Government Areas (LGAs) of Balonne, Banana, Barcaldine, Blackall, Tambo, Central Highlands, Goondiwindi, Maranoa, Murweh, Rockhampton and Western Downs in Queensland (TSSC 2011c).

It is primarily located within the Brigalow Belt Bioregion (ie Bioregion 11). Figure 5 outlines an indicative distribution of Coolibah – Black box TEC in Queensland based on current DEHP certified RE mapping.

9.71.2.3 Biology and reproduction

The Coolibah – Black box TEC has developed in response to the wetting and drying cycles predominantly due to flood wetting rather than local rainfall (Cullen *et al* 2003).

Some species persist in the seed bank and only germinate, grow and reproduce in response to flooding (Capon & Brock 2006), whereas other long-lived species, including Coolibah and Black box, require specific inundation patterns for germination and establishment of seedlings (Roberts & Marston 2000).

Flooding for Coolibah associated with floodways is highly variable, brief and most likely in summer or autumn. Coolibah tolerates long dry interflood conditions as well as periodic flooding. Coolibah is intolerant of long-term water-logged soils or flooding. Broad scale regeneration follows certain flood events. Coolibah may be adapted to regenerate after late summer flooding, as germination rates are high in high temperatures (Roberts & Marston 2000, Nairn *et al* 2009).

Black box, which grows higher on the floodplain, has adaptations and characteristics that favour growth and survival under dry conditions, such as very low transpiration rates, small canopy leaf area and pendulous leaf habit that reduce water demand. Tree death of Black box can result from long periods without flooding, as a result of lack of water and accumulation of salt, in addition to extended periods of flooding/inundation (12 to 18 months) (Roberts & Marston 2000, Nairn *et al* 2009).

Groundcover will fluctuate greatly depending on seasonal conditions. Many species in the semi-arid environment are more rainfall dependant (eg year-long green perennials such as *Austrodanthonia* spp.) than having any regular seasonality of growth and flowering. Changes in season or rainfall can also change the relative dominance of ground layer species (Benson *et al* 2006, Benson 2008).

Flooding can stimulate the dense regeneration of Coolibah, Black box and other species from the soil seed bank. Many dense stands of Coolibah – Black box woodlands can be linked with specific flood events (Maher 1995). As the dense regeneration matures, the seedlings undergo self-thinning leading to a progressively more open tree canopy over time, which may be over a 100 year timeframe (Maher 1995).

Fires are rare in Coolibah – Black box woodlands. Little is known about historical fire regimes in the ecological community, however, an appropriate fire regime may be decades between burns (Benson *et al* 2006, Benson 2008). It is thought that more regular, low intensity fires may have contributed to a sparser ecological community to what is mostly evident today, as fires would have prevented establishment of some seedlings (Maher 1995, DEHP 2012d).

9.71.3 Known TEC populations and their relationship with the CSG Fields

Coolibah – Black box woodlands are prevalent as large good quality patches in ATP 803 associated with the Dawson River and Robinson Creek. This TEC may also be present in smaller patches in ATP 708, PL 10 and ATP 631

9.71.4 Anticipated threats and potential impacts as a result of the Project

Threats affecting this TEC from gas field development are outlined in Section 6.0.

9.71.5 Unavoidable impact from the Project

If the TEC cannot be avoided, EPBC approval conditions and the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be complied with.

Unavoidable clearing will be within the disturbance limits stipulated under the EPBC Approval and in accordance with the Protocol.

9.71.6 Management practices and methods

Management measures for this species are outlined in Section 7.0.

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