



Vegetation Inventory, Mapping, and Characterization Report, Organ Pipe Cactus National Monument

Volume I, Main Report



Parkinsonia microphylla (*Stenocereus thurberi*) / *Simmondsia chinensis* / *Encelia farinosa* Shrubland near Sweetwater Pass in the Ajo Mountains.

NPS

Vegetation Inventory, Mapping, and Characterization Report, Organ Pipe Cactus National Monument: Volume I, Main Report

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Sarah E. Studd ¹, Jeffrey B. Galvin ¹, Joseph S. Black¹, J. Andy Hubbard ¹

¹ National Park Service
Sonoran Desert Network
12661 E. Broadway Blvd.
Tucson, AZ 85748

Stacie Lynn Findon², editor

² Colorado State University
Department of Geosciences
Fort Collins, CO 80521

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Contents

	Page
Figures.....	viii
Tables.....	xviii
Abstract.....	xix
Acronyms.....	xx
Executive Summary.....	xxii
Acknowledgments.....	xxiii
Chapter 1: Introduction.....	1
Inventory Project Background.....	1
Scope and Products.....	1
The NPS Vegetation Mapping Inventory Program.....	2
The National Vegetation Classification Standard.....	3
The National Vegetation Classification.....	5
Terminology and Naming Conventions.....	5
Project Area Description.....	7
Location and Setting.....	7
Urban Pressures.....	8
Park Establishment and Purpose.....	9
Climate, Geology and Hydrology.....	9
Vegetation.....	13
Previous Vegetation Studies.....	15
Exotic (Non-Native) Plants.....	15
Chapter 2: Vegetation Classification.....	17
Planning and Scoping.....	17
Data Collection Overview.....	17
Digital Imagery Acquisition and Processing.....	17
Field Data Collection.....	18
Plot Data Management.....	20
Additional Datasets.....	21

Contents (continued)

	Page
Vegetation Classification Analysis.....	21
Classification Plot Analysis.....	21
Preliminary Classification Results	26
Classification Validation	28
Chapter 3: Mapping of Plant Communities	29
Methods	29
Results	33
Chapter 4: Map Products	34
Final Classification.....	34
Chapter 5: Association Summaries	42
1. (<i>Juniperus arizonica</i> – <i>Vauquelinia californica</i>) / Mixed Shrub Wooded Shrubland Association (P).....	42
(Redberry Juniper – Arizona Rosewood) / Mixed Shrub Wooded Shrubland Association	42
2. <i>Vauquelinia californica</i> / <i>Simmondsia chinensis</i> – <i>Rhamnus crocea</i> Wooded Shrubland Association (P).....	47
Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association	47
3. <i>Quercus ajoensis</i> – <i>Vauquelinia californica</i> / <i>Simmondsia chinensis</i> Intermittently Flooded Woodland Association (P).....	52
Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.....	52
4. <i>Prosopis velutina</i> / <i>Ziziphus obtusifolia</i> – <i>Lycium</i> spp. Wooded Shrubland Association (P)	57
Velvet Mesquite / Lotebush – Desert-Thorn Wooded Shrubland Association	57
5. <i>Isocoma acradenia</i> – <i>Distichlis spicata</i> Open Shrubland Association (P).....	62
Alkali Goldenbush – Saltgrass Open Shrubland Association	62
6. (<i>Parkinsonia microphylla</i>) / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland Association (P)	67
(Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association.....	67

Contents (continued)

	Page
7. <i>Fouquieria splendens</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland Association (P)	71
Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association	71
8. <i>Parkinsonia microphylla</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland Association (P)	76
Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland Association	76
9. <i>Parkinsonia microphylla</i> – <i>Olneya tesota</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Wooded Shrubland Association (P)	80
Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association	80
10. <i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland Association (P)	85
Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland Association	85
11. <i>Parkinsonia microphylla</i> – <i>Stenocereus thurberi</i> – <i>Pachycereus schottii</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Wooded Shrubland Association (P)	89
Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association	89
12. <i>Fouquieria splendens</i> / <i>Selaginella arizonica</i> Shrubby Rock Outcrop Association (P)	94
Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association	94
13. <i>Parkinsonia microphylla</i> / <i>Jatropha cuneata</i> / <i>Encelia farinosa</i> Shrubland Association (P)	99
Yellow Paloverde / Physicnut / Brittlebush Shrubland Association	99
14. <i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Jatropha cuneata</i> / <i>Encelia farinosa</i> Shrubland Association (P)	103
Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland Association	103
15. <i>Parkinsonia microphylla</i> / <i>Jatropha cuneata</i> (<i>Bursera microphylla</i>) / <i>Encelia farinosa</i> Shrubland Association (P)	107
Yellow Paloverde / Physicnut (Elephant Tree) / Brittlebush Shrubland Association	107

Contents (continued)

	Page
16. <i>Parkinsonia microphylla</i> / <i>Simmondsia chinensis</i> / <i>Ambrosia deltoidea</i> Shrubland Association (P)	109
Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association	109
17. <i>Simmondsia chinensis</i> (<i>Bahiopsis parishii</i> – <i>Aloysia wrightii</i> – <i>Eriogonum fasciculatum</i>) Shrubland Association (P)	114
Jojoba (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland Association.....	114
18. <i>Simmondsia chinensis</i> – <i>Atriplex polycarpa</i> (<i>Encelia farinosa</i>) Shrubland Association (P)	119
Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.....	119
19. <i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Simmondsia chinensis</i> / <i>Encelia farinosa</i> Shrubland Association (P)	124
Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association	124
20. (<i>Parkinsonia microphylla</i>) <i>Fouquieria splendens</i> / <i>Simmondsia chinensis</i> (<i>Bursera microphylla</i>) / <i>Encelia farinosa</i> Shrubland Association (P)	129
(Yellow Paloverde) Ocotillo / Jojoba (Elephant Tree) / Brittlebush Shrubland Association	129
21. (<i>Parkinsonia microphylla</i>) / <i>Simmondsia chinensis</i> / <i>Encelia farinosa</i> Shrubland Association (P)	131
(Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association	131
22. <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland Association (P).....	136
Creosote / Triangle Bur Ragweed Shrubland Association	136
23. <i>Larrea tridentata</i> / <i>Ambrosia dumosa</i> Shrubland Association.....	140
Creosote / Burrobush Shrubland Association.....	140
24. <i>Larrea tridentata</i> Shrubland Association	142
Creosote Shrubland Association.....	142
25. <i>Fouquieria splendens</i> / <i>Larrea tridentata</i> / <i>Ambrosia dumosa</i> Shrubland Association	145
Ocotillo / Creosote / Burrobush Shrubland Association	145

Contents (continued)

	Page
26. <i>Larrea tridentata</i> – <i>Atriplex polycarpa</i> Shrubland Association	150
Creosote – Cattle Saltbush Shrubland Association	150
27. <i>Atriplex polycarpa</i> – <i>Suaeda nigra</i> Shrubland Association (P)	155
Cattle Saltbush – Mojave Seablite Shrubland Association	155
28. <i>Prosopis velutina</i> / <i>Larrea tridentata</i> – <i>Atriplex polycarpa</i> Floodplain Association (P)	160
Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association	160
29. (<i>Prosopis velutina</i>) / <i>Larrea tridentata</i> / <i>Hilaria rigida</i> Shrubland Association (P)	165
(Velvet Mesquite) / Creosote / Big Galleta Shrubland Association	165
30. (<i>Prosopis velutina</i>) / <i>Larrea tridentata</i> Shrubland Association (P)	169
(Velvet Mesquite) / Creosote Shrubland Association	169
31. <i>Prosopis velutina</i> / <i>Senegalia greggii</i> – <i>Larrea tridentata</i> Intermittently Flooded Shrubland Association (P)	171
Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland Association	171
32. <i>Prosopis velutina</i> – <i>Parkinsonia florida</i> Intermittently Flooded Woodland (P)	175
Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association	175
33. <i>Simmondsia chinensis</i> – <i>Senegalia greggii</i> – <i>Celtis ehrenbergiana</i> / <i>Ambrosia ambrosioides</i> Intermittently Flooded Shrubland Association (P)	179
Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland	179
34. <i>Schoenoplectus americanus</i> Herbaceous Aquatic Association (P)	184
Chairmaker’s Bulrush Herbaceous Aquatic Association	184
Chapter 6. Project Summary	189
Final Products and Geodatabase Delivery	189
Literature Cited	190

Figures

	Page
Figure 1. Overview of Organ Pipe Cactus National Monument in relation to the Mexican border and adjacent land agencies.	7
Figure 2. General map of Organ Pipe Cactus National Monument showing the Ajo and Bates mountain ranges and the valleys.	8
Figure 3. Maximum and minimum mean monthly air temperatures and precipitation, 1990–2019, ORPI.	10
Figure 4. Watersheds (HUC10) covering ORPI.	12
Figure 5. Seasonally dry desert wash community at ORPI lined with mesquite (<i>Prosopis velutina</i>), palo verde (<i>Parkinsonia florida</i>), and bursage (<i>Ambrosia</i> spp.).....	13
Figure 6. An example of a creosote (<i>Larrea tridentata</i>) dominated community of the valley bottom, with low species richness.....	14
Figure 7. An example of a very diverse, species-rich palo verde (<i>Parkinsonia microphylla</i>) and mixed shrub community growing on the upper bajada and mountain toeslopes at ORPI.....	14
Figure 8. Distribution of 323 classification plots at ORPI sampled between 2009 and 2020.....	18
Figure 9. Distribution of 1,065 photo point locations captured concurrently with classification plot sampling from 2017 to 2020.....	19
Figure 10. Cluster analysis diagram of the 477 classification plots.....	23
Figure 11. Non-metric multidimensional scaling of classification plots, ORPI, 2009–2018.....	24
Figure 12. Dendrogram of Cluster e (Mojave-Sonoran Semi-Desert Scrub Macrogroup [M088]) showing the split between G293 and G295 defined at a 25% similarity level, as indicated by the vertical dashed line.	25
Figure 13. nMDS of cluster data aligning with the Mojave-Sonoran Bajada & Valley Desert Scrub Group [G295].	26
Figure 14. Map depicting number of mismatched classification plots per Warren polygon.	29
Figure 15. The graphics show an example area in the Sonoyta Valley, where linework was updated to digitize medium-sized washes previously unmapped.	32
Figure 16. The graphic shows a small example of updated linework from the north Alamo canyon area, with the original Warren map unit boundaries shown as black lines and the updated VMI map polygons in the different colors.	33

Figures (continued)

	Page
Figure 17. Organ Pipe National Monument vegetation map graphic showing the 34 vegetation associations that were mapped during the vegetation inventory.....	35
Figure 18. Map legend listing the 36 vegetation map classes shown in Figure 17.....	36
Figure 19. Detailed map of the northern extent of the Bates Mountain range at ORPI, and its surrounding areas.	39
Figure 20. Detailed map of the Ajo Mountain range situated along the eastern boundary of ORPI.	40
Figure 21. Detailed map of the creosote and saltbush dominated areas along the southern boundary of ORPI.	41
Figure 22. An example landscape photo showing the (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.	43
Figure 23. A distribution map, showing in green all areas mapped as (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.	44
Figure 24. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.....	45
Figure 25. Map of ORPI with bounding box around the regions mapped and classified as (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.....	46
Figure 26. An example landscape photo showing the Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.	48
Figure 27. A distribution map, showing in green all areas mapped as Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.	49
Figure 28. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.	50
Figure 29. Map of ORPI with bounding box around the regions mapped and classified as Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.....	51
Figure 30. An example landscape photo showing the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.....	53
Figure 31. A distribution map, showing in green all areas mapped as the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.....	54

Figures (continued)

	Page
Figure 32. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.	55
Figure 33. Map of ORPI with bounding box around the regions mapped and classified as the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.	56
Figure 34. An example landscape photo showing the Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.	58
Figure 35. A distribution map, showing in green all areas mapped as Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.	59
Figure 36. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.	60
Figure 37. Map of ORPI with bounding box around the regions mapped and classified as the Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.	61
Figure 38. An example landscape photo showing the Alkali Goldenbush – Saltgrass Open Shrubland Association.	63
Figure 39. A distribution map, showing in green all areas mapped as Alkali Goldenbush – Saltgrass Open Shrubland Association.	64
Figure 40. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Alkali Goldenbush – Saltgrass Open Shrubland Association.	65
Figure 41. Map of ORPI with bounding box around the regions mapped and classified as the Alkali Goldenbush – Saltgrass Open Shrubland Association.	66
Figure 42. An example landscape photo showing the (Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association.	68
Figure 43. A distribution map, showing in green all areas mapped as (Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association.	69
Figure 44. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association.	70
Figure 45. An example landscape photo showing the Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.	72

Figures (continued)

	Page
Figure 46. A distribution map, showing in green all areas mapped as Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.	73
Figure 47. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.	74
Figure 48. Map of ORPI with bounding box around the regions mapped as Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.	75
Figure 49. An example landscape photo showing the Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland Association.	77
Figure 50. A distribution map, showing in green all areas mapped as Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland Association.	78
Figure 51. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland Association.	79
Figure 52. An example landscape photo showing the Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.	81
Figure 53. A distribution map, showing in green all areas mapped as Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.	82
Figure 54. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.	83
Figure 55. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.	84
Figure 56. An example landscape photo showing the Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland Association.	86
Figure 57. A distribution map, showing in green all areas mapped as Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland Association.	87
Figure 58. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland Association.	88

Figures (continued)

	Page
Figure 59. An example landscape photo showing the Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.....	90
Figure 60. A distribution map, showing in green all areas mapped as Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.	91
Figure 61. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.	92
Figure 62. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.	93
Figure 63. An example landscape photo showing the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.....	95
Figure 64. A distribution map, showing in green all areas mapped as the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.	96
Figure 65. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.....	97
Figure 66. Map of ORPI with bounding box around the regions the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.	98
Figure 67. An example landscape photo showing the Yellow Paloverde / Physicnut / Brittlebush Shrubland Association.....	100
Figure 68. A distribution map, showing in green all areas mapped as Yellow Paloverde / Physicnut / Brittlebush Shrubland Association.....	101
Figure 69. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde / Physicnut / Brittlebush Shrubland Association.....	102
Figure 70. An example landscape photo showing the Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland Association.	104
Figure 71. A distribution map, showing in green all areas mapped as Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland Association.	105

Figures (continued)

	Page
Figure 72. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland Association.....	106
Figure 73. An example landscape photo showing the Yellow Paloverde / Physicnut (Elephant Tree) / Brittlebush Shrubland Association.	108
Figure 74. An example landscape photo showing the Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.	110
Figure 75. A distribution map, showing in green all areas mapped as Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.	111
Figure 76. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.	112
Figure 77. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.....	113
Figure 78. An example landscape photo showing the Jojoba (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland Association.....	115
Figure 79. A distribution map, showing in green all areas mapped as Jojoba (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland Association.	116
Figure 80. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Jojoba (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland Association.....	117
Figure 81. Map of ORPI with bounding box around the regions mapped and classified as the Jojoba (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland Association.	118
Figure 82. An example landscape photo showing the Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.	120
Figure 83. A distribution map, showing in green all areas mapped as Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.	121
Figure 84. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.....	122
Figure 85. Map of ORPI with bounding box around the regions mapped and classified as the Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.	123

Figures (continued)

	Page
Figure 86. An example landscape photo showing the Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.....	125
Figure 87. A distribution map, showing in green all areas mapped as Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.	126
Figure 88. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.....	127
Figure 89. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.....	128
Figure 90. An example landscape photo showing the (Yellow Paloverde) Ocotillo / Jojoba (Elephant Tree) / Brittlebush Shrubland Association.	130
Figure 91. An example landscape photo showing the (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.....	132
Figure 92. A distribution map, showing in green all areas mapped as (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.	133
Figure 93. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.....	134
Figure 94. Map of ORPI with bounding box around the regions mapped and classified as the (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.....	135
Figure 95. An example landscape photo showing the Creosote / Triangle Bur Ragweed Shrubland Association.	137
Figure 96. A distribution map, showing in green all areas mapped as the Creosote / Triangle Bur Ragweed Shrubland Association.	138
Figure 97. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Creosote / Triangle Bur Ragweed Shrubland Association.....	139
Figure 98. An example landscape photo showing the Creosote / Burrobush Shrubland Association.....	141
Figure 99. An example landscape photo showing the Creosote Shrubland Association.	142
Figure 100. A distribution map, showing in green all areas mapped as Creosote Shrubland Association.	143
Figure 101. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Creosote Shrubland Association.	144

Figures (continued)

	Page
Figure 102. An example landscape photo showing the Ocotillo / Creosote / Burrobush Shrubland Association.	146
Figure 103. A distribution map, showing in green all areas mapped as Ocotillo / Creosote / Burrobush Shrubland Association.	147
Figure 104. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Ocotillo / Creosote / Burrobush Shrubland Association.	148
Figure 105. Map of ORPI with bounding box around the regions mapped as Ocotillo / Creosote / Burrobush Shrubland Association.	149
Figure 106. An example landscape photo showing the Creosote – Cattle Saltbush Shrubland Association.	151
Figure 107. A distribution map, showing in green all areas mapped as the Creosote – Cattle Saltbush Shrubland Association.	152
Figure 108. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Creosote – Cattle Saltbush Shrubland Association.	153
Figure 109. Map of ORPI with a bounding box around the regions mapped and classified as the Creosote – Cattle Saltbush Shrubland Association.	154
Figure 110. An example landscape photo showing the Cattle Saltbush – Mojave Seablite Shrubland Association.	156
Figure 111. A distribution map, showing in green all areas mapped as Cattle Saltbush – Mojave Seablite Shrubland Association.	157
Figure 112. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Cattle Saltbush – Mojave Seablite Shrubland Association.	158
Figure 113. Map of ORPI with bounding box around the regions mapped and classified as the Cattle Saltbush – Mojave Seablite Shrubland Association.	159
Figure 114. An example landscape photo showing the Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.	161
Figure 115. A distribution map, showing in green all areas mapped as Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.	162
Figure 116. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.	163

Figures (continued)

	Page
Figure 117. Map of ORPI with bounding boxes around the regions mapped and classified as the Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.	164
Figure 118. An example landscape photo showing the (Velvet Mesquite) / Creosote / Big Galleta Shrubland Association.	166
Figure 119. A distribution map, showing in green all areas mapped as the (Velvet Mesquite) / Creosote / Big Galleta Shrubland Association.	167
Figure 120. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (Velvet Mesquite) / Creosote / Big Galleta Shrubland Association.	168
Figure 121. An example landscape photo showing the (Velvet Mesquite) / Creosote Shrubland Association.	170
Figure 122. An example landscape photo showing the Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland Association.	172
Figure 123. A distribution map, showing in green all areas mapped as Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland Association.	173
Figure 124. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland Association.	174
Figure 125. An example landscape photo showing the Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association.	176
Figure 126. A distribution map, showing in green all areas mapped as Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association.	177
Figure 127. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association.	178
Figure 128. Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland.	180
Figure 129. A distribution map, showing in green all areas mapped as Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland.	181
Figure 130. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland.	182

Figures (continued)

	Page
Figure 131. Map of ORPI with box around all areas Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland association might occur.	183
Figure 132. An example landscape photo showing the Chairmaker’s Bulrush Herbaceous Aquatic Association.	185
Figure 133. A distribution map, showing in green all areas mapped as Chairmaker’s Bulrush Herbaceous Aquatic Association.....	186
Figure 134. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Chairmaker’s Bulrush Herbaceous Aquatic Association.	187
Figure 135. Map of ORPI with bounding box around the region mapped and classified as the Chairmaker’s Bulrush Herbaceous Aquatic Association.	188

Tables

	Page
Table 1. Summary of USNVC revised hierarchy levels and criteria for natural vegetation with examples.	4
Table 2. Specific attributes collected on the vegetation and landscape datasheets for both polygons and classification plots.	20
Table 3. Types with the most mismatch between Warren map polygons and SODN classified plots.	30
Table 4. Map classes created from spatially merged associations.	31
Table 5. Placement of the 34 vegetation associations within the U.S. National Vegetation Classification (USNVC), with macrogroup, group, and alliance levels shown where available.	37

Abstract

From 2017 to 2020, the Sonoran Desert Network conducted a vegetation mapping and characterization project at Organ Pipe Cactus National Monument (ORPI) to update the 1981 vegetation map (Warren et al. 1981). This work, which is part of the National Park Service (NPS) Vegetation Mapping Inventory Program, aimed to provide park managers with a digital vegetation map meeting national standards for spatial and thematic accuracy and supporting regional and national comparisons.

The 1981 map, which described 29 vegetation community types using the Brown, Lowe, and Pase classification system (Brown et al. 1979), served as a baseline for the update. Using fine-scale (30 cm) aerial imagery from ca. 2008, modern mapping methods, and new relevé plot data, vegetation communities were reclassified under the United States National Vegetation Classification System (USNVCS) at the association level. Map unit boundaries were aligned with the adjacent Cabeza Prieta National Wildlife Refuge (CPNWR) vegetation map boundaries where applicable and possible. The study area covers approximately 347,058 hectares (857,600 ac) of ORPI.

Field surveys occurred primarily in winter 2017 and spring 2018, with two additional sampling rounds in spring 2019 and fall 2020 targeting under-sampled areas. Crews collected 323 classification plots and 1,065 photo points, resulting in the identification or update of 34 vegetation types at the USNVC association level.

The final products include a geodatabase-based, vector polygon map compatible with Geographic Information Systems (GIS), supporting complex spatial–tabular analyses, concurrent data access, and future updates. These maps facilitate ecologically informed resource management and research, providing a foundation for monitoring vegetation dynamics and responding to disturbance events at ORPI.

Acronyms

AA: accuracy assessment

ac: acre(s)

CEGL: Community Element Global code

CES: NatureServe ecological system

cm: centimeter(s)

DOQQ: digital orthophoto quarter quadrangle

ERDAS: Earth Resources Data Analysis System

ESRI: Environmental Systems Research Institute

FGDC: Federal Geographic Data Committee

ft: foot/feet

GCP: ground control point

GIS: geographic information system

GPS: global positioning system

ha: hectare(s)

I&M: Inventory and Monitoring Program

ITIS: Integrated Taxonomic Information System

km: kilometer(s)

m: meter(s)

mi: mile(s)

MMU: minimum mapping unit

N/A: not applicable

NAD83: North American Datum of 1983

NMAS: National Map Accuracy Standards

NPS: National Park Service

NS: NatureServe

ORPI: Organ Pipe Cactus National Monument

RMD: Rincon Mountain District

RMSE: root mean square error

RRQRR: reversed randomized quadrant-recursive raster

SODN: Sonoran Desert Network

spp.: species (plural)

TMD: Tucson Mountain District

TNC: The Nature Conservancy

UNESCO: United Nations Educational, Scientific and Cultural Organization

USDA: U.S. Department of Agriculture

USGS: U.S. Geological Survey

USNVC: U.S. National Vegetation Classification

USNVCS: U.S. National Vegetation Classification Standard (or System)

UTM: Universal Transverse Mercator

Executive Summary

A vegetation mapping and characterization effort was conducted at Organ Pipe Cactus National Monument (ORPI) by the Sonoran Desert Network, with most field mapping efforts occurring from 2017 to 2020 to build upon and update the existing 1981 vegetation map (Warren et al. 1981). This vegetation mapping effort was completed under the National Park Service (NPS) vegetation mapping inventory program which aims to complete baseline mapping and classification inventories at more than 270 national park units. The vegetation map data was collected to provide park managers with a digital map product that meets national standards of spatial and thematic accuracy, while also placing the vegetation in a regional and national context. The data standard was designed to facilitate the production of uniform statistics about vegetation across the nation, enable the translation of data collected at various scales, and allow data sharing, aggregation, and comparison across regions.

A vegetation mapping project completed for ORPI in 1981 (Warren et al. 1981) described 29 vegetation community types and produced a map delineating their locations. This original project utilized a combination of ground observations and aerial photography to create the map and placed the vegetation classes within the Brown, Lowe, and Pase (BLP) system (Brown et al. 1979). This existing map product was evaluated for use in this current mapping effort and was deemed of sufficiently high quality and mapping accuracy to serve as a baseline to which updates would be made, both thematically and spatially. The goal was to update the 1981 vegetation map using more contemporary (ca. 2008) fine-scale (30 cm) aerial imagery and modern mapping techniques, and to place previously identified and/or newly described communities into the United States National Vegetation Classification System (USNVCS) at the association level rather than the BLP system. Additional effort was expended to crosswalk communities present at ORPI with those described for the vegetation map of the adjacent Cabeza Prieta National Wildlife Refuge (CPNWR) and to align polygon boundaries occurring along the boundary between these units. The study area for this project includes all land contained within ORPI, an area of around 347,058 hectares (857,600 ac).

The bulk of fieldwork took place in the winter of 2017 and spring 2018 after which a preliminary classification was developed and compared to those map types represented in the Warren map. Based on these results, in the spring of 2019 and fall of 2020 field crews completed an additional two rounds of sampling to focus on areas of the monument and vegetation communities previously under-sampled. Across all sampling efforts, crews sampled a total of 323 classification plots and collected 1,065 photo points. The final classification and mapping work resulted in the new description or updating of 34 vegetation types at the association level of the USNVCS.

The products are designed to facilitate ecologically based natural resource management and research. The vector (polygon) map is in digital format within a geodatabase structure that allows for complex relationships to be established between spatial and tabular data and allows much of the data to be accessed concurrently. The Geographic Information System (GIS) format allows user flexibility and will also enable updates to be made as new information becomes available (such as revised USNVC codes or vegetation type names) or in the event of major disturbance events that could impact the vegetation.

Acknowledgments

The authors would like to thank the staff of Organ Pipe Cactus National Monument for their support of this project and assistance with logistics. Former Sonoran Desert Network data manager Kristen Beaupre helped with database design and management. Many people collected and managed the field data, including Nicole Gonzalez, Ethan Sandoval, Tracy Ridlinghafer, Sage Ragland, Sarah Studd, Jeff Galvin, and Joseph Black. On several occasions we consulted with local mapping expert Jim Malusa from the University of Arizona for assistance with field survey methods, classification working sessions and discussions on making the map edge match with similar mapping efforts completed on adjacent federal lands. We also acknowledge the immense scientific contribution of Peter Warren, whose excellent 1981 map formed the basis of this project.

Finally, we would also like to thank Organ Pipe Cactus National Monument geographer Ami Pate and botanist Carolyn Mills, and NPS ecologist Scott Esser for their reviews and helpful comments.

Chapter 1: Introduction

Inventory Project Background

This report describes the methods and results of a multi-year National Park Service (NPS) Vegetation Mapping Inventory Project (2009, 2017–2020) to create an updated vegetation map of Organ Pipe Cactus National Monument (ORPI), located in Pima County in southwestern Arizona. In 1999, the director of NPS approved the Natural Resource Challenge to encourage national parks to focus on the preservation of the nation’s natural heritage through science, natural resource inventories, and expanded resource monitoring. The Natural Resource Challenge provided funding for 12 baseline inventories to be completed in each of the 270 park units that contain significant natural resources. The National Vegetation Mapping Inventory Program (NVMIP) is one of these 12 baseline inventories.

NPS’s Sonoran Desert Network (SODN), part of the service-wide Inventory and Monitoring (I&M) Program, organized and coordinated the vegetation inventory, classification, and updated mapping at ORPI. For ORPI, as well as the other network parks, the SODN uses baseline vegetation data upon which to develop and implement specific monitoring programs. Park managers also need baseline data and information on park vegetation resources for management purposes, such as planning new facilities (trails, campgrounds), prescribed fire planning, habitat and rare plant protection, or restoration efforts.

Vegetation is a primary resource of natural areas, and the description of vegetation composition, structure, and distribution is fundamental to effective land management. The term “vegetation” encompasses plants at multiple scales, from the most refined floristic levels (referred to as “plant communities” or “plant associations” in this report) to the broadest physiognomic or lifeform levels, such as “tropical rainforest” or “savanna”.

The [NPS Vegetation Mapping Inventory Program](#) (NPS, n.d.) has set standards for these inventories to follow, including a minimum mapping unit of 0.5 hectares, 80% thematic accuracy per class, and spatial accuracy meeting the U.S. National Map Accuracy Standards developed by the Federal Geographic Data Committee (FGDC). In addition to meeting the program standards, every effort was made to provide the mapping and classification data to the park in a manner best suited to its specific management objectives and needs.

Scope and Products

The aim of this project was to update the ORPI vegetation map created by Peter Warren and others (1981) by using recent, fine-scale (30 cm) imagery, modern mapping techniques, and placing previously identified and/or newly described communities into the United States National Vegetation Classification System (USNVCS) at the association level. Additional effort was expended to crosswalk communities present at ORPI with those described for the vegetation map of the adjacent Cabeza Prieta National Wildlife Refuge (NWR) in order to align polygon boundaries of comparable communities occurring along the boundary between these units. The study area for this project includes all land contained within ORPI, an area of around 347,058 hectares (857,600 ac).

Products¹ developed for ORPI as part of this project include:

- Two report volumes: the first (this document) describing the project methodologies and summarizing the mapping results, and the second volume (Studd et al. 2025) containing the full vegetation community type descriptions at the USNVC Association level;
- A dichotomous vegetation key to the associations, included as a report supplement¹;
- Digital georeferenced photos of each vegetation plot and additional observation points within map units;
- A geodatabase containing mapped vegetation data, plot data and location, permanent photo point locations, and aerial imagery;
- Printable digital graphics of final map polygons (i.e., vegetation maps in poster format);
- Federal Geographic Data Committee-compliant metadata for all spatial database files and field data.

The NPS Vegetation Mapping Inventory Program

The NPS Vegetation Mapping Inventory Program aims to classify, describe, and map detailed vegetation communities in more than 270 national parks across the United States. NPS is the primary funding agency, providing support to the parks through base funds from the Inventory and Monitoring Division. Data products from the program can be accessed by searching on the NPS [DataStore](#) within the Integrated Resource Management Applications (IRMA) portal.

The vegetation inventory program supports consistent vegetation classification, mapping, and accuracy assessment protocols and standards across all park-mapping projects. The program has established guidance for all vegetation-mapping projects in four documents:

- [Technical guidance](#) (Lea 2011), including classification guidance.
- Methodology for Assessing the Utility of Existing Data for Vegetation Mapping (NPS 2009).
- [Geospatial Standards–Federal Geographic Data Committee \(fgdc.gov\)](#).
- [Accuracy Assessment Guidance \(Lea and Curtis 2010\) Thematic accuracy assessment procedures, NPSVI version 2.0](#).

In addition, the program has defined national standards for all park vegetation classification and mapping projects:

- Vegetation classification follows the Federal Geographic Data Committee (FGDC) standard for vegetation classification, the National Vegetation Classification Standard (NVCS).
- Spatial data formatting follows the FGDC standards for spatial data transfer.

¹ Supplemental materials for this report, including Volume II of this report, are available in NPS's IRMA DataStore: [Vegetation Mapping Inventory Project for Organ Pipe Cactus National Monument](#).

- Metadata for each spatial dataset uses the FGDC metadata standard.
- All plant names used in the classification are consistent with the nationally standardized list maintained by the United States Department of Agriculture (USDA) in the [PLANTS Database](#).
- The minimum mapping unit (MMU) is 0.5 hectares (1.24 ac).

The National Vegetation Classification Standard

Patterns of vegetation vary continuously over landscapes. Classification systems attempt to categorize these patterns by identifying and describing assemblages of plants that repeat under similar environmental conditions. The United States National Vegetation Classification Standard (USNVCS) provides a classification framework that serves as the standard for all NPS vegetation mapping projects (Comer et al. 2003; NPS 2009). In 1997, the FGDC formally adopted USNVCS Version 1 (FGDC 1997). At the time of its adoption, it was recognized as incomplete and work to refine and further develop it began immediately. In October 2007, the FGDC vegetation subcommittee released USNVCS Version 2 (working draft), which was formally endorsed in February 2008 (FGDC 2008).

The USNVCS evolved from vegetation classification primarily conducted over more than two decades by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network (Grossman et al. 1998). It derives in part from earlier vegetation classification frameworks produced by the United Nations Educational, Scientific and Cultural Organization (Driscoll et al. 1984; UNESCO 1973). The use of this standardized classification system helps ensure data compatibility throughout NPS and other agencies. The USNVCS was designed to facilitate the production of uniform statistics about vegetation across the nation, enable the translation of data collected at various scales, and allow data sharing, aggregation, and comparison across regions.

The USNVCS is a hierarchical system that allows vegetation classification to occur at multiple scales. Existing vegetation is classified based on both physiognomic and floristic criteria. The upper three levels—Formation Class, Formation Subclass, and Formation—are physiognomic, based primarily on growth form, structure, and cover, indicating characteristics that reflect geographically widespread (global) topographic factors. The middle three levels—Division, Macrogroup, and Group—were new to the USNVCS hierarchy and focus largely on biogeographic and habitat factors along broad continental-to-regional topographic, edaphic, and disturbance gradients. The lower two levels—Alliance and Association—are floristic, based primarily on species composition and abundance. Table 1 shows the revised Version 2, under which this project was conducted, and which is at the time of writing being utilized by NatureServe and the Ecological Society of America (ESA) vegetation panel to substantially update the structure and content of the USNVCS.

The USNVCS also distinguishes between natural and cultural vegetation, with the former primarily determined by ecological processes and the latter by regular human activity. Vegetated areas intermediate between the two—such as those influenced by human activities like logging, fire, and grazing, as well as by ecological processes—are defined as semi-natural.

Table 1. Summary of USNVC revised hierarchy levels and criteria for natural vegetation with examples.

Levels	Hierarchy Level	Criteria	Examples
Upper: Physiognomy plays a predominant role	L1—Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate/aquatic conditions.	Desert and Semi-desert
	L2—Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position or that reflect overriding substrate/aquatic conditions.	TT5.b. Warm Desert & Semi-desert woodland, scrub and grassland
	L3—Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	TT5.b1. Succulent-Thorny Desert & Semi-desert
Middle: Floristics and physiognomy play predominant roles	L4—Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	TT5.b1.Na. Southwest North American Warm Desert
	L5—Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	M088. Mojave-Sonoran Semi-Desert Scrub
	L6—Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes.	G295. Mojave-Sonoran Bajada & Valley Desert Scrub
Lower: Floristics plays a predominant role	L7—Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.	A3278. <i>Larrea tridentata</i> – <i>Fouquieria splendens</i> Upper Bajada & Rock Outcrop Desert Scrub Alliance
	L8—Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.	CEGL005136. <i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Fouquieria splendens</i> Shrubland

The National Vegetation Classification

The USNVCS provides a framework for levels of classification but does not provide descriptions of all existing vegetation types at all levels. Those descriptions comprise the National Vegetation Classification (USNVC), which is populated by data from various completed vegetation mapping inventory projects, such as the present one, and other sources. The USNVC, which is predominantly maintained by NatureServe and used by many federal agencies, including NPS, includes the plant communities (associations and alliances) defined for the United States.

NatureServe manages a database of USNVC plant community entities. Their online database, [NatureServe Explorer](#), provides public access to regularly updated versions of the USNVC plant community listings and descriptions. NatureServe's documentation of associations and, in some cases, alliances has been the most accessible listing available until recently. However, the plant community listings within the USNVC are not yet complete and are currently being revised to fall within Version 2 of the FGDC hierarchy. The other website hosting [USNVC data](#) posts all new descriptions as well as information on the changes to the hierarchy and displays these vegetation type descriptions in the new hierarchy (Table 1). Many, but not all, vegetation associations listed on this site are linked to the full and updated descriptions on the NatureServe Explorer site.

This project has utilized information available in the USNVC database and NatureServe to classify vegetation at ORPI to the association level, with USNVC group and alliance membership noted when known. Existing USNVC associations were used whenever possible. However, in the frequent cases where no published USNVC association adequately described vegetation types observed during this project, new associations were described and shown within the existing USNVCS framework using the authors' best ecological judgment. New vegetation associations proposed here are based solely on data collected during this effort, and naming conventions were developed as fitting to identify dominant and diagnostic (characteristic plants that help define a group) species groupings.

For more information on the USNVC, visit the [NPS Vegetation Mapping Inventory Program](#) or see Grossman et al. (1998).

Terminology and Naming Conventions

Alliances and associations are classified based on both the dominant (greatest canopy cover) species in the upper strata of a contiguous vegetation unit and on diagnostic species (any plant taxon or group of taxa whose relative constancy or abundance can be used to differentiate one vegetation type from another). Associations, which describe and identify the characteristic range of species composition, diagnostic species, and physiognomy of a community, are the most specific and basic classification unit and are hierarchically subsumed within alliances (Jennings et al. 2009). Typically, each association is included in only one alliance, while each alliance may include many associations.

Associations define distinct plant compositions that repeat across the landscape and are generally named using both the dominant species in the uppermost stratum of the vegetation and one or more dominant species in the lower strata (or a diagnostic species in any stratum). The strata used in this project are defined as follows:

- Top canopy: greater than 5 meters in height
- Canopy: between 2 and 5 meters in height
- Sub-canopy: between 0.5 and 2 meters in height
- Field: below 0.5 meters in height

Associations are defined as having consistent species composition, uniform physiognomy, and similar habitat conditions. Naming conventions and syntax for all USNVC names are as follows:

- A dash with a space on either side (–) separates the names of species occurring in the same stratum.
- A slash (/) with a space on either side separates the names of species occurring in different strata.
- Species that occur in the uppermost stratum are listed first, followed successively by those in the lower strata.
- The order of species names generally reflects decreasing levels of dominance, constancy, or indicator value.
- Parentheses around a species name indicate the species is less consistently found either in all associations of an alliance or in all occurrences of an association.
- Square brackets around two species' names indicate that the species are co-dominant or trade dominance, with either or both being dominant in each stand.
- Association names include the dominant species of the significant strata, followed by the structural class in which they are classified (e.g., forest, woodland, or herbaceous).
- A “(P)” at the end of an association name implies that the type is proposed (i.e., it was identified and described based on the results of this or another recent SODN project) and is not yet a formally accepted vegetation type within the USNVC. These proposed types are reviewed on an ongoing basis and may be added to the USNVC when sufficient data have been collected and funding is available to support their addition.
- A “(PS)” at the end of an association name denotes that the type is a “park special”, meaning it has been described as a unique community that is expected to be found only at that park unit. This typically occurs when an area has a unique disturbance or management history.

Vascular and nonvascular plant species nomenclature for Association names follows the nationally standardized list maintained by USDA in the [PLANTS database](#) with very few exceptions. Examples of association names from ORPI:

- (*Prosopis velutina*) / *Larrea tridentata* Shrubland Association
- *Simmondsia chinensis* / *Atriplex polycarpa* Shrubland Association
- *Isocoma acradenia* – *Distichlis spicata* Open Shrubland Association

Project Area Description

Location and Setting

Organ Pipe Cactus National Monument (ORPI) falls within the basin and range physiographic region of the United States of America (USA) and is divided between two subdivisions of the Sonoran Desert, the Arizona Uplands to the east and the Lower Colorado Valley to the west. It is in southern Arizona, in the southwestern portion of Pima County, due south of the small town of Ajo. The monument is situated between the Cabeza Prieta National Wildlife Refuge (NWR) to the west and the Tohono O’odham Nation to the east (Figure 1). The southern boundary of the monument runs along almost 48 km of the international border between the USA and Mexico with the city of Sonoyta, Sonora sitting just over the border to the south. El Pinacate and Gran Desierto de Altar Biosphere Reserve also adjoins the monument along the southwest corner of the park and international boundary.

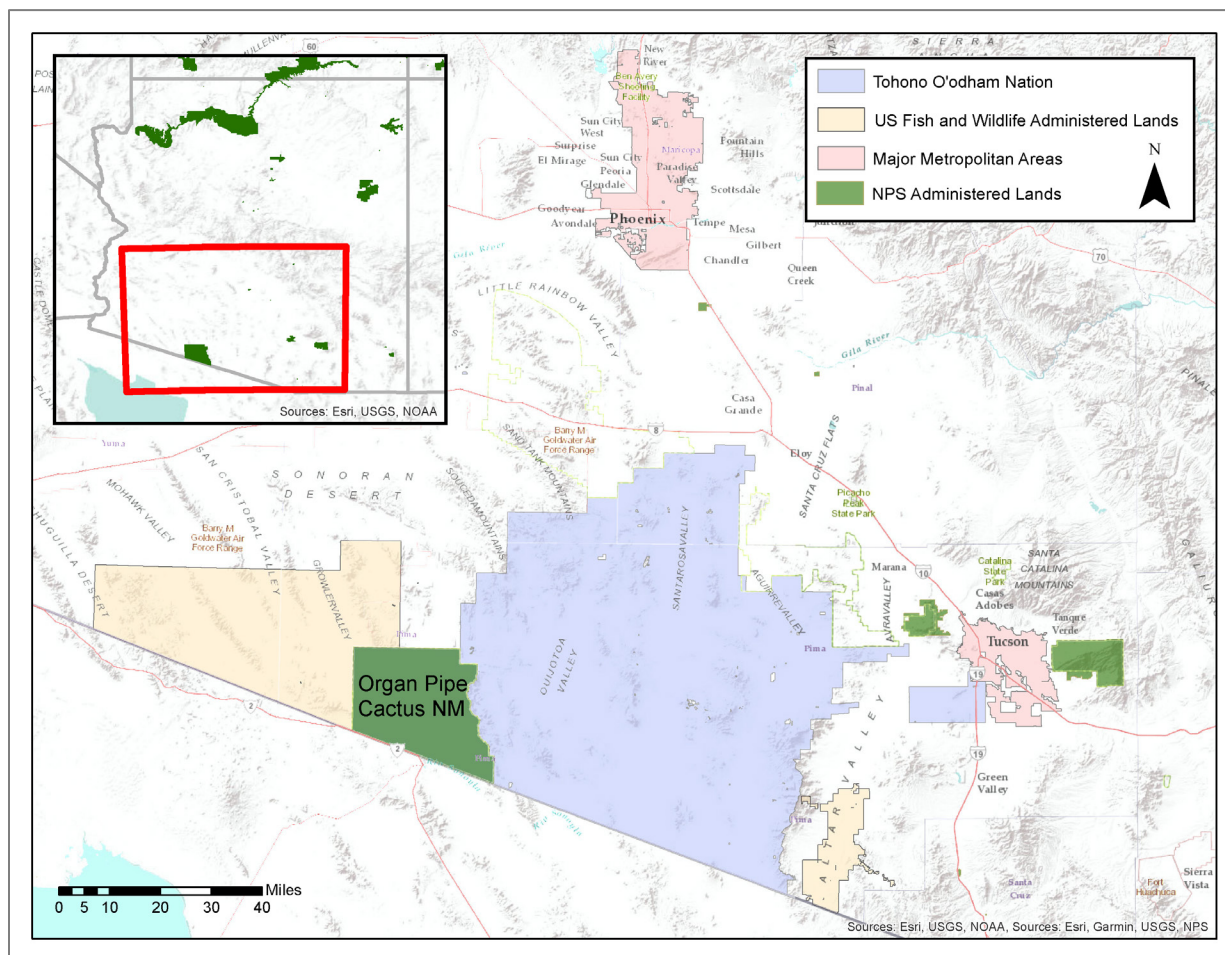


Figure 1. Overview of Organ Pipe Cactus National Monument in relation to the Mexican border and adjacent land agencies.

NPS

The monument covers 347,058 hectares (857,600 ac) ranging from 300 meters (984 ft) elevation in the southwest corner of the monument to 1,466 meters (4,808 ft) at the summit of Mount Ajo, the high point of the Ajo Mountains. The monument includes six mountain ranges: the Ajo Mountains, which run north/south along the eastern boundary, the Bates Mountains situated in the northwestern portion of the monument, and the Cipriano Hills, Quitobaquito Hills, Puerto Blanco Mountains, and Diablo Mountains. It also contains parts of four others, Growler Mountains, Sonoyta Mountains, Sierra de Santa Rosa and Gunsight Hills. Outside of these ranges, large valleys characterize much of the monument, the largest of which include the Valley of the Ajo, the Growler Valley, the Sonoyta Valley, and the La Abra Plains (Figure 2).

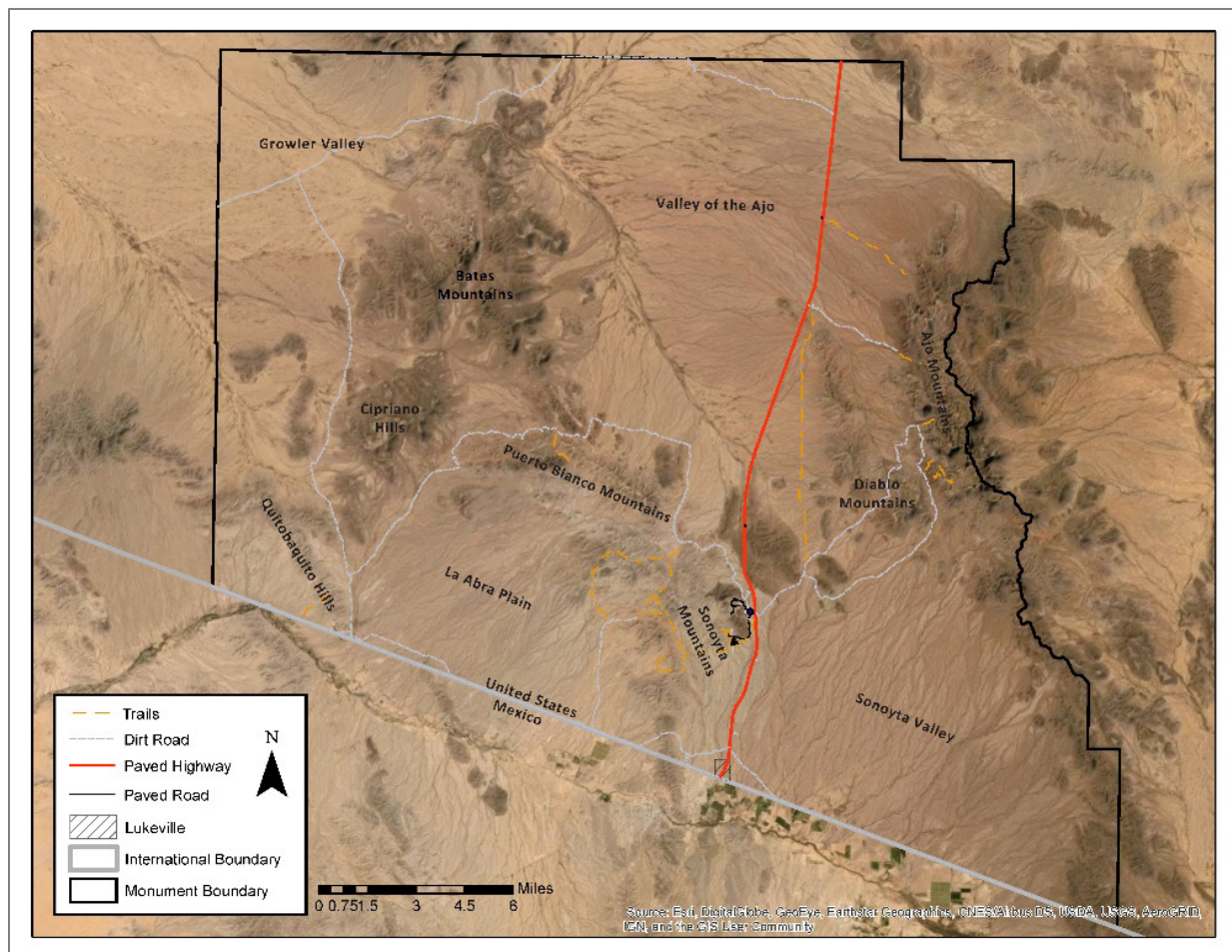


Figure 2. General map of Organ Pipe Cactus National Monument showing the Ajo and Bates mountain ranges and the valleys.

NPS

Urban Pressures

ORPI has long been subject to human development pressures due to the shared border with Mexico which has for many years seen cross-country activity and disturbance due to immigrant migration, smuggling, the associated law enforcement presence, and various iterations of barriers and walls to

separate Mexico and the United States. Disturbances from people migrating across the monument have included unsanctioned foot and vehicle trails and trash deposits scattered across the landscape. Law enforcement efforts have also had impacts on the landscape including similar off-road vehicle tracks and the removal of swaths of vegetation to allow for border fencing construction. Additionally, signal fires and fires for warmth have escalated into larger fires at the monument, impacting vegetation.

Other pressures such as increased water use, pollution and spread of non-native plants come from the growth of the city of Sonoyta, nearby agricultural fields, and the heavily trafficked Mexican Highway 2, one of the main routes for agricultural produce to enter Arizona on semi-trucks. The highway that runs north-south through the monument receives substantial traffic as it is the main route for vacationers traveling to Sonora, Mexico's beach resorts of Puerto Peñasco. Travelers into Mexico pass through the small town of Lukeville situated on the U.S.–Mexico border where the Port of Entry, a gas station, and a post office are located.

Park Establishment and Purpose

Organ Pipe Cactus National Monument (ORPI) was established by Presidential Proclamation on April 13, 1937 (Roosevelt 1937). It was noted in the proclamation that these lands “contain historic landmarks and have situated thereon various objects of historic and scientific interests” (Presidential Proclamation No. 2232; 34 Stat. 225). The most prominent of these objects of scientific interest was the organ pipe cactus (*Stenocereus thurberi*), the monument's namesake, which is widespread in northwestern Mexico but is very narrowly distributed in the United States. At the time of establishment, the monument encompassed 133,825 hectares (330,690 ac), just 13,233 hectares (5,355 ac) smaller than its current size. As with many NPS-administered lands in the desert Southwest, the monument included a number of private inholdings, predominantly owned by the Gray family, such as Bates Well Ranch and Dos Lomitas Ranch. On January 25, 1939, two years following the establishment of the monument, the adjacent lands to the west were designated the Cabeza Prieta Game Range (GR) in Executive Order 8038 (EOP 1939). These lands were set aside with the purpose of assisting in the recovery of desert bighorn sheep (*Ovis canadensis* subsp. *nelsoni*). In 1966, then Secretary of the Interior and former Arizona congressman Stewart Udall submitted a proposal to combine Organ Pipe Cactus National Monument and Cabeza Prieta Game Range into Sonoran Desert National Park (NPS 1965). This proposal never gained significant traction and the two remain separate public land units.

Climate, Geology and Hydrology

Climate

ORPI experiences climate typical of the Sonoran Desert ecoregion: highly-variable, bimodal precipitation with a considerable range in daily and seasonal air temperature, and relatively high potential evapotranspiration rates (Tercek et al. 2023). Lower elevations of the monument receive just under half of their annual precipitation during summer thunderstorms (Figure 3), with average maximum air temperatures often exceeding 100°F. The bulk of the remaining annual precipitation falls in relatively gentle cool season events.

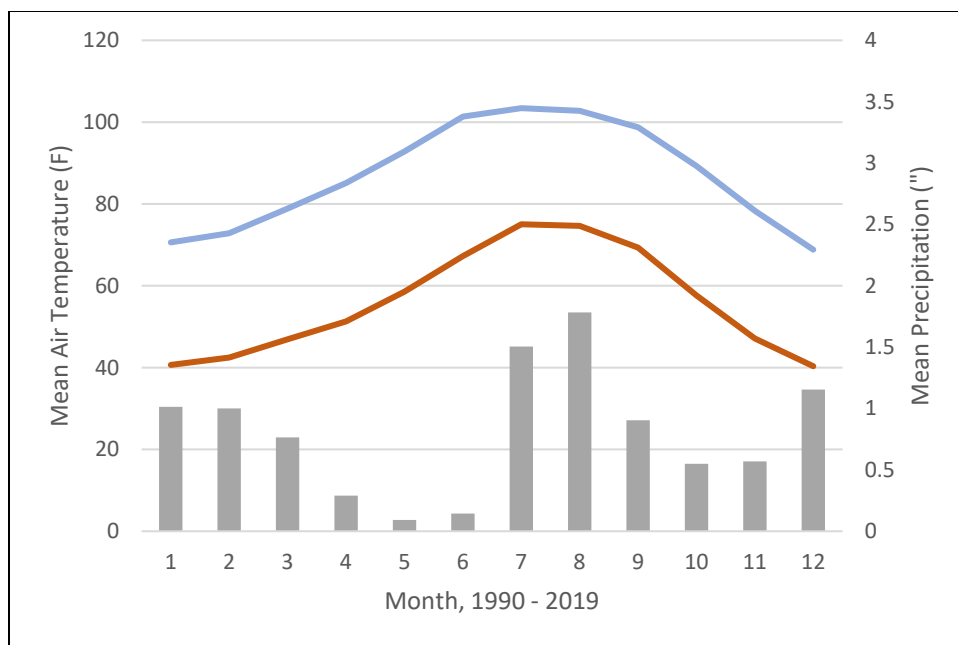


Figure 3. Maximum and minimum mean monthly air temperatures and precipitation, 1990–2019, ORPI. Average annual precipitation is 10.0 inches. Data are from [The Climate Analyzer](#).

NPS

Geology

Similar to El Pinacate and Gran Desierto del Altar Biosphere Reserve to the south in Mexico, the mountains of ORPI are predominantly of volcanic origin. Distinctive rocks of this volcanic field such as rhyolite and tuff deposits can be seen along the steep mountain fronts of the Ajo Range and elsewhere. ORPI sits within the Basin and Range geological province, characterized by basins formed by crustal blocks faulting downwards and mountain ranges formed by crustal blocks faulting upwards (Hunt 1972).

NPS recently completed a geological inventory report (KellerLynn 2022), noting:

The monument is noted for its ruggedness. Six mountain ranges—Bates Mountains, Cipriano Hills, Quitobaquito Hills, Puerto Blanco Mountains, Diablo Mountains, and Ajo Range—and parts of four others—Growler Mountains, Sonoyta Mountains, Sierra de Santa Rosa, and Gunsight Hills—are in the monument. Intermontane valleys include Growler, Sonoyta, La Abra Plain, and Valley of the Ajo. Elevation differences between mountaintops and valley floors exceed 1,000 m (3,500 ft). For instance, the highest peak in the monument, Mount Ajo, stands 1,469 m (4,819 ft) above sea level, whereas the valley floor below it is about 413 m (1,355 ft) above sea level—a difference of 1,056 m (3,464 ft). The valleys in the monument contain four major wash systems including, from north to south, Cuerda de Leña, Kuakatch, Alamo, and Cherioni. These washes drain the central and eastern areas of the monument and are greatly influenced by bajadas (broad, gently inclined surface at the base of a mountain front).

In the Ajo Range on the eastern side of the monument, Bull Pasture represents a human–geologic connection. A combination of topography and geology—creating a hidden valley with a spring, tinajas, and grass suitable for grazing—drew and focused human activity to the site. Bull Pasture covers about 60 hectares (150 ac) and averages 950 meters (3,100 ft) in elevation. It overlooks Estes Canyon and is surrounded by ridges. Topographic differences between valley floor and ridgetop result in a large grassy, enclosed “pasture,” which is underlain by alluvium and colluvium. Adjacent cliffs consist of the rhyolite of Montezuma’s Head. A spring—Bull Pasture Spring—emerges at the northern part of the pasture, and several tinajas provide water.

Hydrology

ORPI spans seven watersheds (HUC10) predominantly split by the Bates and Puerto Blanco Mountains. The two watersheds covering the Valley of the Ajo and the two covering the Growler Valley drain to the northwest into the Cabeza Prieta and eventually the Gila River (Figure 4). The watersheds spanning the Sonoyta Valley and La Abra Plains flow south into the Rio Sonoyta in Mexico. All watersheds contained within the monument eventually flow to the Gulf of California via the Rio Sonoyta or Colorado River. Within the monument, the primary water courses are seasonally dry desert washes, typically lined with xerophytic shrubs and trees, such as velvet mesquite (*Prosopis velutina*), whitethorn acacia (*Vachellia constricta*), blue paloverde (*Parkinsonia florida*), and catclaw acacia (*Senegalia greggii*) (Figure 5). These ephemeral water courses are fed by summer thunderstorms and winter rain and appear as broad, sandy washes in the lower elevations and rocky drainages in the higher areas. These features are generally dry and flow only after significant precipitation events. The higher elevation, deep and rocky drainages that bisect the mountain ranges are often dotted with runoff and sometimes spring-fed tinajas. These are most prominent in the Ajo Range and adjacent Diablo Mountains. Quitobaquito Pond is a historic water feature supported by the Quitobaquito Spring Complex in the southwest corner of the monument. Home to many rare and a few endemic aquatic species, the pond and spring complex also support obligate and facultative riparian trees, shrubs, and herbaceous plants.



Figure 5. Seasonally dry desert wash community at ORPI lined with mesquite (*Prosopis velutina*), palo verde (*Parkinsonia florida*), and bursage (*Ambrosia* spp.).

NPS

Vegetation

Vegetation Communities

ORPI is home to many unique species of cacti and vegetation communities not found elsewhere in the USA and comprises the northernmost extent of the range for the namesake organ pipe cactus (*Stenocereus thurberi*). The large size and diverse geology of the monument create multiple geologic landscapes capable of supporting varied communities transitioning across broad elevational, precipitation and soil gradients. The dominant lifeforms of ORPI's vegetation communities are shrubs, columnar cacti, woody subshrubs, and short-statured desert trees, but large trees can be found where sheltered canyons or large ephemeral washes provide concentrated access to water and/or lower temperatures. As noted in early treatments (Warren et al. 1981), the vegetation communities here appear to transition from subtropical woodland to desert scrub presumably driven primarily by moisture availability. Another readily noticeable gradient in community structure is associated with the change in soil rock fragment content, with lower elevation valley bottom sites having fine silty soils that support low diversity creosote communities (Figure 6), whereas the upper bajada contains ample large rock fragments, and with that comes the increased soil water holding capacity and thus the ability to support diverse palo verde-mixed cactus communities (Figure 7).



Figure 6. An example of a creosote (*Larrea tridentata*) dominated community of the valley bottom, with low species richness.

NPS



Figure 7. An example of a very diverse, species-rich palo verde (*Parkinsonia microphylla*) and mixed shrub community growing on the upper bajada and mountain toeslopes at ORPI.

NPS

Flora

ORPI is home to roughly 650 species of vascular plants in 93 families (Felger et al. 2013; Schmidt et al. 2006). When compared to other NPS units within the Sonoran Desert Network, many of which are a small fraction of the size of ORPI, this number appears relatively low considering the monument's large size and topographic complexity. However, this is to be expected given the comparatively arid climate that characterizes ORPI relative to other Sonoran Desert Network parks.

The monument's flora includes many species which, while common elsewhere in the Sonoran Desert in Mexico, have a very limited distribution within the United States. Among these are two species of columnar cacti: the monument's namesake organ pipe cactus (*Stenocereus thurberi*) and the senita cactus (*Lophocereus schottii*). Other such species include the dahlia-root cereus (*Peniocereus striatus*, Cactaceae), Hinds' nightshade (*Solanum hindsianum*, Solanaceae), ashy limberbush (*Jatropha cinerea*, Euphorbiaceae), and atamisquea (*Atamisquea emarginata*, Capparaceae). The monument also contains populations of several rare species of conservation concern, including the acuña cactus (*Echinomastus erectocentrus* var. *acunensis*), Harrison's barberry (*Berberis harrisoniana*), and the Ajo rockdaisy (*Perityle ajoensis*), which is known only from the Ajo and adjacent Diablo mountains.

The Ajo Mountains (often referred to as simply the Ajo Range), the tallest range within the monument, contain relatively isolated relict populations of sky island species including redberry juniper (*Juniperus arizonica*) and Arizona rosewood (*Vauquelinia californica*). The Ajo Mountain Scrub oak (*Quercus ajoensis*) is found in Alamo and Arch Canyons, at Bull Pasture, and at higher elevations throughout the range. Some authors have found *Q. ajoensis* to be insufficiently distinct from the closely related *Q. turbinella* to warrant recognition as its own species; as such, it has been variously treated as *Q. turbinella* subsp. *ajoensis* or simply as *Q. turbinella* (see Felger and Rutman 2015). For this project, the species will be referred to as *Q. ajoensis* (Nixon and Muller 1997).

Previous Vegetation Studies

The monument has had several notable botanists study the flora resulting in a wealth of knowledge about plant species and their distributions.

- Ajo Peak to Tinajas Altas: A flora of southwestern Arizona (Felger et al. 2013) available online <https://herbarium.arizona.edu/projects/flora-sw-arizona>
- Vascular Plant and Vertebrate Inventory of Organ Pipe Cactus National Monument (Schmidt et al. 2006)
- Non-Native Plants of Organ Pipe Cactus National Monument (Felger 1990)
- Flora of Organ Pipe Cactus National Monument (Bowers 1980)

Exotic (Non-Native) Plants

As many as 75 species of non-native plants have been reported at various times for the monument (Felger et al. 2013), though many of these had no established reproducing populations at the time of writing. The 2006 biological species inventory listed 55 non-native taxa (Schmidt et al. 2006), while Felger et al. (2013) identified only 51 with true reproducing populations within the monument. As

such, non-native plants probably contribute between 7 and 9% of the total flora. Some species, such as pomegranate (*Punica granatum*), were intentionally planted in historically inhabited areas (e.g., Quitobaquito Spring) but these pomegranates have since died out. Other species are present in localized patches within disturbed areas but are not widespread. However, several non-native species have become invasive and pose a serious management concern. A 1990 study of the ORPI's non-native flora identified 16 species that have successfully invaded beyond disturbed areas and "have become an integral part of the natural landscape and ecosystem of the monument as well as the surrounding regions" (Felger 1990). Of these, buffelgrass (*Cenchrus ciliaris*) and Sahara mustard (*Brassica tournefortii*) are of particular concern due to their aggressive spread and competition with native plants and are the focus of ongoing control efforts by NPS staff.

Stinknet (*Oncosiphon pilulifer*), first documented in the monument ca. 2005 (SEINet Portal Network 2024), represents an emerging threat. In recent years this plant has colonized and thoroughly invaded a wide variety of open Sonoran Desert habitat, especially in the Phoenix metro area roughly 120 km northeast of ORPI (Chamberland 2023; Hedrick and McDonald 2020). It threatens to severely alter the ecology of invaded areas by outcompeting native annuals, degrading native wildlife habitat, and, when dry, acting as a continuous and flashy fuel source for wildfires (Hedrick and McDonald 2020).

Chapter 2: Vegetation Classification

Planning and Scoping

An initial scoping meeting took place on April 16, 2015, at Organ Pipe Cactus National Monument (ORPI) resources building. Key staff attended including the resource lead, the park ecologist, geographic information system (GIS) specialist and the park botanist. This meeting set forward the plan to build upon and update the existing 1981 vegetation map rather than create an entirely new map and classification. This decision was made due to the limited time and funds available for this project, as well as the high quality and detail of the previous map. This meeting identified multiple existing data sets that were available, such as a large set of border impacts monitoring plots. Other data already in possession by SODN was discussed and imagery needs were determined to be adequately met by the most recent, freely available high-resolution aerial imagery of ORPI.

Data Collection Overview

The methods used to classify vegetation at ORPI followed the guidelines outlined in the NPS technical guidance and support documents found at <https://www.nps.gov/im/technical-guidance.htm>. However, the lack of existing USNVC classes for Arizona required additional steps, such as drafting a set of new vegetation association descriptions not currently described in the USNVC.

Additional variation from the established guidelines became necessary to accommodate our plans to update the 1981 map. Our method involved utilizing the existing data available to us from multiple sources to develop an updated classification of vegetation types, which was then applied to the existing polygons from the Warren map. Concurrently and iteratively, we updated the boundaries of existing polygons that remained valid from the 1981 map and created many new polygons to add finer detail to the map. While generally quite good, we found the Warren map often had poor linework (polygon boundaries) especially on one side or the other of hillslopes which was in part due to the inherent limitations of the older aerial photographs used, such as deep shadows and lower resolution.

Throughout the project, we took an iterative approach to all data collection and mapping work, first adding more data collection points (plots and photo points) and then conducting more in-depth digitizing updates. For both we focused on a singular section of the park at a time, such as the Ajo mountains or washes in the La Abra Plain.

Digital Imagery Acquisition and Processing

Park GIS staff were able to provide us with copies of 30 cm resolution multispectral aerial imagery covering the entire monument at no cost to our project. This imagery had been collected in 2008 by the Department of Homeland Security for uses related to border security but was later made available for natural resource studies. Due to the immense size of the monument the images were provided across multiple digital orthoquarter quads (DOQQ) files. This imagery was later stitched into a mosaic file for use at the SODN office while digitizing map polygons.

Field Data Collection

Prior to the start of the primary classification effort in 2018, preliminary data was collected during scoping trips and opportunistically during other SODN sampling events at the monument. Across these sporadic events, crews sampled a total of 39 plots and collected data for 49 photo points. Primary plot data collection occurred in the winter of 2017 and spring 2018. Over this time frame, crews sampled a total of 148 subjectively placed classification plots and collected additional photo point data ($n = 192$) to aid in the mapping phase of the project.

Following this round of sampling, these data were used to classify the vegetation communities sampled in 2017 and compared to those represented in the Warren map (see vegetation classification analysis section below). Based on these results, in the spring of 2019 and fall of 2020 field crews completed an additional two rounds of sampling to focus on areas of the monument and vegetation communities under-sampled during the 2017–2018 sampling effort. Across these two sampling efforts, crews sampled an additional 136 subjectively placed plots, as well as an additional 824 photo points. Across all sampling efforts, crews sampled a total of 323 classification plots (Figure 8) and collected 1,065 photo points (Figure 9).

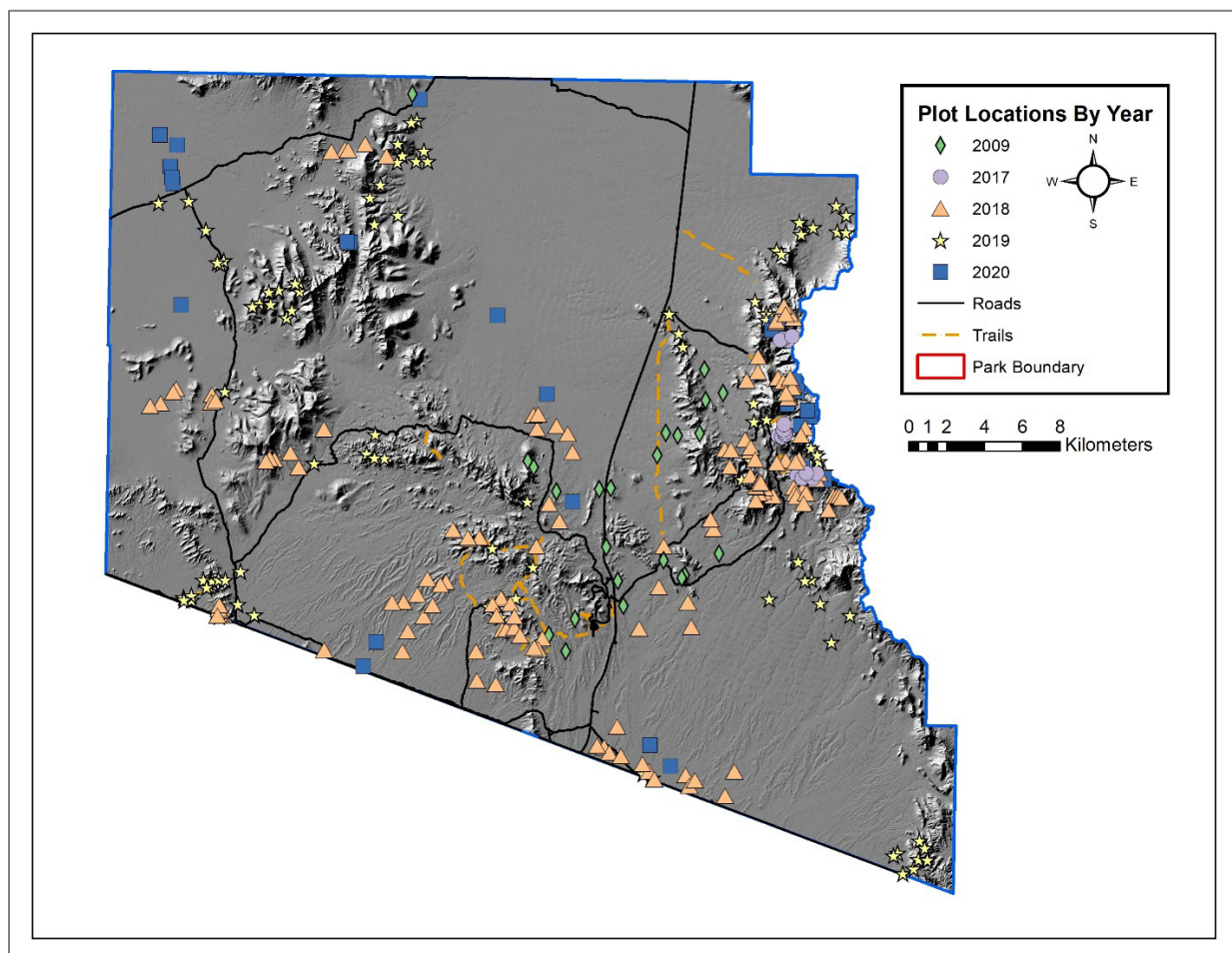


Figure 8. Distribution of 323 classification plots at ORPI sampled between 2009 and 2020.

NPS

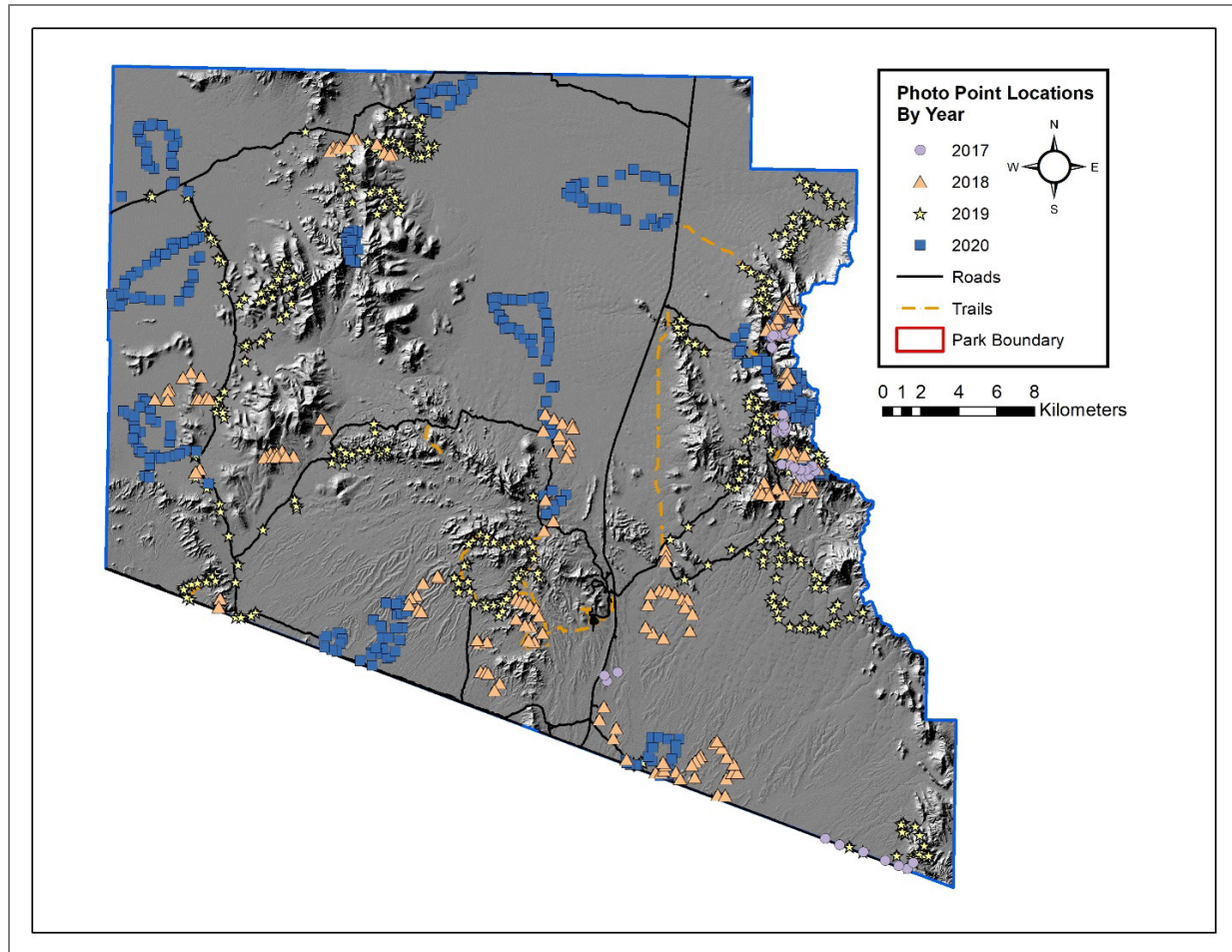


Figure 9. Distribution of 1,065 photo point locations captured concurrently with classification plot sampling from 2017 to 2020.

NPS

An NPS crew of 2–4 people, typically working in pairs, collected all classification plot data. Crew leads had experience in vegetation mapping at other SODN parks (e.g., Saguaro National Park, Coronado National Memorial) for several months prior to this field effort and were proficient in all classification methodologies. Working in teams of two or more to facilitate a multiple-observer, consensus-based approach, the field crew established and sampled all 323 classification plots. Due to the subjective placement of all plots, crews selected the location of each plot during the field effort. Project leads directed crews to specific areas of the monument to capture un- and under-represented plant communities. Each field plot covered 1,000 m² and was oriented to best capture the surrounding vegetation community. Crews employed various shapes to best capture the targeted community, but the preponderance of plots were circular, with a radius of approximately 18 meters. For more linear communities, typically associated with washes and drainages, plots ranged in shape from 25 × 40 meters to 10 × 100 meters, but always covered 1,000 m². Plots were marked only with GPS points rather than with permanent hardware and subjectively delineated using ocular estimation of distances or with rangefinders, or occasionally with laying out of tapes.

Within each plot, crews collected semi-quantitative data on absolute canopy cover for all vascular plant species in four height strata: field (0–0.5 m), sub-canopy (0.5–2 m), lower canopy (2–5 m), and upper canopy (>5 m). In each stratum, crewmembers placed each documented species into one of nine cover classes: 1 (<1%), 2 (1–5%), 3 (6–10%), 4 (11–25%), 5 (26–33%), 6 (34–50%), 7 (51–75%), 8 (76–95%), and 9 (96–100%). In general, crews only included perennial native and both perennial and annual non-native species. Native annuals were occasionally documented when they provided a noteworthy amount of cover or were diagnostic of the plant community.

Up to three species per stratum were assigned a dominance rank based on their cover class and/or importance to the sampled vegetation community. Additionally, crews recorded the average plant height (lower and upper canopy only), lifeform (excluding the field stratum), disturbance types (using the USNVC-constrained vocabulary), total absolute cover by stratum, and a range of soil and landscape characteristics (Table 2). A single representative photograph was taken looking towards the center of the plot from the edge. Two brief narratives were written to describe the tentative association type of the polygon, noting the ways in which this association/area differed from the adjacent areas, and any topographic features contributing to the divisions of floristic similarities.

Table 2. Specific attributes collected on the vegetation and landscape datasheets for both polygons and classification plots.

Type of information	Items noted
Plot/Polygon metadata	Date, time, observer name(s), recorder name(s), park code, sub-map number, protocol version
Plot/Polygon documentation	Location, original ID, field ID, new ID, tentative formation, keyed formation, area (standard for all plots)
Environmental description	Topographic position, landform type, parent material, slope class, erosion features, aspect
Surface cover (% cover classes)	Bare soil, gravel, rock, bedrock outcrops, physical crust, biological soil crust, downed wood, litter
Vegetation description	Qualitative narrative: community structure, notable inclusions, leaf phenology, community structure
Vegetation strata data	Lifeform, dominance rank, cover class and height in each of four height classes (0–0.5 m, 0.5–2 m, 2–5 m, >5 m), associated species
Plant species	Scientific name (6-letter codes were used)
Other vegetation characteristics	Homogeneity, stand maturity, similarity to other types, mortality, disturbance

Plot Data Management

All classification plot data were entered into a Microsoft Access (2007) database created by the SODN data manager (later transferred into the VMI program PLOTS database during creation of final products and deliverables). The digital data were subsequently checked for accuracy against the original datasheets, and any transcription errors were rectified prior to analysis. An alternate team member validated the data for logical errors or unusual species entries. These processes followed the

quality standards outlined in the global operating procedures written by the SODN data management program. All datasheets were copied and stored separately from the original set. Photo point locations (shapefiles) were similarly checked for spatial accuracy and attribute completeness. Review and analysis of data took place only after the completion of all quality checks.

Additional Datasets

In addition to the plot data collected specifically for this project, other datasets were acquired to increase the sample size and improve the classification. These datasets include 56 upland vegetation monitoring plots (Hubbard et al. 2012) sampled by SODN from 2009 to 2013 and 235 border impact plots sampled by USGS from 2009 to 2011. These datasets were appropriately transformed to align with data from the vegetation mapping classification plots. For instance, numeric cover values generated from line point intercept (the technique used in the upland vegetation and border impact plots) were converted to the corresponding cover class used in the classification plots.

Vegetation Classification Analysis

Classification Plot Analysis

Following the 2018 field data collection effort, data from all sampled classification plots ($n = 186$), SODN upland vegetation monitoring plots ($n = 56$), and USGS border impact plots ($n = 235$), were combined and analyzed using a multivariate approach to identify distinct vegetation communities.

A data matrix of cover values for all species for each plot location was exported from the Access database where field data was initially entered. This data matrix had species as variables (rows), plots as samples (columns), and midpoint cover values as the matrix values. For all analyses, we used the midpoint of the selected cover class. For example, the value used from the cover class that spans 11–25% was changed to a value of 18. The resulting matrix was then imported into the program Plymouth Routines in Multivariate Ecological Research (PRIMER), version 7 (Clarke and Gorley 2006). We square root transformed the data to balance the contributions from common and rare species in the measure of similarity between two samples (Clarke and Warwick 2001).

Then, using the resemblance tool in PRIMER, the transformed values were converted into a similarity matrix using the Bray-Curtis similarity coefficient (Bray and Curtis 1957). This matrix contains values comparing the similarity of every combination of samples (plots) with values ranging from 0, indicating no similarity, to 100, indicating identical samples. Using this matrix, we employed a group-average cluster analysis with an associated dendrogram to aid in assigning plots to groups based on the similarity/dissimilarity of documented species and their associated cover values.

Within the cluster routine, we performed a SIMPROF (similarity profile) permutation test which looks for statistically significant groupings and identifies them on the dendrogram graph using color. SIMPROF is a permutation test of the null hypothesis such that “a specified set of samples, which are not *a priori* divided into groups, do not differ from one another in a multivariate structure” (Clarke and Gorley 2006). The output indicates at which point in the branch of the dendrogram that the grouping reaches a designated significance. This was used to help determine the juncture at which the dendrogram groups were assigned.

The dendrogram and associated SIMPROF test split the data into 60 small groups containing as few as one and as many as 64 plots. The SIMPROF identified these small groupings at high levels of similarity, ranging between 40% and 80%. This similarity value is useful for exploring the data but is often too high to use for vegetation-classification efforts, as it would result in a cumbersome classification with a large number of narrowly defined communities that obscures the broader patterns that vegetation maps intend to capture.

Initially, we evaluated the results at a subjective similarity of 15%, where plots fell within five broad clusters (a–e) (Figure 10). These clusters were further analyzed using the similarity percentages routine (SIMPER). SIMPER takes the dissimilarity between each pair of groups and breaks it down into the contributions from each species. It first utilizes the within-group similarities to find the *typical* species defining the group and then identifies the *discriminating* species between pairs of groups and orders the species into decreasing contributions to the overall average (dis)similarity (Clarke and Gorley 2015). Tabular output from PRIMER showed the average similarity of members within each cluster, as well as the contribution of each species to that similarity. Based on this information, we determined that each group was generally defined by the presence or absence of certain diagnostic species and corresponded with the major landform types found at the monument.

- Cluster a (28% similarity): A very small cluster ($n = 7$) of plots associated with hydrologic features, specifically Williams and Quitobaquito springs. These plots were defined by the presence and abundance of alkali goldenbush (*Isocoma acradenia*), saltgrass (*Distichlis spicata*), velvet mesquite (*Prosopis velutina*), arrowweed (*Pluchea sericea*), and lotebush (*Ziziphus obtusifolia*).
- Cluster b (22% similarity): A cluster ($n = 58$) of plots defined by the presence of jojoba (*Simmondsia chinensis*) and restricted the Ajo Mountain Range. Additional noteworthy species contributing to within-cluster similarity, include ocotillo (*Fouquieria splendens*), Arizona rosewood (*Vauquelinia californica*), and Parish's goldeneye (*Bahiopsis parishii*).
- Cluster c (43.7% similarity): A very small cluster ($n = 4$) of plots defined by the dominance of saltbush (*Atriplex* spp.), including cattle saltbush (*Atriplex polycarpa*) and thinleaf fourwing saltbush (*Atriplex linearis*). These plots are restricted to areas adjacent to the southern boundary of the monument.
- Cluster d (30% similarity): A small cluster ($n = 10$) of plots associated with the ephemeral wash systems that bisect the bajada throughout the monument. In these plots, the most important species included velvet mesquite (*Prosopis velutina*), catclaw acacia (*Senegalia greggii*), and blue paloverde (*Parkinsonia florida*).
- Cluster e (33% similarity): A very large cluster ($n = 398$) of plots occupying the valleys, bajadas, and low mountain slopes. These areas are most prominently dominated by creosote (*Larrea tridentata*), triangle bur ragweed (*Ambrosia deltoidea*), yellow paloverde (*Parkinsonia microphylla*), brittlebush (*Encelia farinosa*), saguaro (*Carnegiea gigantea*), and organ pipe cactus (*Stenocereus thurberi*). This cluster roughly aligns with the USNVC Mojave-Sonoran Semi-Desert Scrub Macrogroup [M088].

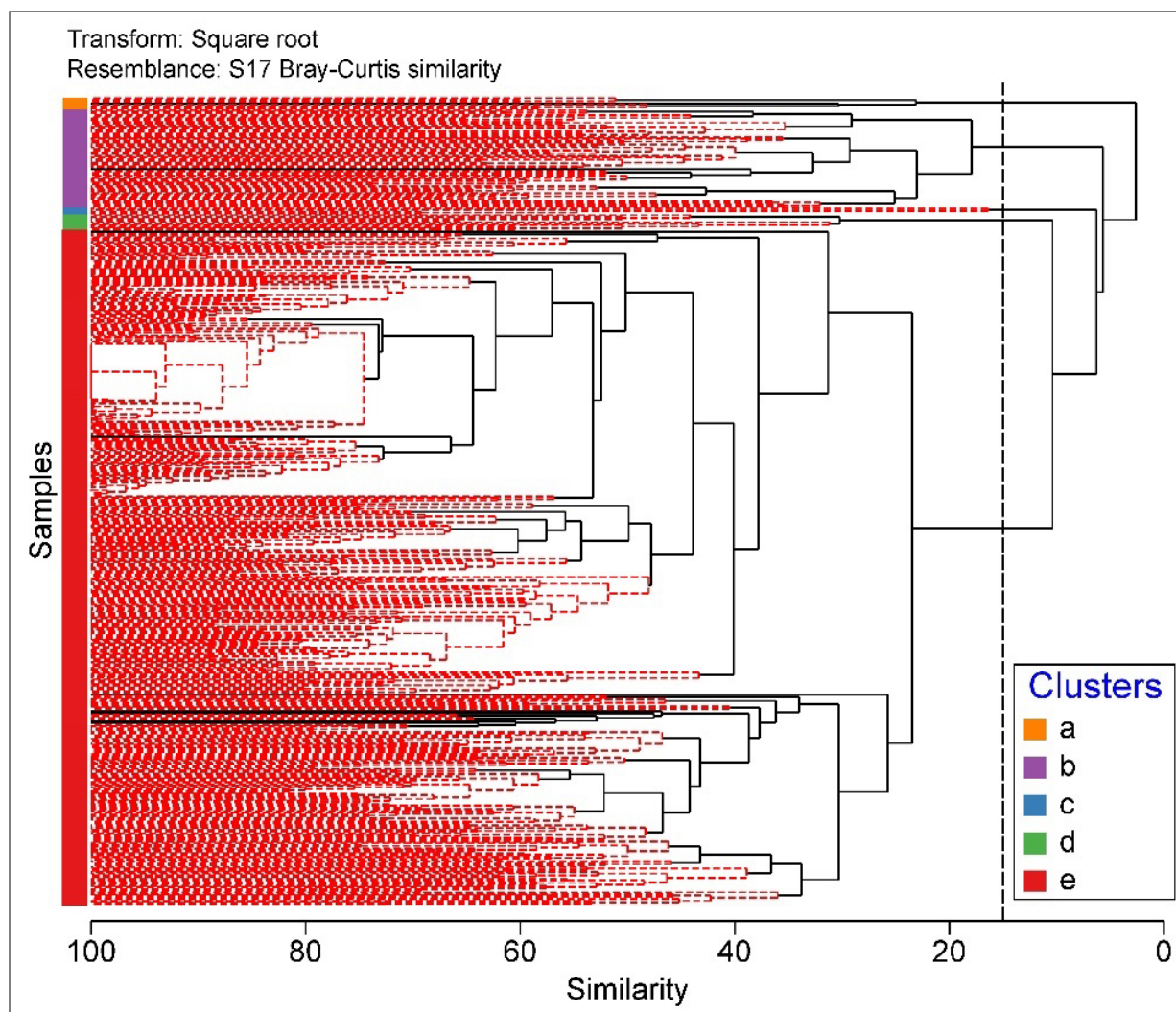


Figure 10. Cluster analysis diagram of the 477 classification plots. Level 1 groupings are indicated by a cut in the cluster tree at 15% similarity, as indicated by the vertical dashed line. Data are from ORPI, 2009–2018.

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With the data split into broad clusters, we further analyzed them by employing non-metric multidimensional scaling (nMDS). nMDS is a robust tool for visualizing high-dimensional systems on the basis of a chosen resemblance measure ([Clarke 1993](#); [Kruskal and Wish 1978](#)). In the resulting diagram (Figure 11), similarity/dissimilarity between sites can be assessed based on the distance between points (samples). Using the nMDS, SIMPROF groups, and SIMPER profiles, we further explored the finer grouping within each cluster. Due to the large number of groups/vegetation associations identified during this process, we deemed it too cumbersome to fully detail within this report. Instead, a few examples associated with Cluster e are examined in further detail to exemplify the process.

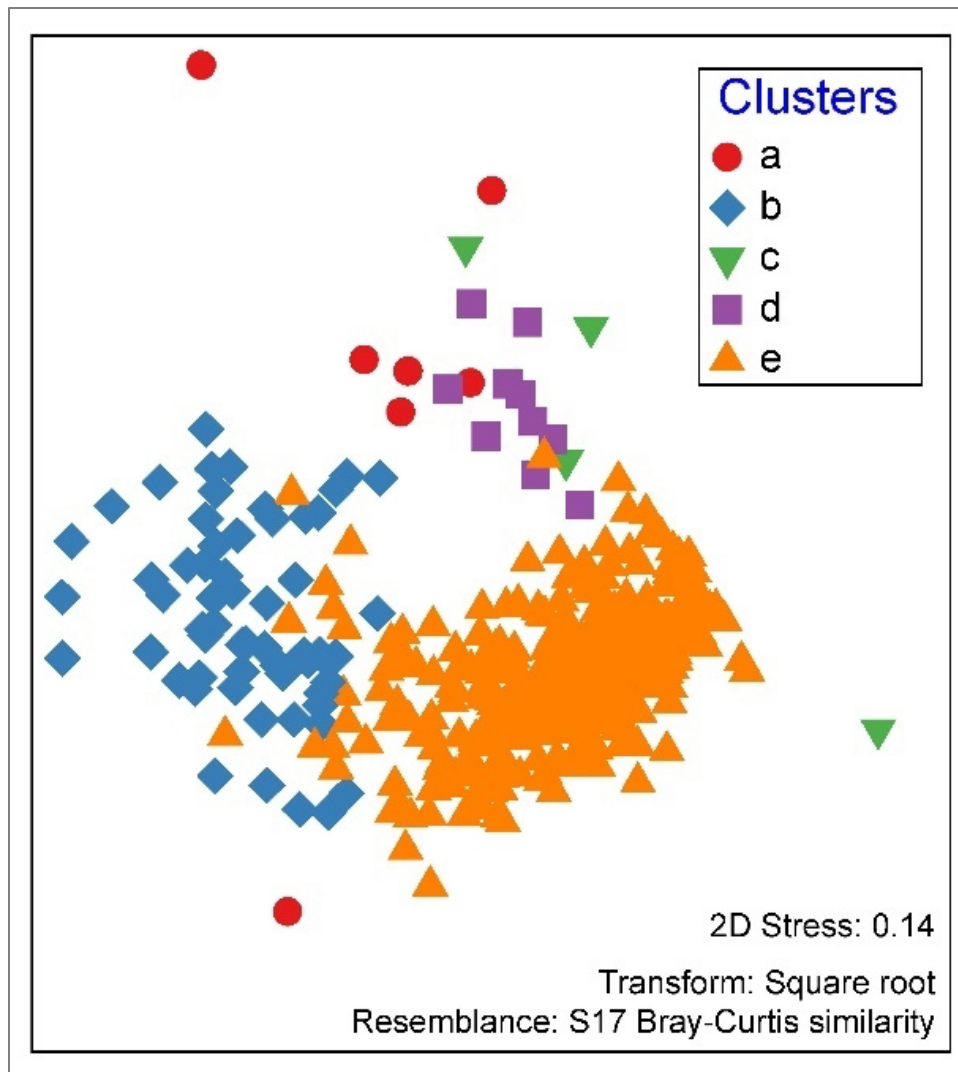


Figure 11. Non-metric multidimensional scaling of classification plots, ORPI, 2009–2018.
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As defined above, Cluster e roughly aligns with an established USNVC macrogroup, Mojave-Sonoran Semi-Desert Scrub, M088. The first major split within this cluster separates the Mojave-Sonoran Bajada & Valley Desert Scrub Group [G295] from Sonoran Paloverde – Mixed Cacti Desert Scrub Group [G293] (Figure 12). Plots that fell within the G295 branch are defined by the overwhelming dominance of creosote (*Larrea tridentata*) with a low cover mix of associate subshrubs, such as burrobush (*Ambrosia dumosa*) and triangle bur ragweed (*Ambrosia deltoidea*). Plots that fell within the G293 branch are a far more diverse collection of plots defined by consistent yellow paloverde (*Parkinsonia microphylla*) and saguaro (*Carnegiea gigantea*) with a more diverse understory of shrubs and succulents.

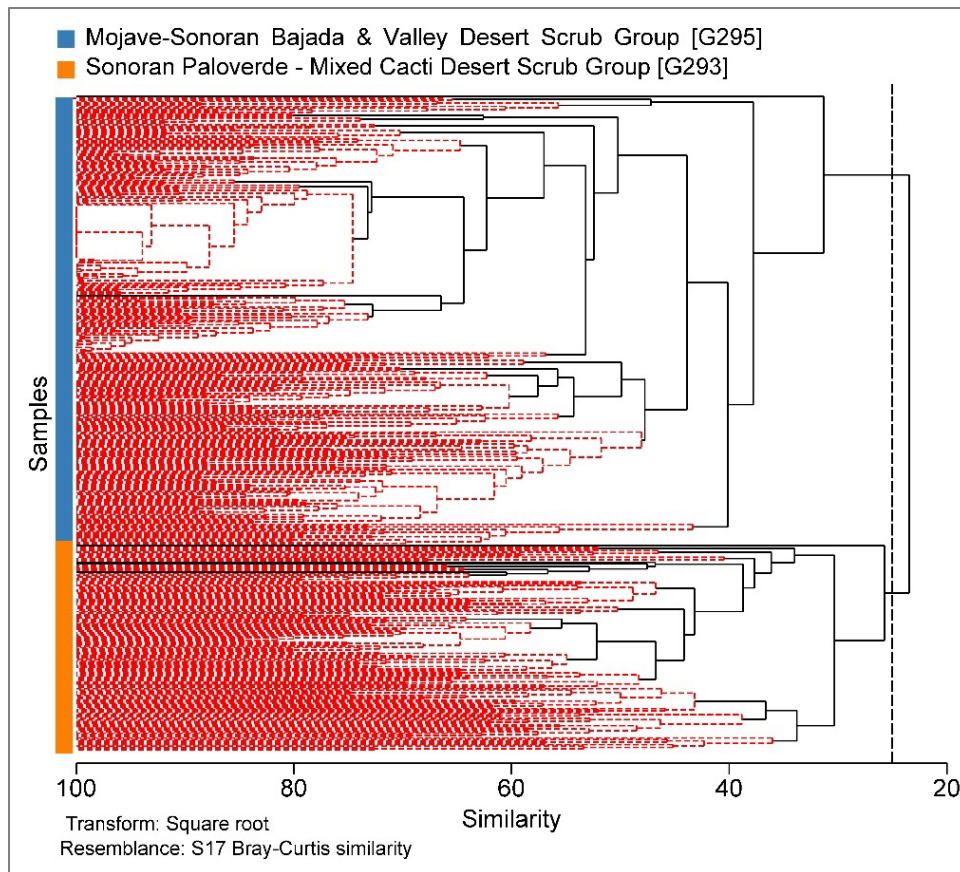


Figure 12. Dendrogram of Cluster e (Mojave-Sonoran Semi-Desert Scrub Macrogroup [M088]) showing the split between G293 and G295 defined at a 25% similarity level, as indicated by the vertical dashed line. Data are from ORPI, 2009–2018.

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Under the G295 branch, we identified five associations that roughly aligned with the SIMPROF groupings (Figure 13). Due to the overwhelming dominance of creosote (*L. tridentata*) in all plots in the G295 branch, the 2-dimensional nMDS plot (Figure 12) visualizes clusters (corresponding to vegetation associations) as broadly overlapping and rather indistinct. The more subtle differences between these associations, driven by differences in cover of codominant or associate species, can be difficult to discern solely from this diagram. However, these differences are more readily identifiable when SIMPROF and SIMPER results are considered.

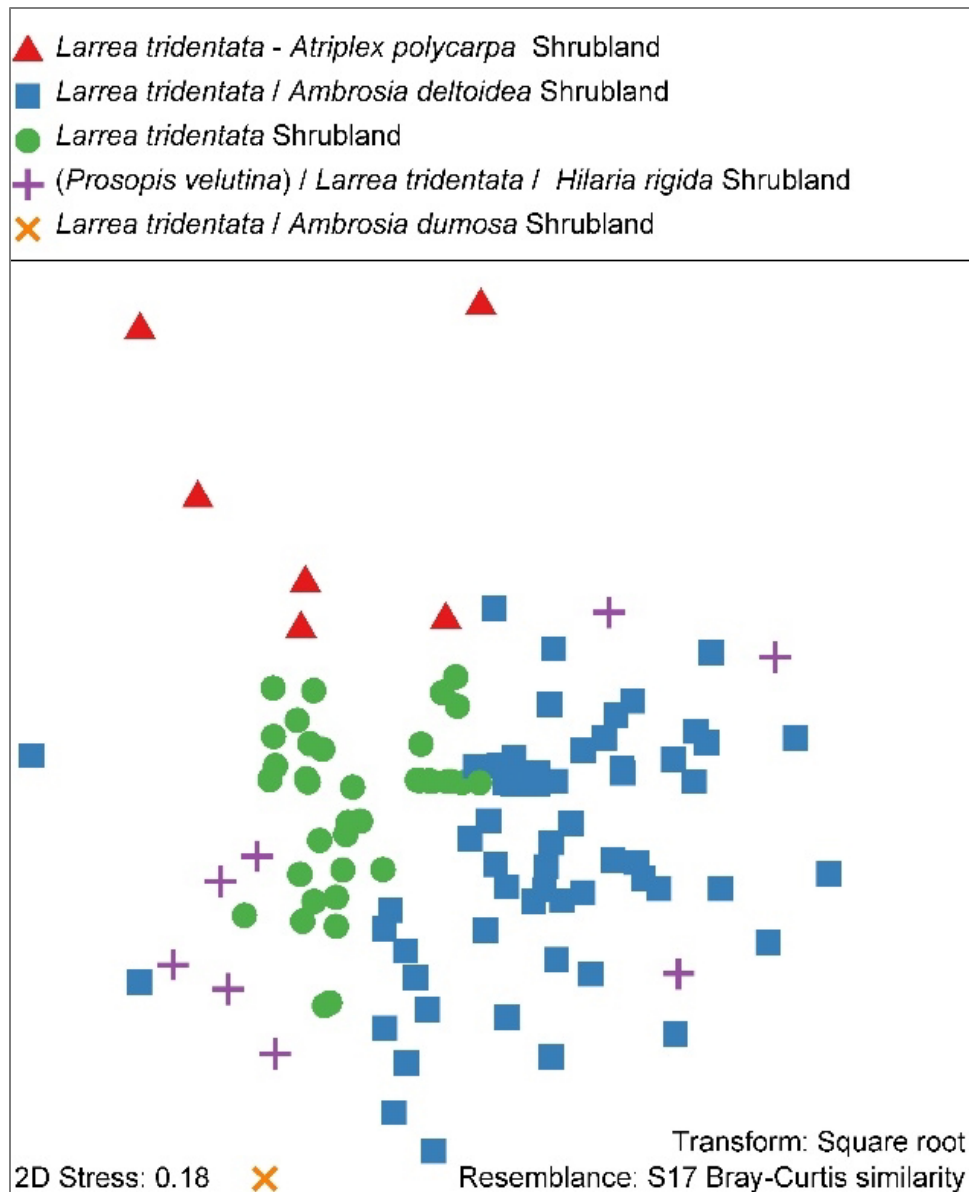


Figure 13. nMDS of cluster data aligning with the Mojave-Sonoran Bajada & Valley Desert Scrub Group [G295]. Data are from ORPI, 2009–2018.

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Preliminary Classification Results

A similar process of classifying all sampled plots was completed for the remainder of the dataset and a list of preliminary associations created. We compared this list of preliminary types to those identified for the Warren map to determine overlap and any new communities. During this initial round of classification, we identified a total of 34 vegetation communities at the association level (see below). Within these 34 associations, a corollary existed for all 28 communities identified for the Warren map. We also identified six additional communities not included in the Warren map. These six “new” types are a mix of previously undescribed communities as well as variations on existing Warren types that were determined to be distinct from one another. More detail on where final

associations were distributed can be found in this report in Chapter 5: Association Summaries. Associations marked with an asterisk (*) are those without a corollary on the Warren map.

1. (*Juniperus arizonica* – *Vauquelinia californica*) / Mixed Shrub Wooded Shrubland (P)
2. *Vauquelinia californica* / *Simmondsia chinensis* – *Rhamnus crocea* Wooded Shrubland (P)
3. *Quercus ajoensis* – *Vauquelinia californica* / *Simmondsia chinensis* Intermittently Flooded Woodland (P)
4. *Prosopis velutina* / *Ziziphus obtusifolia* – *Lycium* spp. Wooded Shrubland (P)
5. *Isocoma acradenia* – *Distichlis spicata* Open Shrubland (P)
6. (*Parkinsonia microphylla*) / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland (P)
7. *Fouquieria splendens* / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland (P)
8. *Parkinsonia microphylla* / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland (P)
9. *Parkinsonia microphylla* – *Olneya tesota* / *Larrea tridentata* / *Ambrosia deltoidea* Wooded Shrubland (P)
10. *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland (P)
11. *Parkinsonia microphylla* – *Stenocereus thurberi* – *Pachycereus schottii* / *Larrea tridentata* / *Ambrosia deltoidea* Wooded Shrubland (P)
12. *Fouquieria splendens* / *Selaginella arizonica* Shrubby Rock Outcrop (P)*
13. *Parkinsonia microphylla* / *Jatropha cuneata* / *Encelia farinosa* Shrubland (P)
14. *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Jatropha cuneata* / *Encelia farinosa* Shrubland (P)
15. *Parkinsonia microphylla* / *Jatropha cuneata* (*Bursera microphylla*) / *Encelia farinosa* Shrubland (P)
16. *Parkinsonia microphylla* / *Simmondsia chinensis* / *Ambrosia deltoidea* Shrubland (P)
17. *Simmondsia chinensis* (*Bahiopsis parishii* – *Aloysia wrightii* – *Eriogonum fasciculatum*) Shrubland (P)
18. *Simmondsia chinensis* – *Atriplex polycarpa* (*Encelia farinosa*) Shrubland (P)
19. *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Simmondsia chinensis* / *Encelia farinosa* Shrubland (P)*
20. (*Parkinsonia microphylla*) *Fouquieria splendens* / *Simmondsia chinensis* (*Bursera microphylla*) / *Encelia farinosa* Shrubland (P)*
21. (*Parkinsonia microphylla*) / *Simmondsia chinensis* / *Encelia farinosa* Shrubland Association (P)
22. *Larrea tridentata* / *Ambrosia deltoidea* Shrubland (P)*

23. *Larrea tridentata* / *Ambrosia dumosa* Shrubland
24. *Larrea tridentata* Shrubland
25. *Fouquieria splendens* / *Larrea tridentata* / *Ambrosia dumosa* Shrubland
26. *Larrea tridentata* – *Atriplex polycarpa* Shrubland
27. *Atriplex polycarpa* – *Suaeda nigra* Shrubland Association (P)
28. *Prosopis velutina* / *Larrea tridentata* – *Atriplex polycarpa* Floodplain (P)
29. (*Prosopis velutina*) / *Larrea tridentata* / *Hilaria rigida* Shrubland (P)*
30. (*Prosopis velutina*) / *Larrea tridentata* Shrubland (P)
31. *Prosopis velutina* / *Senegalia greggii* – *Larrea tridentata* Intermittently Flooded Shrubland (P)
32. *Prosopis velutina* – *Parkinsonia florida* Intermittently Flooded Woodland (P)
33. *Simmondsia chinensis* – *Senegalia greggii* – *Celtis ehrenbergiana* / *Ambrosia ambrosioides* Intermittently Flooded Shrubland (P)*
34. *Schoenoplectus americanus* Herbaceous Aquatic (P)

Classification Validation

Following this initial round of sampling and analysis of those data, we determined additional fieldwork was required to better describe under-sampled communities and to assess a few areas of the park not sampled during the initial round of sampling. This second phase of fieldwork was completed in the spring of 2019 and the fall of 2020. Crews sampled a total of 136 subjectively placed plots (Figure 9) and 824 photo points (Figure 9) across an additional 25 field days. These supplemental data addressed under-sampled areas (Kino Peak, Ajo Peak, Santa Rosa Mountains, Williams Spring, Kuakatch Wash), increased plots in previously under-sampled communities, and described communities undocumented in the initial round of sampling. Outcomes of this step are presented in the final classification (Chapter 4).

Chapter 3: Mapping of Plant Communities

Methods

Unlike previous vegetation maps created by SODN, this map builds upon a legacy map product (Warren et al. 1981). While other SODN parks have a legacy map product (e.g., Saguaro National Park, Montezuma Castle National Monument, Chiricahua National Monument), only the Organ Pipe Cactus National Monument (ORPI) map was of sufficiently high quality (in terms of both mapping and the classes used) to be used as a base for a SODN VMI map product. Prior to making edits to the Warren map, we attempted to identify and quantify problematic types and areas across the monument. To achieve this, we performed a makeshift accuracy assessment by comparing the Warren map to all classified plots across the monument (Figure 14). This helped to find areas of the monument with high error rates (Growler Valley, Ajo Mountains, Valley of the Ajo) or without sufficient data (Bates Mountains, washes, Santa Rosa Mountains). In addition, this process helped determine the most problematic types where classifications are consistently in disagreement with the legacy map (Table 3).

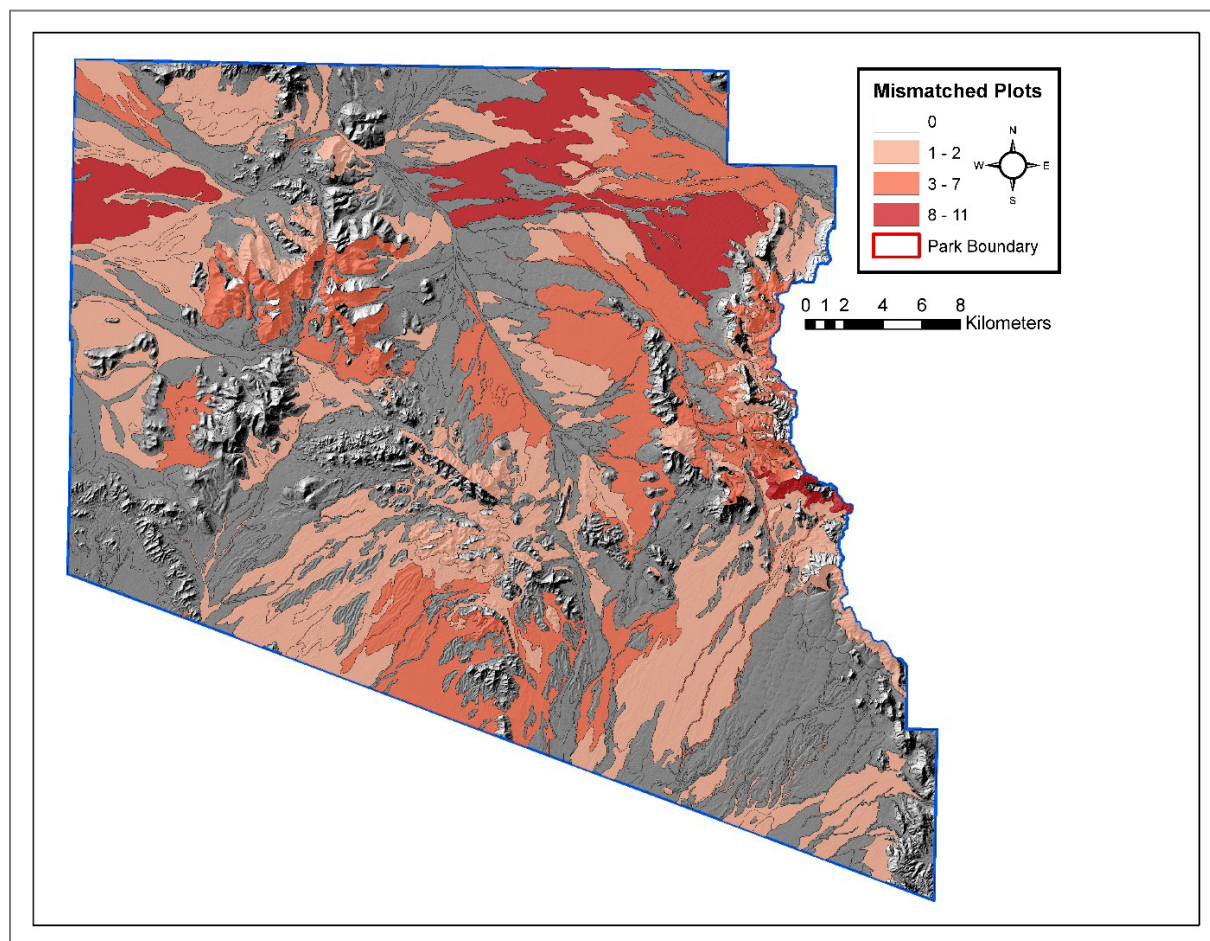


Figure 14. Map depicting number of mismatched classification plots per Warren polygon. Data are from ORPI, 2009–2018.

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Table 3. Types with the most mismatch between Warren map polygons and SODN classified plots. Data are from ORPI, 2009–2018.

Warren Name	SODN Name	Mismatched Plots
<i>Ambrosia deltoidea</i> – <i>Parkinsonia microphylla</i> middle bajada	<i>Parkinsonia microphylla</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P)	49
<i>Larrea divaricata tridentata</i> – <i>Ambrosia dumosa</i>	<i>Larrea tridentata</i> / <i>Ambrosia dumosa</i> Shrubland	32
<i>Larrea divaricata tridentata</i> – <i>Ambrosia</i> mixed scrub	(<i>Parkinsonia microphylla</i>) / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P)	29
<i>Parkinsonia microphylla</i> – <i>Encelia</i> – <i>Ambrosia deltoidea</i>	<i>Parkinsonia microphylla</i> / <i>Jatropha cuneata</i> / <i>Encelia farinosa</i> Shrubland (P)	23
<i>Larrea divaricata tridentata</i> – <i>Ambrosia deltoidea</i> – <i>Fouquieria splendens</i>	<i>Fouquieria splendens</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P)	16
<i>Parkinsonia microphylla</i> – <i>Ambrosia deltoidea</i> – <i>Simmondsia</i> pediment	<i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P)	15
<i>Parkinsonia microphylla</i> – <i>Encelia</i> – <i>Stenocereus</i> – <i>Jatropha</i>	<i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Jatropha cuneata</i> / <i>Encelia farinosa</i> Shrubland (P)	14
<i>Simmondsia</i> – <i>Viguiera</i> – <i>Eriogonum</i>	<i>Simmondsia chinensis</i> (<i>Bahiopsis parishii</i> – <i>Aloysia wrightii</i> – <i>Eriogonum fasciculatum</i>) Shrubland (P)	13
<i>Parkinsonia microphylla</i> – <i>Encelia</i> – <i>Stenocereus</i> – <i>Bursera</i>	<i>Parkinsonia microphylla</i> / <i>Jatropha cuneata</i> (<i>Bursera microphylla</i>) / <i>Encelia farinosa</i> Shrubland (P)	11
<i>Acacia</i> – <i>Ambrosia ambrosioides</i>	<i>Prosopis velutina</i> / <i>Senegalia greggii</i> – <i>Larrea tridentata</i> Intermittently Flooded Shrubland (P)	10
<i>Ambrosia deltoidea</i> – <i>Parkinsonia microphylla</i> pediment mixed shrub	<i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P)	10

As the classified plot dataset is a composite of distinct projects it is therefore not a spatially balanced snapshot of the monument. These results helped inform future survey plans but did not serve as definitive evidence of specific errors within the Warren map. Following this assessment, field crews completed two additional rounds of surveys, in the spring of 2019 and fall of 2020 (see Classification Validation section). These field efforts focused on under-sampled areas and communities, as well as communities and areas with a high number of mismatches between classification plots and the Warren map. Attention was also focused on identifying and confirming the spatial patterns of communities across the monument. Using these additional datapoints along with legacy datasets, imagery, and explanatory rasters we updated the Warren map line work. Edits ranged from adjusting misaligned washes to parsing out entire mountain ranges. In addition, we added non-vegetated classes to the map that include paved roads, Highway 85, sparsely vegetated bedrock, talus slopes, and developed areas.

During the additional field efforts and in the process of map edits, it became evident that we were unable to accurately and consistently map certain similar associations. The primary driver of these issues is the patchy distribution of certain diagnostic species, such as elephant tree (*Bursera*

microphylla), burrobrush (*Ambrosia dumosa*), and big galleta (*Hilaria rigida*), which are difficult or impossible to discern in the aerial imagery used to delineate polygons. As a result, we determined that four sets of two associations should be merged into map classes (Table 4).

Table 4. Map classes created from spatially merged associations.

Map Class	Component Associations
<i>(Prosopis velutina) / Larrea tridentata</i> Shrubland	<i>(Prosopis velutina) / Larrea tridentata / Hilaria rigida</i> Shrubland (P)
	<i>(Prosopis velutina) / Larrea tridentata</i> Shrubland (P)
<i>Larrea tridentata / Ambrosia (deltoidea – dumosa)</i> Shrubland	<i>Larrea tridentata / Ambrosia deltoidea</i> Shrubland (P)
	<i>Larrea tridentata / Ambrosia dumosa</i> Shrubland
<i>Parkinsonia microphylla (Stenocereus thurberi) / Jatropha cuneata / Encelia farinosa</i> Shrubland	<i>Parkinsonia microphylla (Stenocereus thurberi) / Jatropha cuneata / Encelia farinosa</i> Shrubland (P)
	<i>Parkinsonia microphylla / Jatropha cuneata (Bursera microphylla) / Encelia farinosa</i> Shrubland (P)
<i>Parkinsonia microphylla (Stenocereus thurberi) / Jatropha cuneata – Simmondsia chinensis / Encelia farinosa</i> Shrubland	<i>Parkinsonia microphylla (Stenocereus thurberi) / Simmondsia chinensis / Encelia farinosa</i> Shrubland (P)
	<i>(Parkinsonia microphylla) Fouquieria splendens / Simmondsia chinensis (Bursera microphylla) / Encelia farinosa</i> Shrubland (P)

Our mapping updates included hundreds of hours of heads-up digitizing to map previously unmapped washes that were of a certain size/width as the project team felt these were an important landscape feature that could be of use in future natural or cultural resource studies (Figure 15). As a guideline to help in determining which washes to digitize, we created a hydrologic raster based on a digital elevation model (DEM) that allowed us to calculate the number of pixels flowing into each section of wash. We came up with a system to rate these 1 to 5, with 5 being the largest washes. We attempted to digitize all wash sections rated 3 and above, but also strongly used visual image interpretation (i.e., verified that there was a change in vegetation along that area indicating an ecological influence from the wash) to make the final decision. Primarily the tool helped us to not over-map smaller less significant washes and prioritize our time.

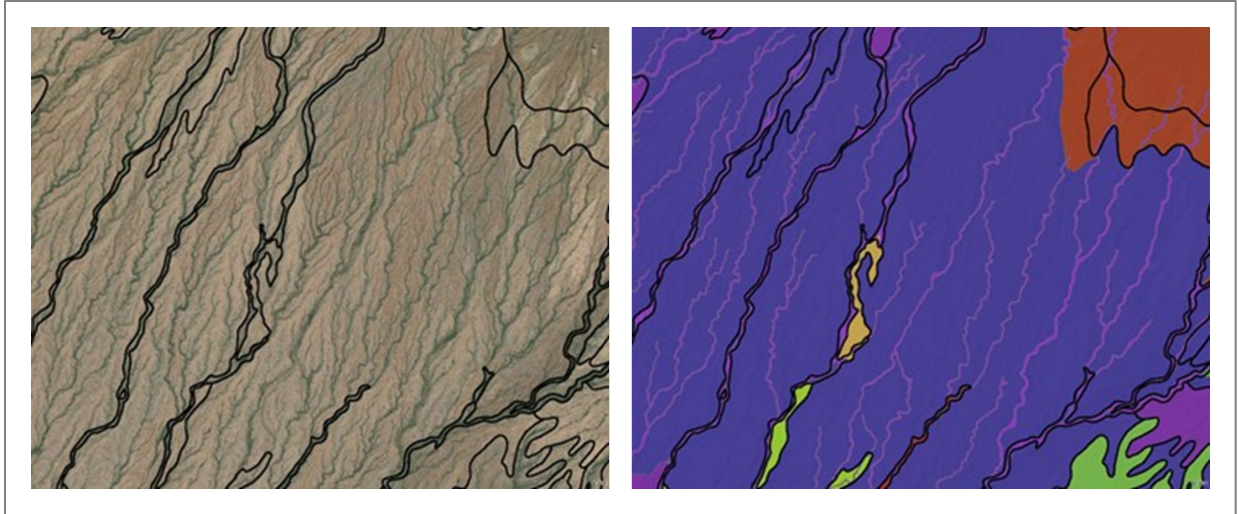


Figure 15. The graphics show an example area in the Sonoyta Valley, where linework was updated to digitize medium-sized washes previously unmapped. In the image on the left, black lines show the mapped washes from the 1981 Warren map. On the right, lighter purple lines show the newly mapped washes in addition to those mapped in the earlier Warren map.

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Similarly, our efforts included digitizing non-vegetated areas such as large bedrock outcrops. Our updates also involved correcting polygon edges to match with the modern high-resolution 30 cm imagery, resolving many errors that were due to limitations of older techniques, software and shadowy-heavy aerial photos. Overall, the revised polygons now better match with slope and aspect shifts and have greatly increased the detail and specificity of the mapped communities (Figure 16).



Figure 16. The graphic shows a small example of updated linework from the north Alamo canyon area, with the original Warren map unit boundaries shown as black lines and the updated VMI map polygons in the different colors. On the right side of the image, the small light-colored patches that resemble clouds are the digitized large bedrock outcrops.

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Results

The original Warren map published in 1981 contains 28 vegetated classes and 1 non-vegetated class (Lukeville) spread across 818 individual polygons. Following all rounds of edits, the final SODN map contains six non-vegetated classes, and 30 vegetated map classes consolidated from the 34 vegetation associations spread across 3,218 polygons. These polygons range in size from less than 0.5 ha, often a result of polygons split by roads, to a 2,101 ha polygon that covers much of the Growler Valley.

Chapter 4: Map Products

Final Classification

In the final map, there are 34 associations placed in 36 map classes (Figure 17). These classes include six unvegetated or minimally vegetated classes, including developed (housing, visitor center, facilities), roads (only paved roads), Highway 85, sparsely vegetated expanses of exposed bedrock, talus slopes, and the town of Lukeville (Figure 18). Twenty-six map classes contain only one association, while the remaining four vegetated map classes contain two associations each (Table 4).

Four of the 34 final associations had accepted corollaries within the USNVC at the time of report preparation. This number is expected to increase in future years as the USNVC is refined and the inclusion of more data leads to new type descriptions. There were many similar associations documented within the USNVC, but they were either not great fits for our associations or lacked detailed descriptions rendering them impossible to compare to our detailed and data-based descriptions. The USNVC “Elcodes” or SODN placeholder codes (for currently unaccepted types) are shown in Table 5. Associations followed by a (P) indicate they are not currently in the USNVC but will be “proposed” for inclusion.

Following the overview map and legend (Figures 17 and 18) and detailed maps of the Bates Mountains, Ajo Mountains and Lukeville area (Figures 19–21) are one-page summaries of the 34 associations identified and mapped at Organ Pipe Cactus National Monument (ORPI) during this project. These summaries are abridged versions of the full association descriptions provided in Volume II of this report. Each summary briefly describes the floristic and structural characteristics of the vegetation and shows a representative photo of the association, a map displaying the distribution of each occurrence of the association across the park, an example of the aerial imagery for one polygon and finally, for types with narrower distributions, a park-wide map showing the area of the park it is found across. Readers may refer to the digital maps and databases accompanying this report for more detail.

All final products², including this report, Volume II of this report (Studd et al. 2025), keys to vegetation formations and the dichotomous key to community types, and the geodatabase, are available for download in NPS’s IRMA DataStore. Products can also be requested directly from SODN offices or accessed via [SODN’s Reports & Publications, Inventory and Assessments](#).

² Supplemental materials for this report, including Volume II of this report, are available in NPS’s IRMA DataStore: [Vegetation Mapping Inventory Project for Organ Pipe Cactus National Monument](#).

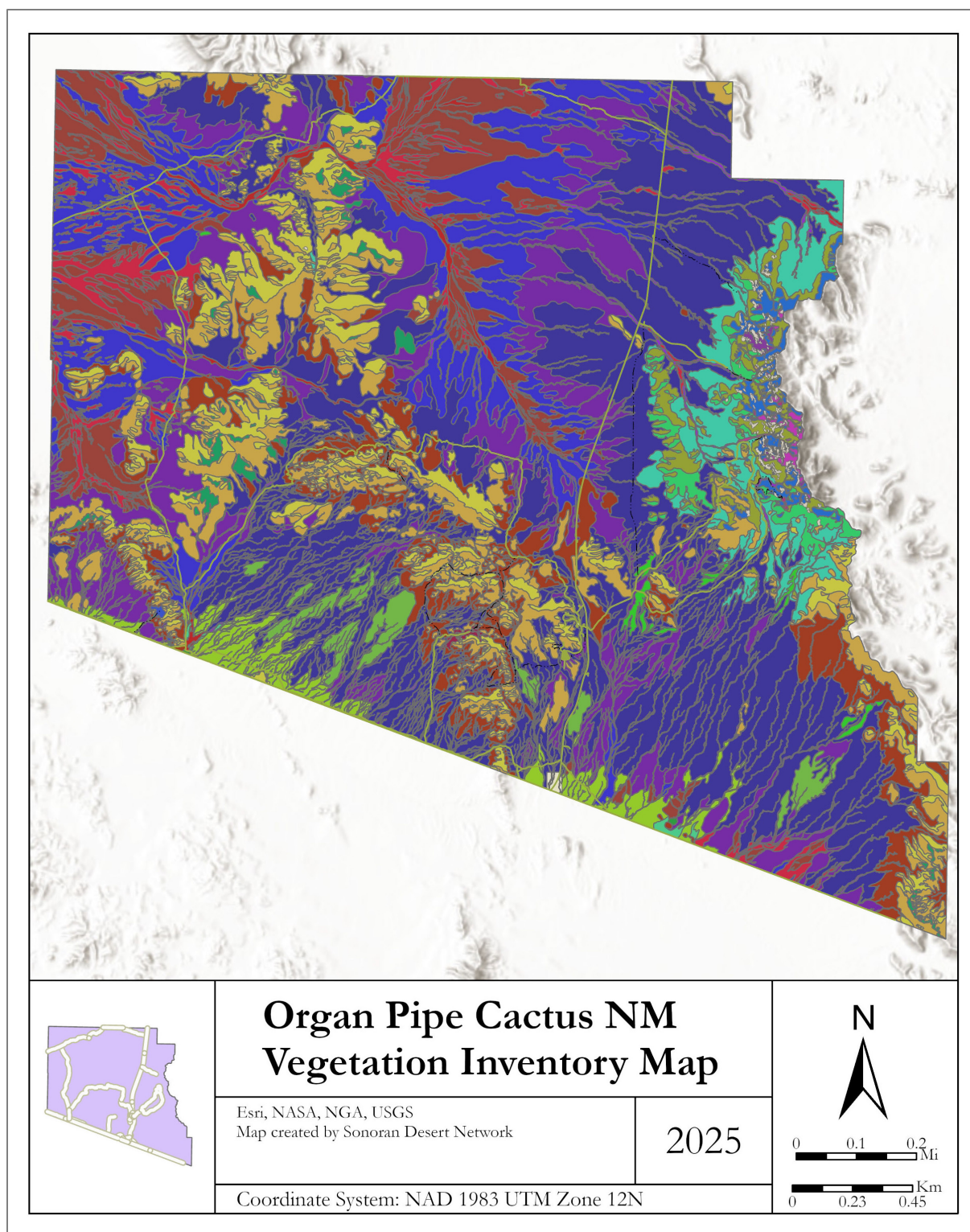


Figure 17. Organ Pipe National Monument vegetation map graphic showing the 34 vegetation associations that were mapped during the vegetation inventory. Each color represents a unique community, as shown in the legend in Figure 18 and listed in Table 5. Roads are shown as snaking yellow lines and are also visible in the smaller inset map.

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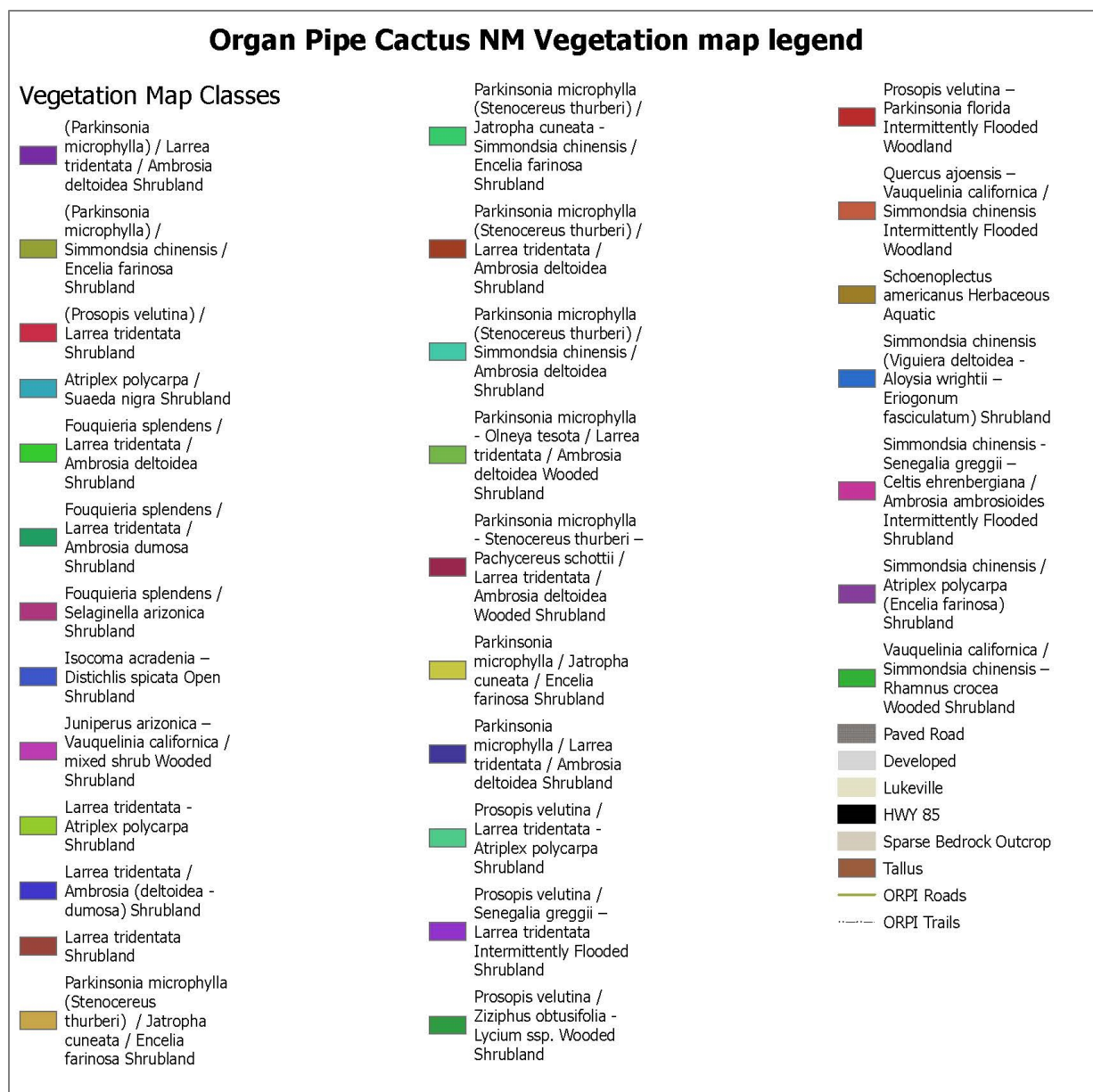


Figure 18. Map legend listing the 36 vegetation map classes shown in Figure 17.

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Table 5. Placement of the 34 vegetation associations within the U.S. National Vegetation Classification (USNVC), with macrogroup, group, and alliance levels shown where available. Alliances shown as “undescribed” indicate that the authors believe the association does fit ecologically under the group shown but that an alliance (and by extension the association beneath it) has not yet been formally described and accepted in the USNVC.

MACROGROUP	GROUP	ALLIANCE	ASSOCIATION	CODE
M010 Madrean Lowland Evergreen Woodland	G487 Madrean Juniper Open Woodland	Undescribed	(<i>Juniperus arizonica</i> – <i>Vauquelinia californica</i>) / Mixed Shrub Wooded Shrubland (P) Common name: (redberry Juniper – Arizona Rosewood) / Mixed Shrub Wooded Shrubland	NPSSODN200
	G487 Madrean Juniper Open Woodland	Undescribed	<i>Vauquelinia californica</i> / <i>Simmondsia chinensis</i> – <i>Rhamnus crocea</i> Wooded Shrubland (P) Common name: Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland	NPSSODN201
	G487 Madrean Juniper Open Woodland	Undescribed	<i>Quercus ajoensis</i> – <i>Vauquelinia californica</i> / <i>Simmondsia chinensis</i> Intermittently Flooded Woodland (P) Common name: Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland	NPSSODN203
M076 Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland	G533 North American Warm Desert Riparian Low Bosque & Shrubland	A3877 Honey Mesquite–Velvet Mesquite–Screwbean Mesquite Wet Scrub	<i>Prosopis velutina</i> / <i>Ziziphus obtusifolia</i> – <i>Lycium</i> spp. Wooded Shrubland (P) Common name: Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland	NPSSODN191
M082 Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G537 North American Desert Alkaline-Saline Wet Scrub	A3880 Mojave Seablite–Red Swampfire–Alkali Goldenbush Alkaline Wet Scrub	<i>Isocoma acradenia</i> – <i>Distichlis spicata</i> Open Shrubland (P) Common name: Alkali Goldenbush – Saltgrass Open Shrubland	NPSSODN193
M088–Mohave-Sonoran Semi-Desert Shrub	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3282 Saguaro–Yellow Paloverde–Velvet Mesquite Desert Scrub	(<i>Parkinsonia microphylla</i>) / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P) Common name: (Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland	NPSSODN183
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3282 Saguaro–Yellow Paloverde–Velvet Mesquite Desert Scrub	<i>Fouquieria splendens</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P) Common name: Ocotillo / Creosote / Triangle Bur Ragweed Shrubland	NPSSODN186
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3282 Saguaro–Yellow Paloverde–Velvet Mesquite Desert Scrub	<i>Parkinsonia microphylla</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P) Common name: Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland	NPSSODN184
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3282 Saguaro–Yellow Paloverde–Velvet Mesquite Desert Scrub	<i>Parkinsonia microphylla</i> – <i>Olneya tesota</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Wooded Shrubland (P) Common name: Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland	NPSSODN185
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	Undescribed	<i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P) Common name: Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland	NPSSODN194
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	Undescribed	<i>Parkinsonia microphylla</i> – <i>Stenocereus thurberi</i> – <i>Pachycereus schottii</i> / <i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Wooded Shrubland (P) Common name: Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland	NPSSODN195
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	Undescribed	<i>Fouquieria splendens</i> / <i>Selaginella arizonica</i> Shrubby Rock Outcrop (P) Common name: Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop	NPSSODN196
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	Undescribed	<i>Parkinsonia microphylla</i> / <i>Jatropha cuneata</i> / <i>Encelia farinosa</i> Shrubland (P) Common name: Yellow Paloverde / Physicnut / Brittlebush Shrubland	NPSSODN197
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	Undescribed	<i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Jatropha cuneata</i> / <i>Encelia farinosa</i> Shrubland (P) Common name: Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland	NPSSODN198
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	Undescribed	<i>Parkinsonia microphylla</i> / <i>Jatropha cuneata</i> (<i>Bursera microphylla</i>) / <i>Encelia farinosa</i> Shrubland (P) Common name: Yellow Paloverde / Physicnut (Elephant Tree) / Brittlebush Shrubland	NPSSODN199
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3283 Jojoba – Crucifixion thorn/Triangle-leaf bursage Desert Scrub	<i>Parkinsonia microphylla</i> / <i>Simmondsia chinensis</i> / <i>Ambrosia deltoidea</i> Shrubland (P) Common name: Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland	NPSSODN204
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3283 Jojoba – Crucifixion thorn/Triangle-leaf bursage Desert Scrub	<i>Simmondsia chinensis</i> (<i>Bahiopsis parishii</i> – <i>Aloysia wrightii</i> – <i>Eriogonum fasciculatum</i>) Shrubland (P) Common name: Jojoba (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland	NPSSODN205
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3283 Jojoba – Crucifixion thorn/Triangle-leaf bursage Desert Scrub	<i>Simmondsia chinensis</i> – <i>Atriplex polycarpa</i> (<i>Encelia farinosa</i>) Shrubland (P) Common name: Jojoba – Cattle Saltbush (Brittlebush) Shrubland	NPSSODN206

Table 5 (continued). Placement of the 34 vegetation associations within the U.S. National Vegetation Classification (USNVC), with macrogroup, group, and alliance levels shown where available. Alliances shown as “undescribed” indicate that the authors believe the association does fit ecologically under the group shown but that an alliance (and by extension the association beneath it) has not yet been formally described and accepted in the USNVC.

MACROGROUP	GROUP	ALLIANCE	ASSOCIATION	CODE
M088–Mohave-Sonoran Semi-Desert Shrub (continued)	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3283 Jojoba – Crucifixion thorn/Triangle-leaf bursage Desert Scrub	<i>Parkinsonia microphylla</i> (<i>Stenocereus thurberi</i>) / <i>Simmondsia chinensis</i> / <i>Encelia farinosa</i> Shrubland (P) Common name: Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland	NPSSODN207
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3283 Jojoba – Crucifixion thorn/Triangle-leaf bursage Desert Scrub	(<i>Parkinsonia microphylla</i>) <i>Fouquieria splendens</i> / <i>Simmondsia chinensis</i> (<i>Bursera microphylla</i>) / <i>Encelia farinosa</i> Shrubland (P) Common name: (Yellow Paloverde) Ocotillo / Jojoba (Elephant Tree) / Brittlebush Shrubland	NPSSODN208
	G293 Saguaro – Yellow Paloverde – Triangle Bur Ragweed Mixed Cacti Desert Scrub	A3283 Jojoba – Crucifixion thorn/Triangle-leaf bursage Desert Scrub	(<i>Parkinsonia microphylla</i>) / <i>Simmondsia chinensis</i> / <i>Encelia farinosa</i> Shrubland (P) Common name: (Yellow Paloverde) / Jojoba / Brittlebush Shrubland	NPSSODN209
	G295 Mojave-Sonoran Bajada & Valley Desert Scrub	A3277 Creosotebush – Burrobush Bajada & Valley Desert Scrub	<i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i> Shrubland (P) Common name: Creosote / Triangle Bur Ragweed Shrubland	NPSSODN182
	G295 Mojave-Sonoran Bajada & Valley Desert Scrub	A3277 Creosotebush – Burrobush Bajada & Valley Desert Scrub	<i>Larrea tridentata</i> / <i>Ambrosia dumosa</i> Shrubland Common name: Creosote / Burrobush Shrubland	CEGL002954
	G295 Mojave-Sonoran Bajada & Valley Desert Scrub	A3277 Creosotebush – Burrobush Bajada & Valley Desert Scrub	<i>Larrea tridentata</i> Shrubland Common name: Creosote Shrubland	CEGL001261
	G295 Mojave-Sonoran Bajada & Valley Desert Scrub	A3277 Creosotebush – Burrobush Bajada & Valley Desert Scrub	<i>Fouquieria splendens</i> / <i>Larrea tridentata</i> / <i>Ambrosia dumosa</i> Shrubland Common name: Ocotillo / Creosote / Burrobush Shrubland	CEGL005136
	G295 Mojave-Sonoran Bajada & Valley Desert Scrub	A3277 Creosotebush – Burrobush Bajada & Valley Desert Scrub	<i>Larrea tridentata</i> – <i>Atriplex polycarpa</i> Shrubland Common name: Creosote – Cattle Saltbush Shrubland	CEGL005765
	G295 Mojave-Sonoran Bajada & Valley Desert Scrub	A3277 Creosotebush – Burrobush Bajada & Valley Desert Scrub	<i>Atriplex polycarpa</i> – <i>Suaeda nigra</i> Shrubland (P) Common name: Cattle Saltbush – Mojave Seablite Shrubland	NPSSODN180
	G295 Mojave-Sonoran Bajada & Valley Desert Scrub	A3277 Creosotebush – Burrobush Bajada & Valley Desert Scrub	<i>Prosopis velutina</i> / <i>Larrea tridentata</i> – <i>Atriplex polycarpa</i> Floodplain (P) Common name: Velvet Mesquite / Creosote – Cattle Saltbush Floodplain	NPSSODN181
M092 North American Warm-Desert Xeric-Riparian Scrub	G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope	Undescribed	(<i>Prosopis velutina</i>) / <i>Larrea tridentata</i> / <i>Hilaria rigida</i> Shrubland (P) Common name: (Velvet Mesquite) / Creosote / Big Galleta Shrubland	NPSSODN187
	G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope	Undescribed	(<i>Prosopis velutina</i>) / <i>Larrea tridentata</i> Shrubland (P) Common name: (Velvet Mesquite) / Creosote Shrubland	NPSSODN188
	G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope	A4187 Catclaw Acacia – Desert-lavender – Beloperone Desert Wash Scrub	<i>Prosopis velutina</i> / <i>Senegalia greggii</i> – <i>Larrea tridentata</i> Intermittently Flooded Shrubland (P) Common name: Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland	NPSSODN189
	G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope	A0588 Blue Paloverde–Desert Ironwood Desert Wash Scrub	<i>Prosopis velutina</i> – <i>Parkinsonia florida</i> Intermittently Flooded Woodland (P) Common name: Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland	NPSSODN190
	G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope	Undescribed	<i>Simmondsia chinensis</i> – <i>Senegalia greggii</i> – <i>Celtis ehrenbergiana</i> / <i>Ambrosia ambrosioides</i> Intermittently Flooded Shrubland (P) Common name: Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland	NPSSODN202
M888 Arid West Interior Freshwater Marsh	G531 Arid West Interior Freshwater Marsh	A3895 Chairmaker’s Bulrush–Hardstem Bulrush–California Bulrush Marsh	<i>Schoenoplectus americanus</i> Herbaceous Aquatic (P) Common name: Chairmaker’s Bulrush Herbaceous Aquatic	NPSSODN192

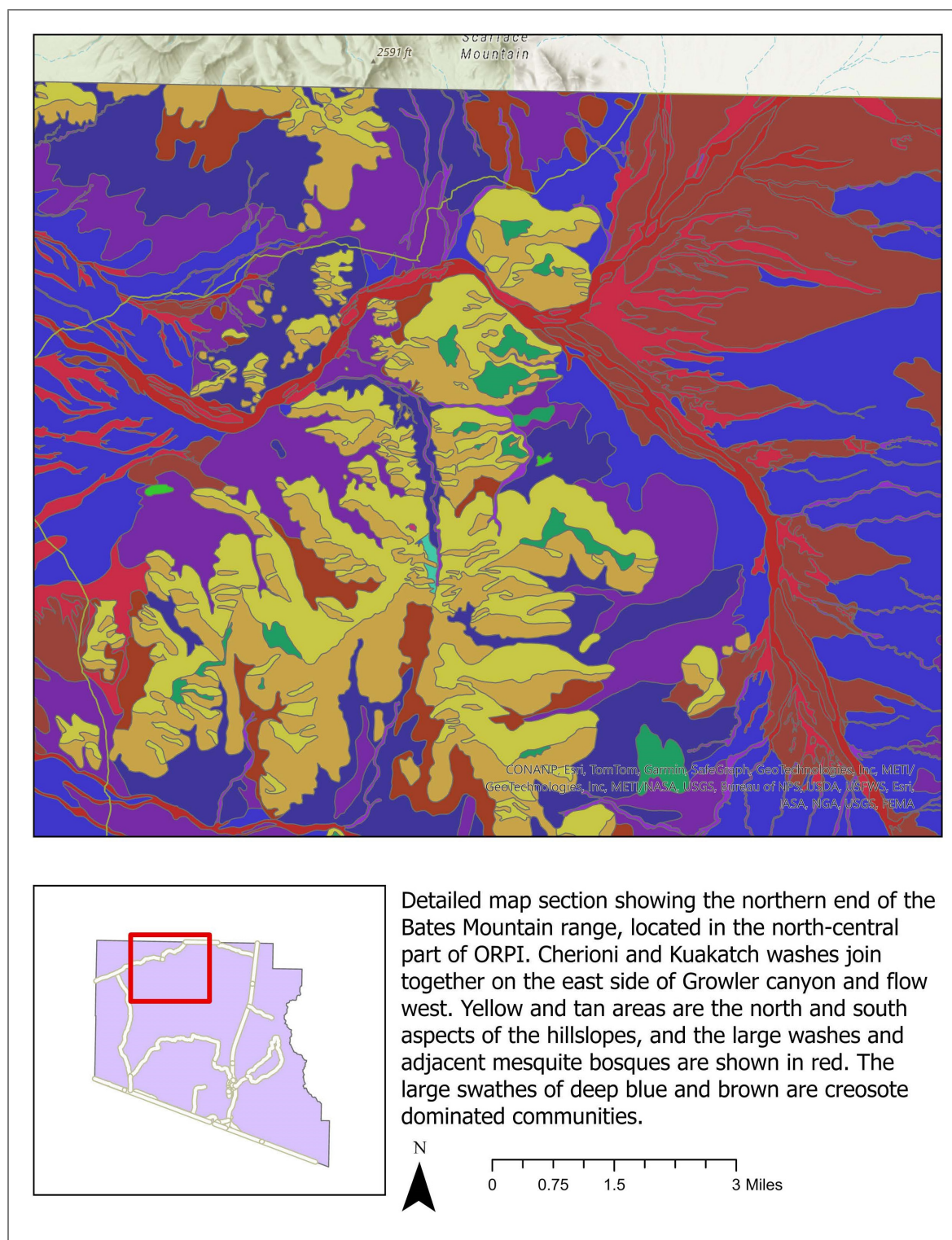


Figure 19. Detailed map of the northern extent of the Bates Mountain range at ORPI, and its surrounding areas. The different colors represent the various vegetation communities found in this area (Figure 18) The map shows two of the monument's major ephemeral washes, Kuakatch and Cherioni, as they run through the Growler Canyon.

NPS

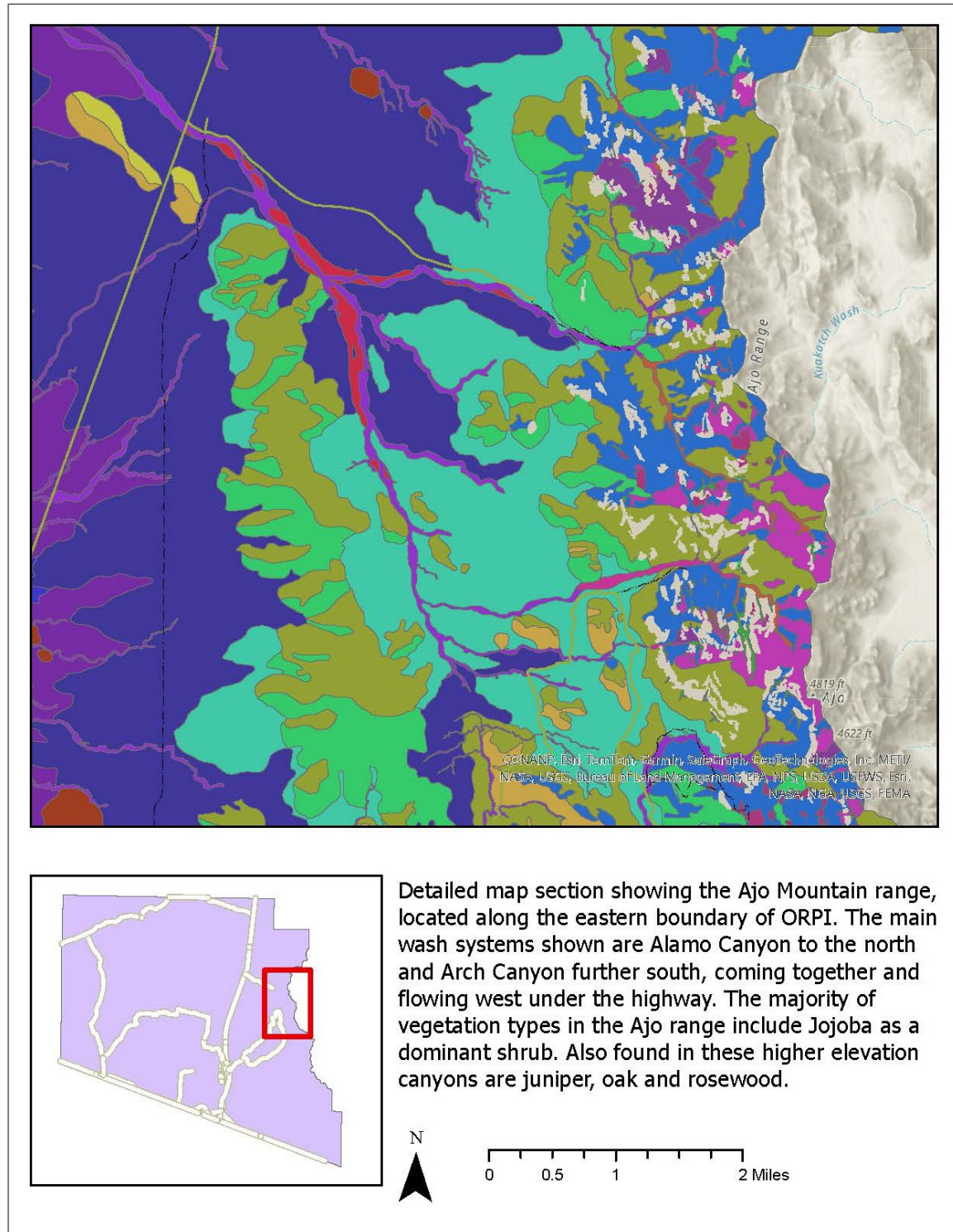


Figure 20. Detailed map of the Ajo Mountain range situated along the eastern boundary of ORPI. The different colors represent the various vegetation communities found in this area (Figure 18), with many in this area dominated by jojoba (*Simmondsia chinensis*). Alamo and Arch canyons, recognized by the snaking skinny purple and red lines in the center of the map, flow out of the Ajo Range and come together, ultimately flowing west into the bajada.

NPS

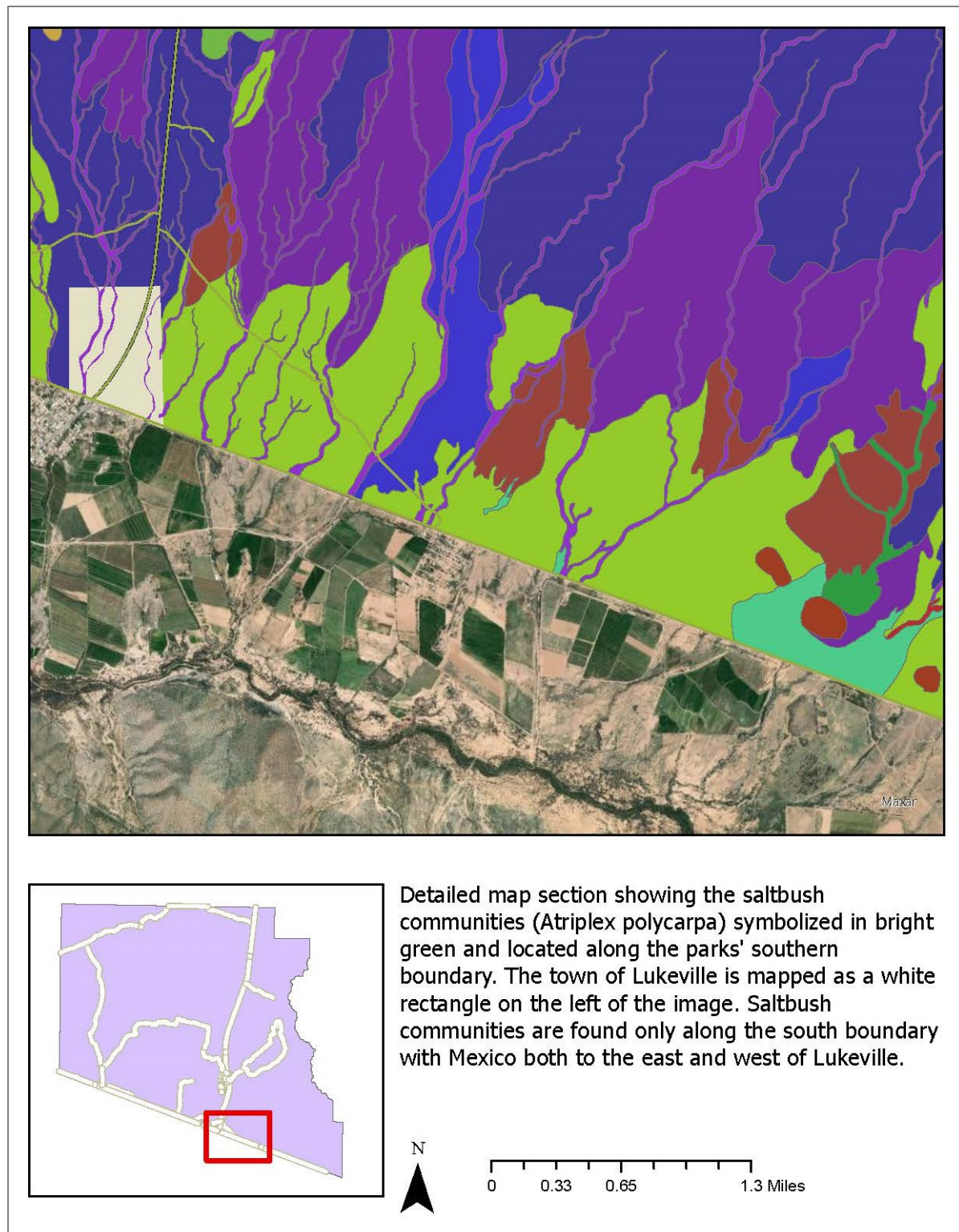


Figure 21. Detailed map of the creosote and saltbush dominated areas along the southern boundary of ORPI. The different colors represent the various vegetation communities found in this area (Figure 18), with the bright green representing the creosote and saltbush (*Atriplex polycarpa*) shrublands.

NPS

Chapter 5: Association Summaries

1. (*Juniperus arizonica* – *Vauquelinia californica*) / Mixed Shrub Wooded Shrubland Association (P)

(Redberry Juniper – Arizona Rosewood) / Mixed Shrub Wooded Shrubland Association

This community is characterized by an open (10 [30]%) canopy (>2 m) of *Juniperus arizonica* (redberry juniper) and *Vauquelinia californica* (Arizona rosewood) with a variable and diverse understory of shrubs, subshrubs, and perennial bunch grasses.

J. arizonica (redberry juniper) is a consistent (1.0) and diagnostic component of this community, which provides an average of 5% cover across the community, with some areas reaching up to 10%. *V. californica* (Arizona rosewood) is a less consistent (0.86) component that, when present provides slightly higher average cover (6–7%) than *J. arizonica* (redberry juniper). The sub-canopy stratum (0.5–2 m) contains two distinct variations defined by the understory species composition. At lower elevations and on steep slopes, *S. chinensis* (jojoba) may provide cover approaching or exceeding that of the trees, with an average around 8%. Conversely, at the upper end of the elevational range of this community and on lower-angle ridges and summits, *S. chinensis* (jojoba) is often sparse (1%) to absent. The variable (5–25%) field layer is characterized by a mix of perennial grasses and subshrubs. The most abundant species in this stratum include *Bouteloua curtipendula* (sideoats grama), *Muhlenbergia porteri* (bush muhly), and *Bahiopsis parishii* (Parish's goldeneye).

This wooded shrubland community covers about 0.17% (234 ha, 575 ac) of Organ Pipe Cactus National Monument (ORPI), exclusively in the Ajo Mountains. In this area the community spans a mix of steep (35–50+%) backslopes and lower-angle (<20%) ridges and summits from 900 to 1,400 m (2,952–4,593 ft). While this community can be found on any aspect, most examples tend to have north-trending slopes.

Common Species: *Juniperus arizonica*, *Vauquelinia californica*, *Simmondsia chinensis*, *Bouteloua curtipendula*, *Muhlenbergia porteri*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 22–25.



Figure 22. An example landscape photo showing the (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.

NPS

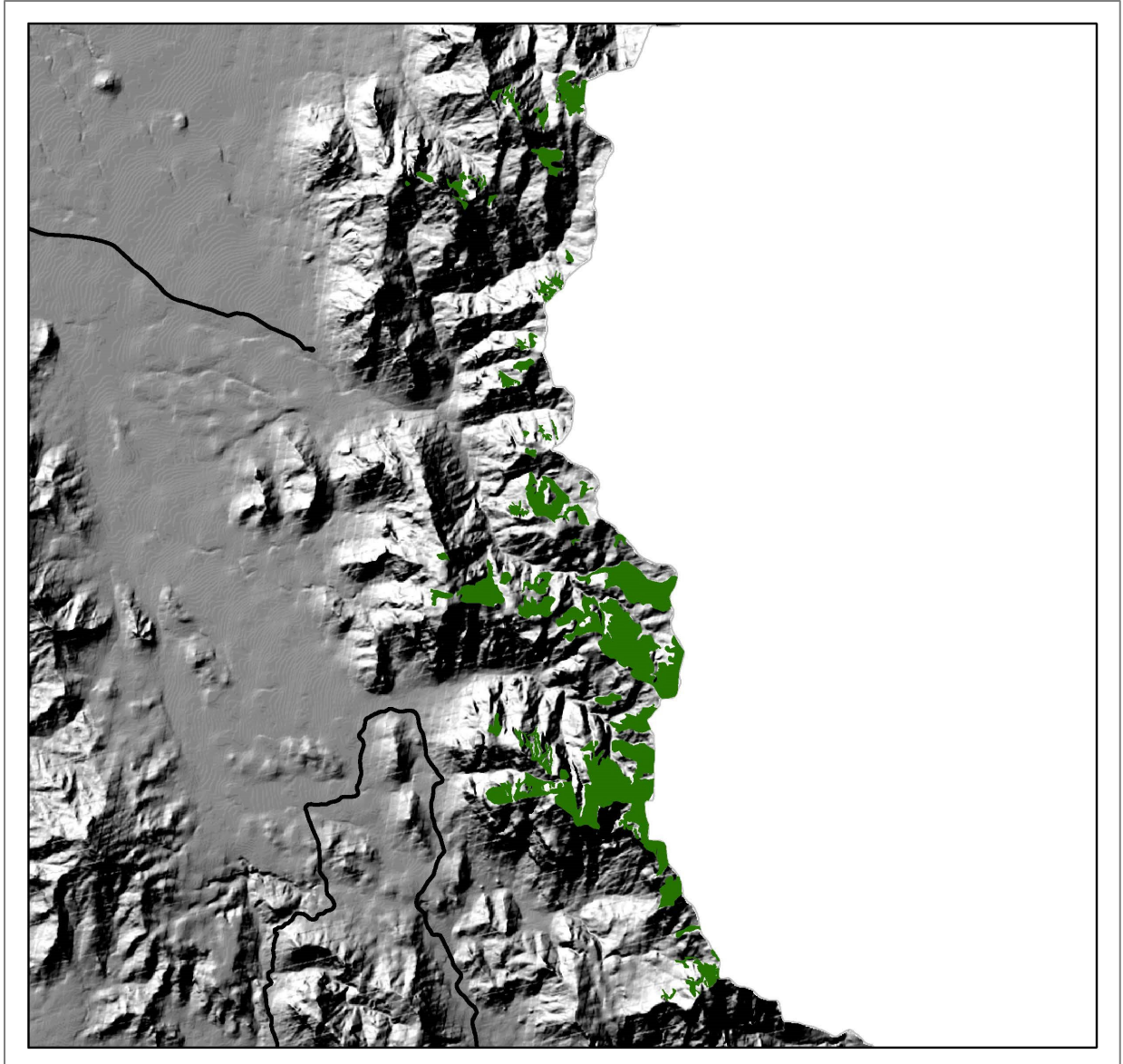


Figure 23. A distribution map, showing in green all areas mapped as (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.

NPS

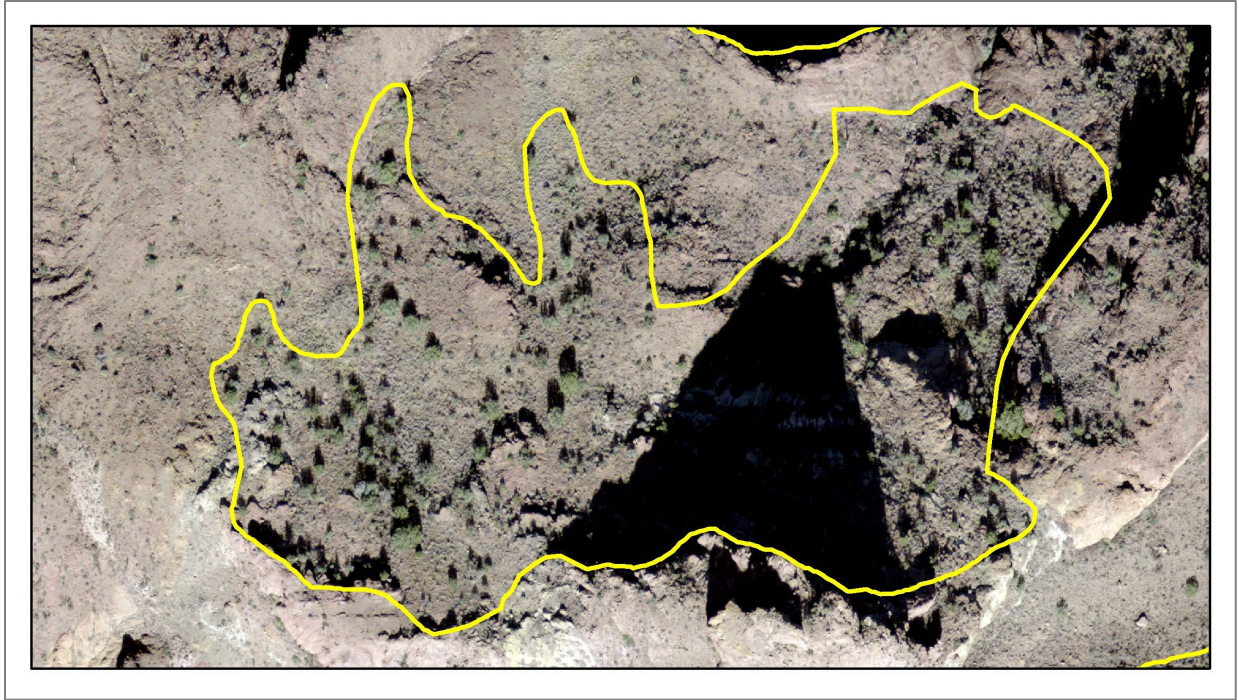


Figure 24. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.
NPS

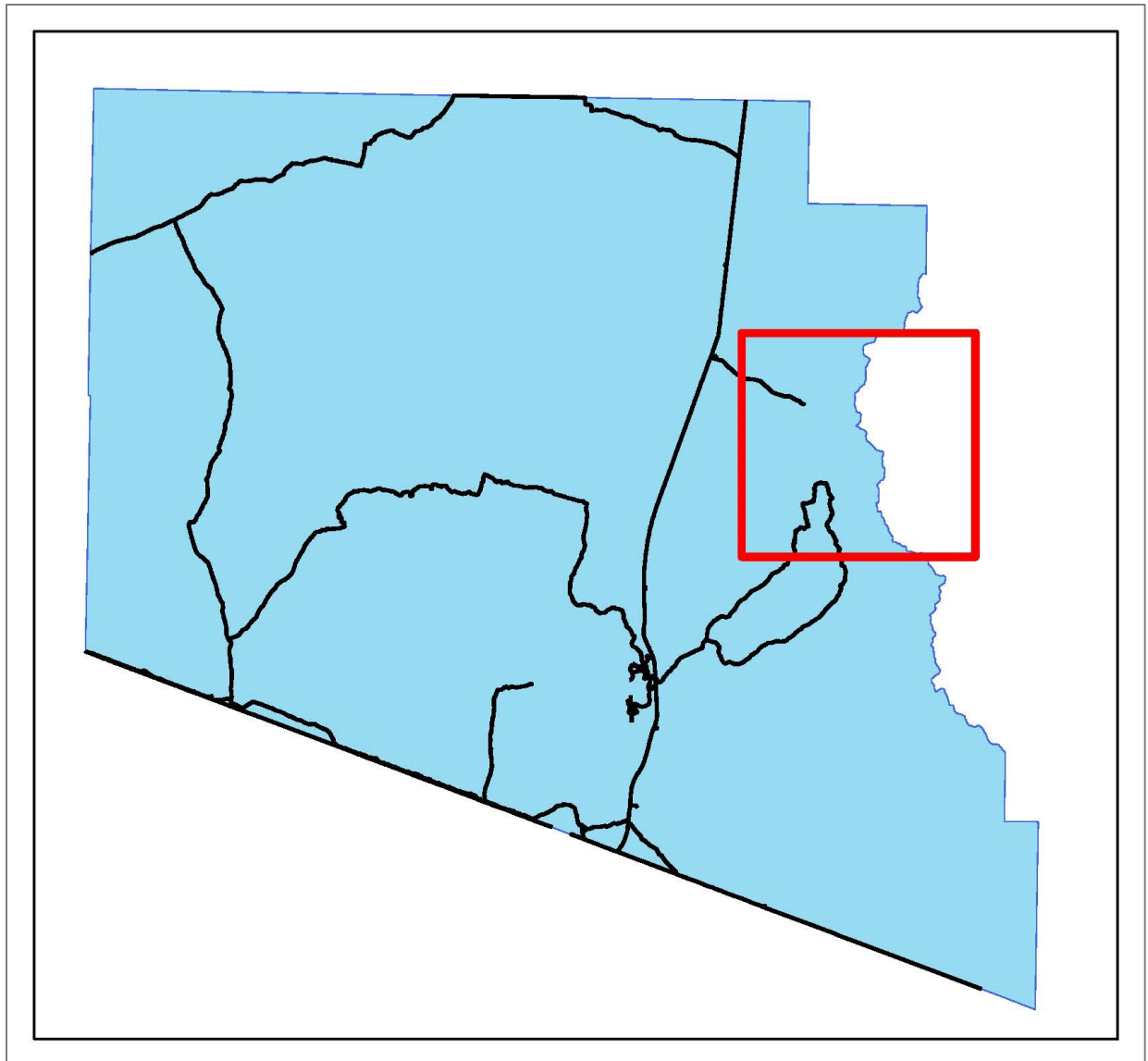


Figure 25. Map of ORPI with bounding box around the regions mapped and classified as (redberry juniper – Arizona rosewood) / Mixed Shrub Wooded Shrubland Association.

NPS

2. *Vauquelinia californica* / *Simmondsia chinensis* – *Rhamnus crocea* Wooded Shrubland Association (P)

***Arizona Rosewood* / *Jojoba* – *Redberry Buckthorn* Wooded Shrubland Association**

This community is characterized by a moderately open (15–20%) canopy (>2 m) of *Vauquelinia californica* (Arizona rosewood) with a denser (20–40%) sub-canopy (0.5–2 m) of mixed shrubs, most commonly dominated by *Simmondsia chinensis* (jojoba) and *Rhamnus crocea* (redberry buckthorn).

Vauquelinia californica (Arizona rosewood) is a consistent (1.0), small (3–4 [5] m) canopy tree that provides cover from 10 to 20%. Cover of this species can be distributed throughout the community but will often form dense stands in the most sheltered locations along the base of the outcrops. *Celtis reticulata* (netleaf hackberry) is a common (0.75) associate with cover rarely surpassing 5%. *S. chinensis* (jojoba) and *R. crocea* (redberry buckthorn) are consistent (1.0) sub-canopy dominants that, on average, contribute around 6% cover each. A number of additional sub-canopy species occur that are restricted to this community including, *Salvia pinguifolia* (rock sage), *Ribes quercetorum* (rock gooseberry), *Ptelea trifoliata* (hoptree), *Berberis harrisoniana* (Harrison's barberry), and *Keckiella antirrhinoides* (snapdragon penstemon). The sparse (<10%) field layer is characterized by a mix of perennial grasses and subshrubs without any consistent dominants or common associates.

This wooded shrubland community covers about 0.02% (20 ha, 50 ac) of ORPI, exclusively in the Ajo Mountains. It occupies north-trending, sheltered corridors between large outcrops of exposed bedrock from 990–1,300 m (2,952–4,271 ft). These corridors typically occur on the upper backslopes and shoulders of mountain slopes throughout the range. Slope varies greatly, ranging from low-angle (<10%) to extremely steep (50+%) areas covered in loose rocks. The surface cover is dominated by exposed bedrock, loose rocks, and boulders often covered with a dense litter layer.

Common Species: *Vauquelinia californica*, *Simmondsia chinensis*, *Rhamnus crocea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 26–29.



Figure 26. An example landscape photo showing the Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.

NPS

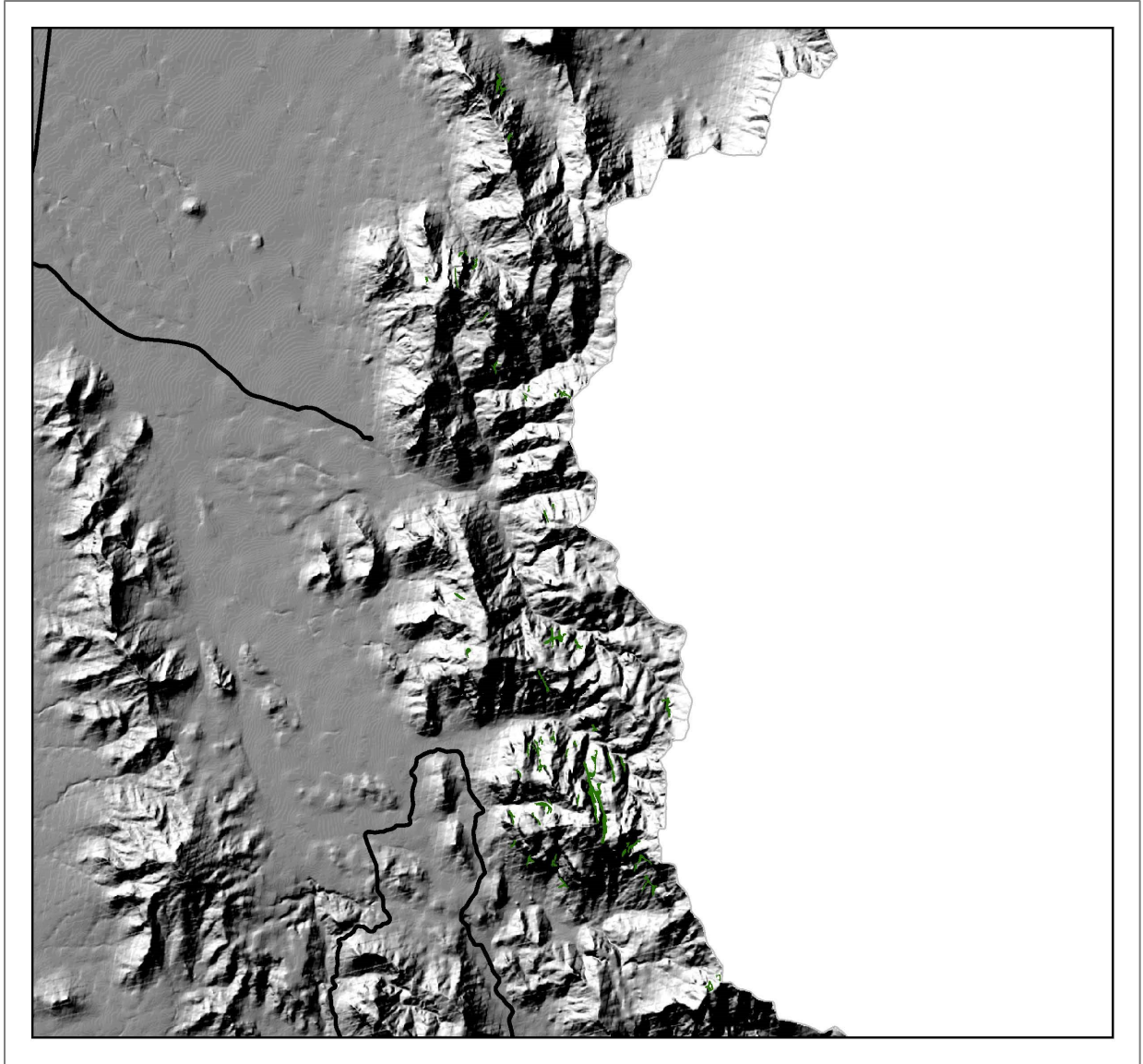


Figure 27. A distribution map, showing in green all areas mapped as Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.

NPS

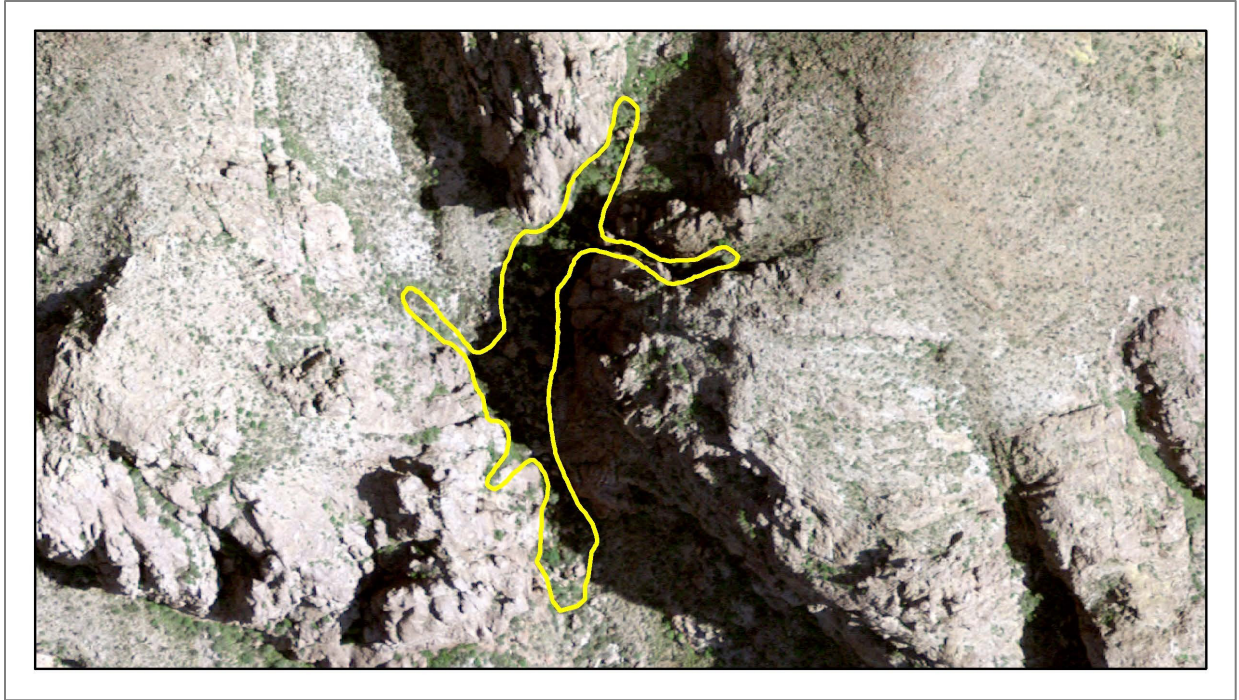


Figure 28. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.

NPS

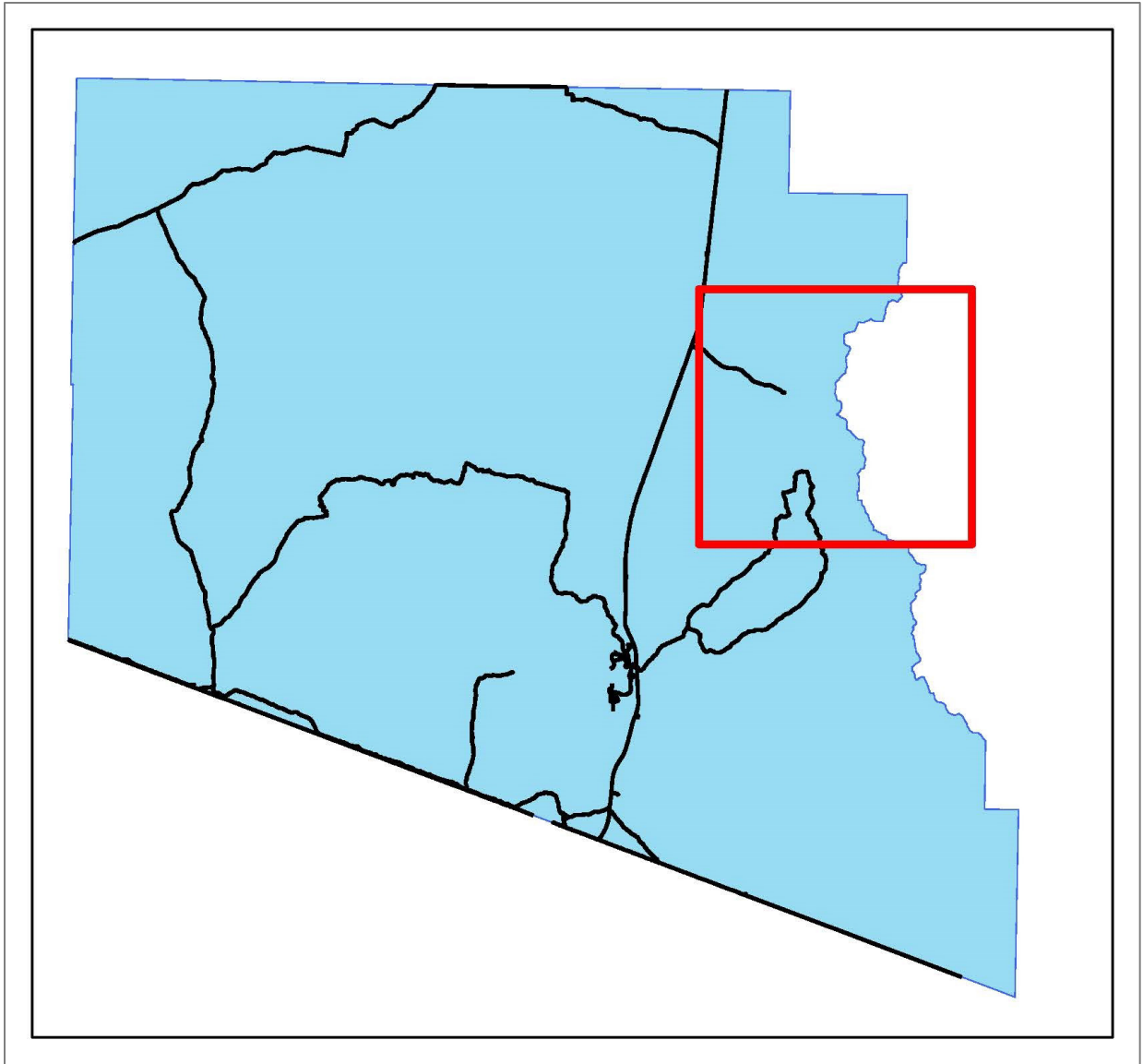


Figure 29. Map of ORPI with bounding box around the regions mapped and classified as Arizona Rosewood / Jojoba – Redberry Buckthorn Wooded Shrubland Association.

NPS

3. *Quercus ajoensis* – *Vauquelinia californica* / *Simmondsia chinensis* Intermittently Flooded Woodland Association (P)

Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association

This intermittently flooded woodland is characterized by variable ([10] 20–40%) canopy (>2 m) dominated by *Quercus ajoensis* (Ajo Mountain scrub oak) and *Vauquelinia californica* (Arizona rosewood) with a variable (5–20%) sub-canopy (0.5–2 m) of mixed shrubs, most commonly dominated by *Simmondsia chinensis* (jojoba). This community typically occupies the upper reaches of mountain drainages, above the adjacent shrub dominated associations.

Q. ajoensis (Ajo Mountain scrub oak) is present in two forms, a tall (4–5 [6] m), single-trunk tree and small ([1] 2–3 m) shrubs. Across both growth forms, this species provides cover that typically ranges from [5] 10–20%. Distribution of this cover can be variable with open areas of patchy trees to dense, impenetrable thickets. *Vauquelinia californica* (Arizona rosewood) is a consistent (0.85) associate sub-dominant to *Q. ajoensis* (Ajo mountain scrub oak) with cover typically ranging from 5–10 [15]%. *Juniperus arizonica* (redberry juniper) is an occasional (0.57) associate that, when present, typically provides cover around 5% with heights reaching above 5 m. *Simmondsia chinensis* (jojoba) is consistent (0.86) associate that is dominant in about half of the examples of this community. When present as an associate, this species provides cover below 5%, and between 10–20% when dominant. Distribution of this species is patchy, often appearing as dense thickets along the margins of the drainages. The sparse (<5%) field stratum (<0.5 m) is characterized by a mix of low-cover shrubs without any consistent dominants or common associates.

This intermittently flooded woodland community covers about 0.02% (25 ha, 61 ac) of ORPI, exclusively in the Ajo Mountains. It spans low-angle (<10%) drainages and the steeper (30–50%), adjacent slopes from 730–1,180 m (2,395–3,871 ft). The surface cover is dominated by a mix of coarse gravel, cobble, and large boulders with consistent areas of exposed bedrock.

Common Species: *Quercus ajoensis*, *Vauquelinia californica*, *Simmondsia chinensis*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 30–33.



Figure 30. An example landscape photo showing the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.

NPS

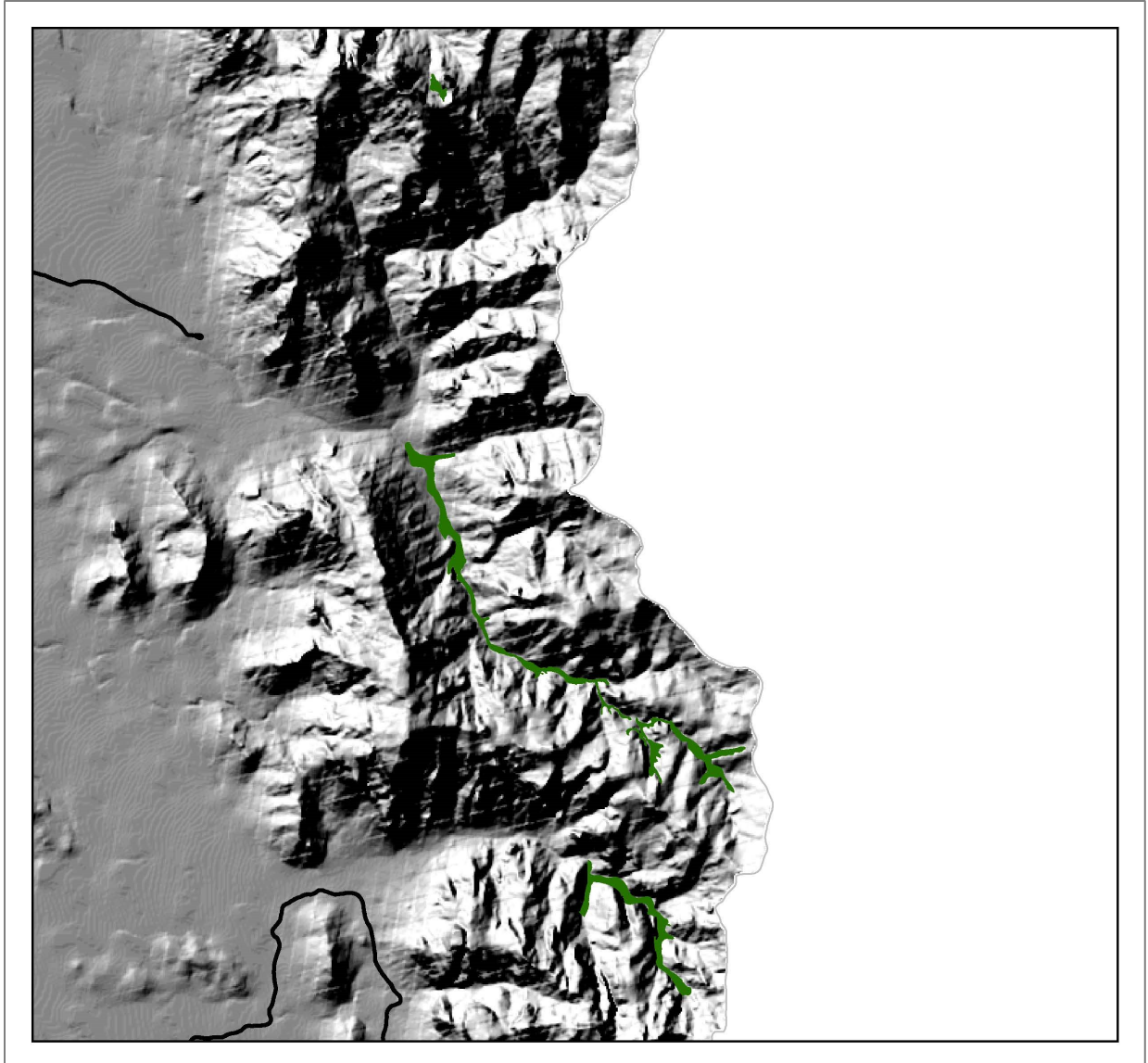


Figure 31. A distribution map, showing in green all areas mapped as the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.

NPS

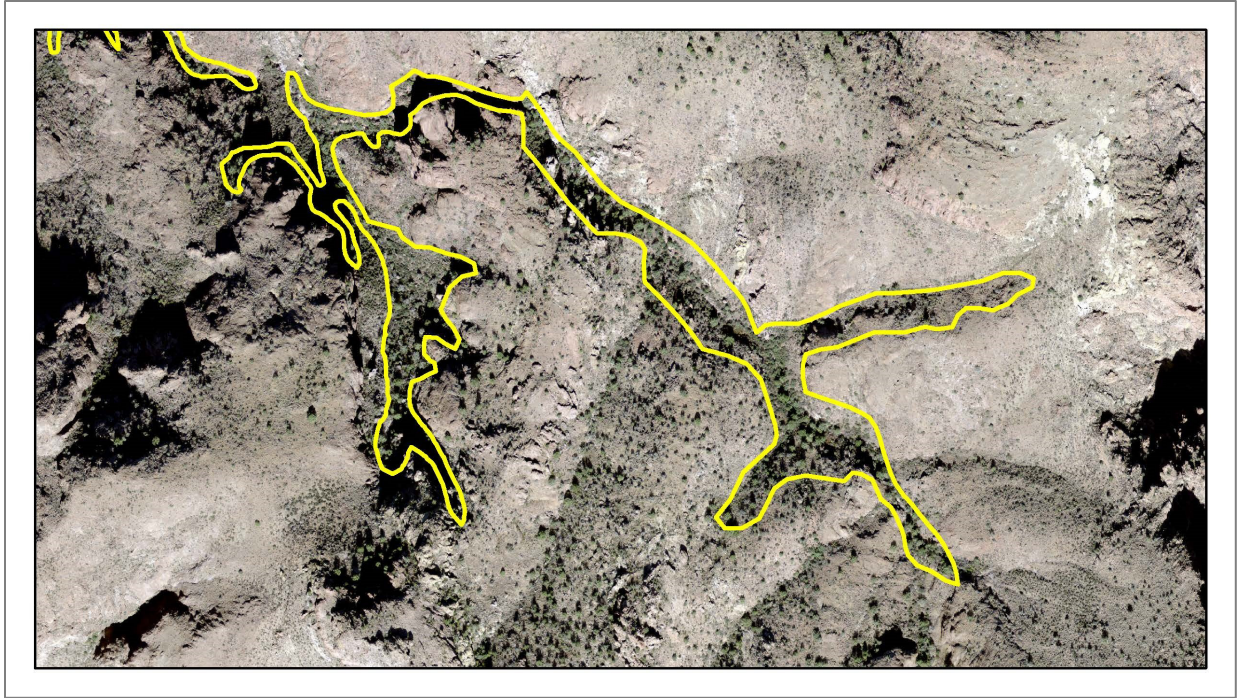


Figure 32. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.

NPS

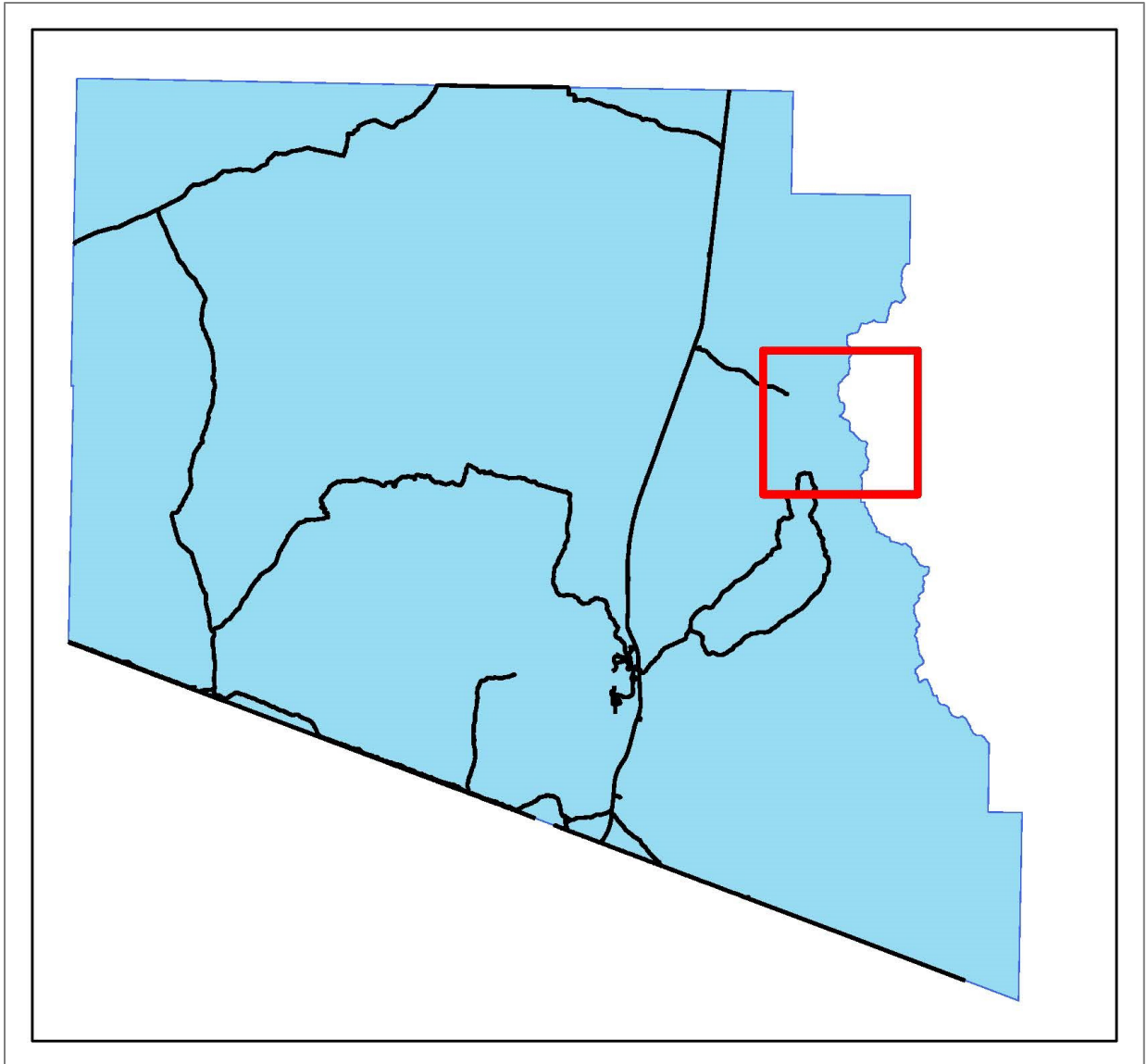


Figure 33. Map of ORPI with bounding box around the regions mapped and classified as the Ajo Mountain Scrub Oak – Arizona Rosewood / Jojoba Intermittently Flooded Woodland Association.
NPS

4. *Prosopis velutina* / *Ziziphus obtusifolia* – *Lycium* spp. Wooded Shrubland Association (P)

***Velvet Mesquite* / *Lotebush* – *Desert-Thorn* Wooded Shrubland Association**

This wooded shrubland is characterized by a variable (20–30 [40]%) canopy (>2 m) of *Prosopis velutina* (velvet mesquite) with an understory of mixed shrubs. This community is often intermixed with the adjacent *Isocoma acradenia* (alkali goldenbush) – *Distichlis spicata* (saltgrass) shrubland.

P. velutina (velvet mesquite) is a consistent (1.0) canopy (>2 m) dominant that provides cover that ranges from 15 to 30% with one dense inclusion up to 40%. The variable (10–25%) sub-canopy (0.5–2 m) stratum is characterized by a mix of shrubs, often dominated by *Z. obtusifolia* (lotebush) and *Lycium* spp. (desert-thorn). *Z. obtusifolia* (lotebush) is a consistent (0.75) shrub species with cover that ranges from 3–6%. *Lycium* spp. (desert-thorn) is another consistent (0.88) shrub with average cover around 4% with some areas reaching up to 6%. The sparse (1–3%) field stratum (<0.5 m) is characterized by the low cover (1%) presence of *Isocoma acradenia* (alkali goldenbush) and *Distichlis spicata* (saltgrass). The dominance of these species defines the adjacent *I. acradenia* (alkali goldenbush) – *D. spicata* (saltgrass) shrubland community. They should never outcompete the shrubs and trees but may become more prevalent in the ecotone between the two communities.

This wooded shrubland community covers about 0.07% (89 ha, 220 ac) of ORPI, mainly in the vicinity of Quitobaquito Spring. It occurs on low-angle (<5 [15]%) south-trending slopes from 320–350 m (1,050–1,150 ft). The surface cover is characterized by shallow and well-drained soils with a notable, but shallow layer of leaf litter.

Common Species: *Prosopis velutina*, *Ziziphus obtusifolia*, *Lycium* spp.

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 34–37.



Figure 34. An example landscape photo showing the Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.

NPS

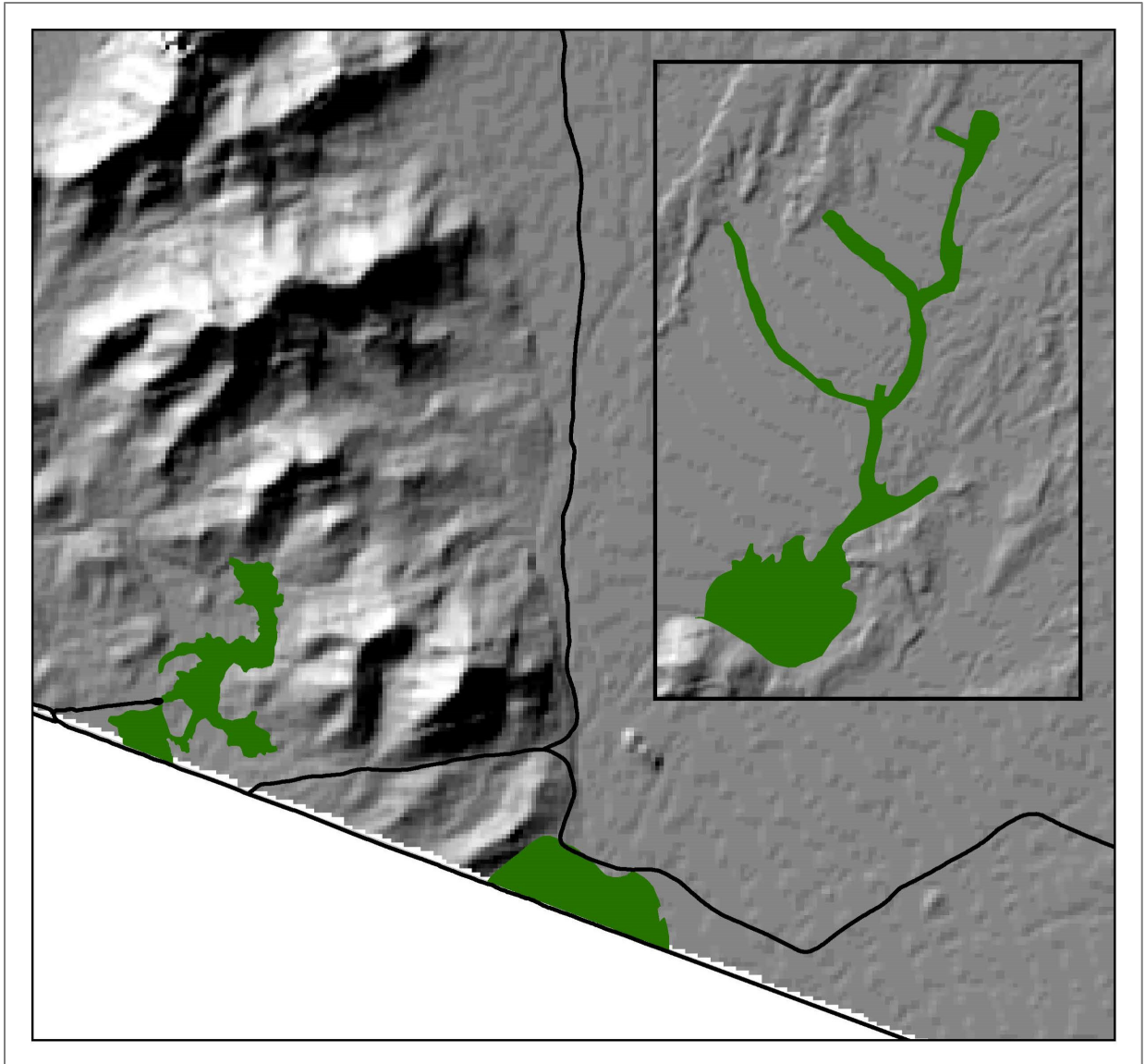


Figure 35. A distribution map, showing in green all areas mapped as Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.

NPS

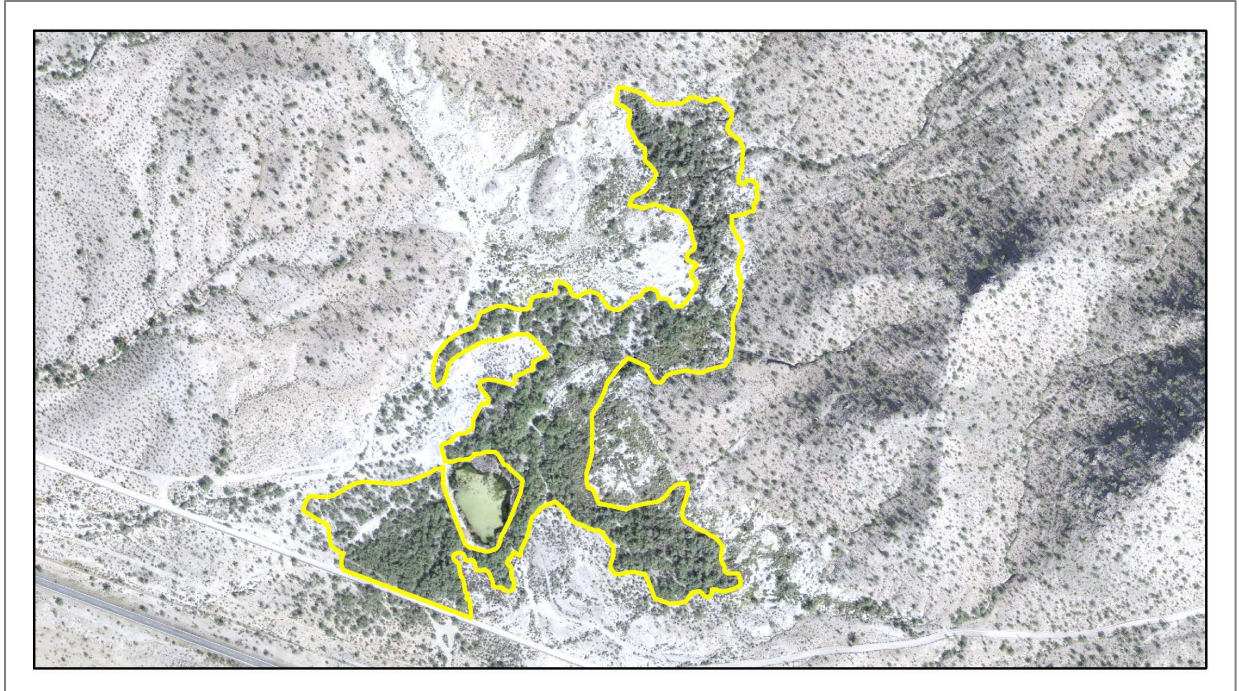


Figure 36. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.

NPS

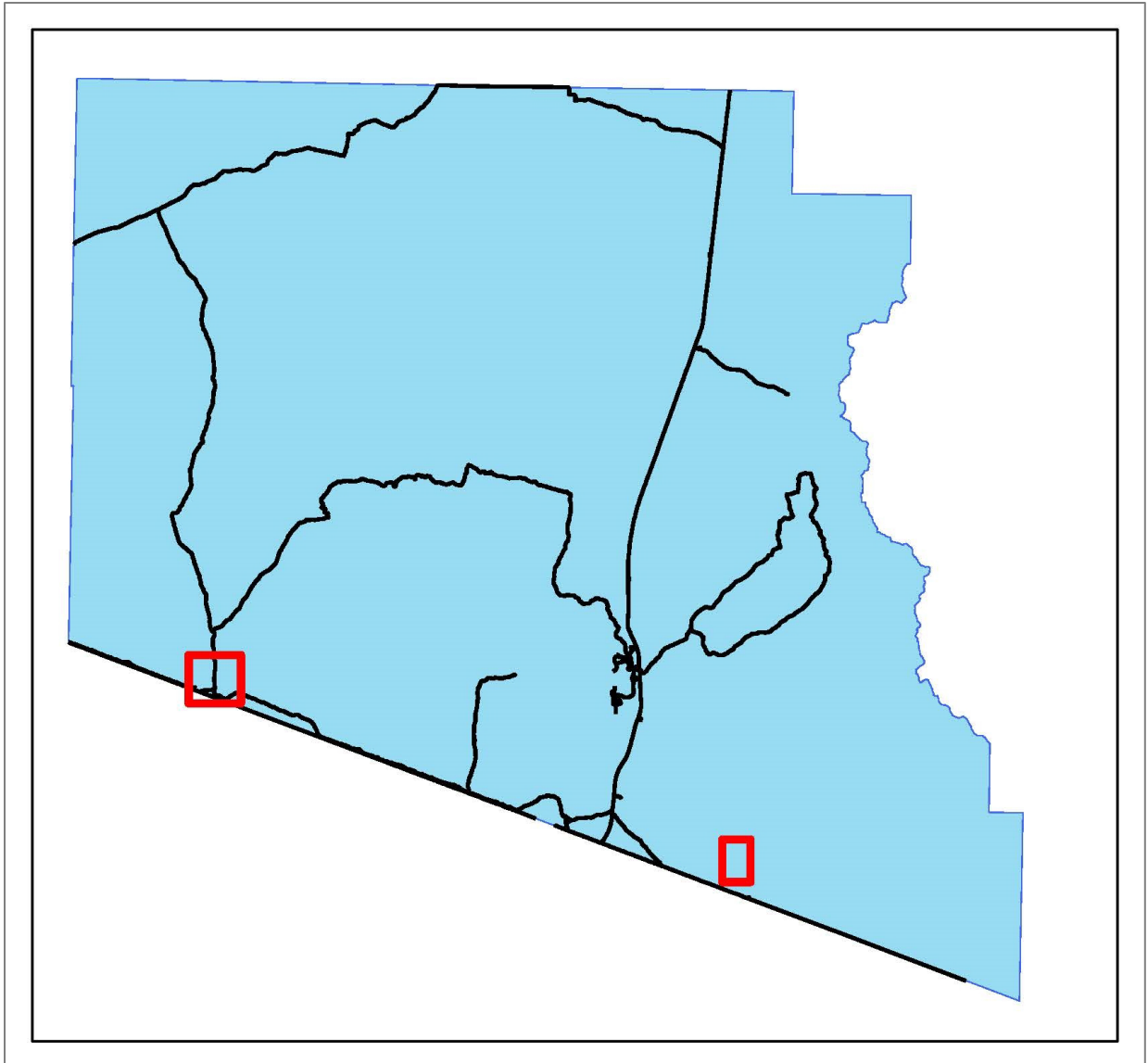


Figure 37. Map of ORPI with bounding box around the regions mapped and classified as the Velvet Mesquite / Lotebush – Desert-thorn Wooded Shrubland Association.

NPS

5. *Isocoma acradenia* – *Distichlis spicata* Open Shrubland Association (P)

Alkali Goldenbush – Saltgrass Open Shrubland Association

This shrubland community is characterized by an open (5%) to absent overstory (>2 m) with a variable (15–20 [40]%) understory stratum (<2 m) dominated by *Isocoma acradenia* (alkali goldenbush) and *Distichlis spicata* (saltgrass).

When present (0.67), cover in the canopy strata (>2 m) is typically composed of *Prosopis velutina* (velvet mesquite) with occasional *Olneya tesota* (ironwood). The sub-canopy stratum (<0.5–2 m) is characterized by a sparse (<5%) mix of shrubs with no consistent dominants or common associates. *I. acradenia* (alkali goldenbush) and *D. spicata* (saltgrass) are consistent (1.0, 0.83) and diagnostic components in the field stratum (<0.5 m) with either or both species always dominant. *I. acradenia* (alkali goldenbush) is the most commonly dominant species with average cover around 15% with some dense inclusions reaching above 30%. *D. spicata* (saltgrass) ranges from a patchy, low cover associate generating between 1 and 2% cover to a dominant species providing 5–10% cover. A very sparsely vegetated variation of this community can be found intermixed with the more representative example described above. In this variation, species composition is similar while overall perennial cover is greatly reduced to under 5%. Seasonally, the annual forb *Wislizenia refracta* (spectacle fruit) can provide dominance with cover up to 20%.

This shrubland community covers about 0.02% (32 ha, 79 ac) of ORPI, exclusively in the vicinity of Quitobaquito and Williams Springs. This open shrubland community spans low-angle (<5%) south-trending slopes from 320–350 m (1,050–1,150 ft). The surface cover is dominated by shallow, well-drained soils that tend to be somewhat alkaline.

Common Species: *Isocoma acradenia*, *Distichlis spicata*, *Prosopis velutina*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 38–41.



Figure 38. An example landscape photo showing the Alkali Goldenbush – Saltgrass Open Shrubland Association.

NPS

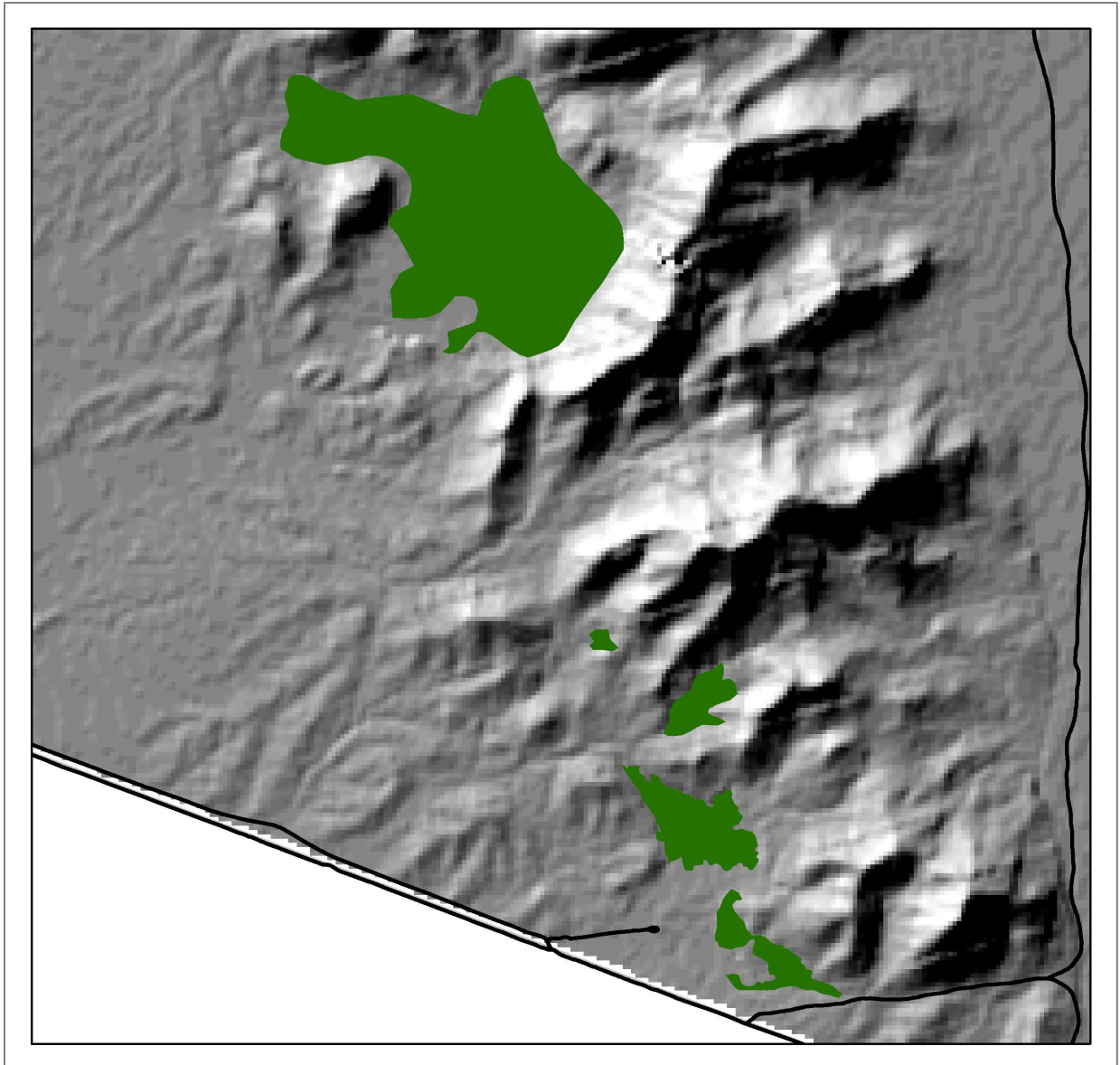


Figure 39. A distribution map, showing in green all areas mapped as Alkali Goldenbush – Saltgrass Open Shrubland Association.

NPS

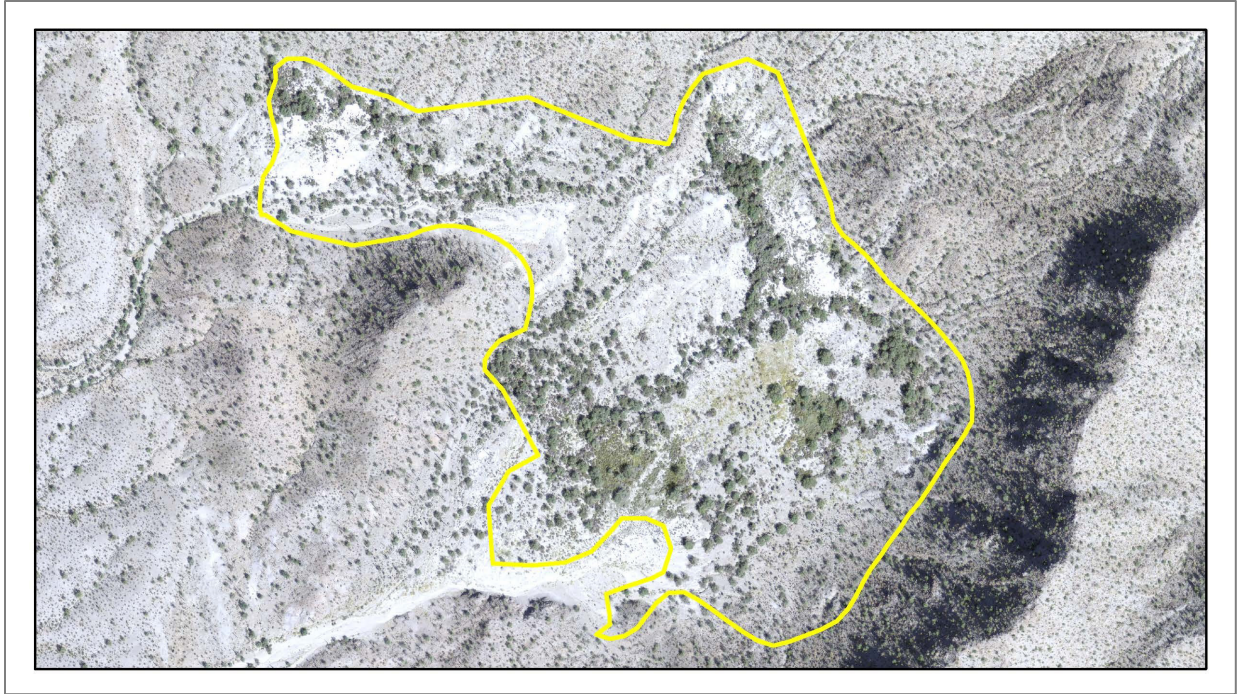


Figure 40. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Alkali Goldenbush – Saltgrass Open Shrubland Association.

NPS

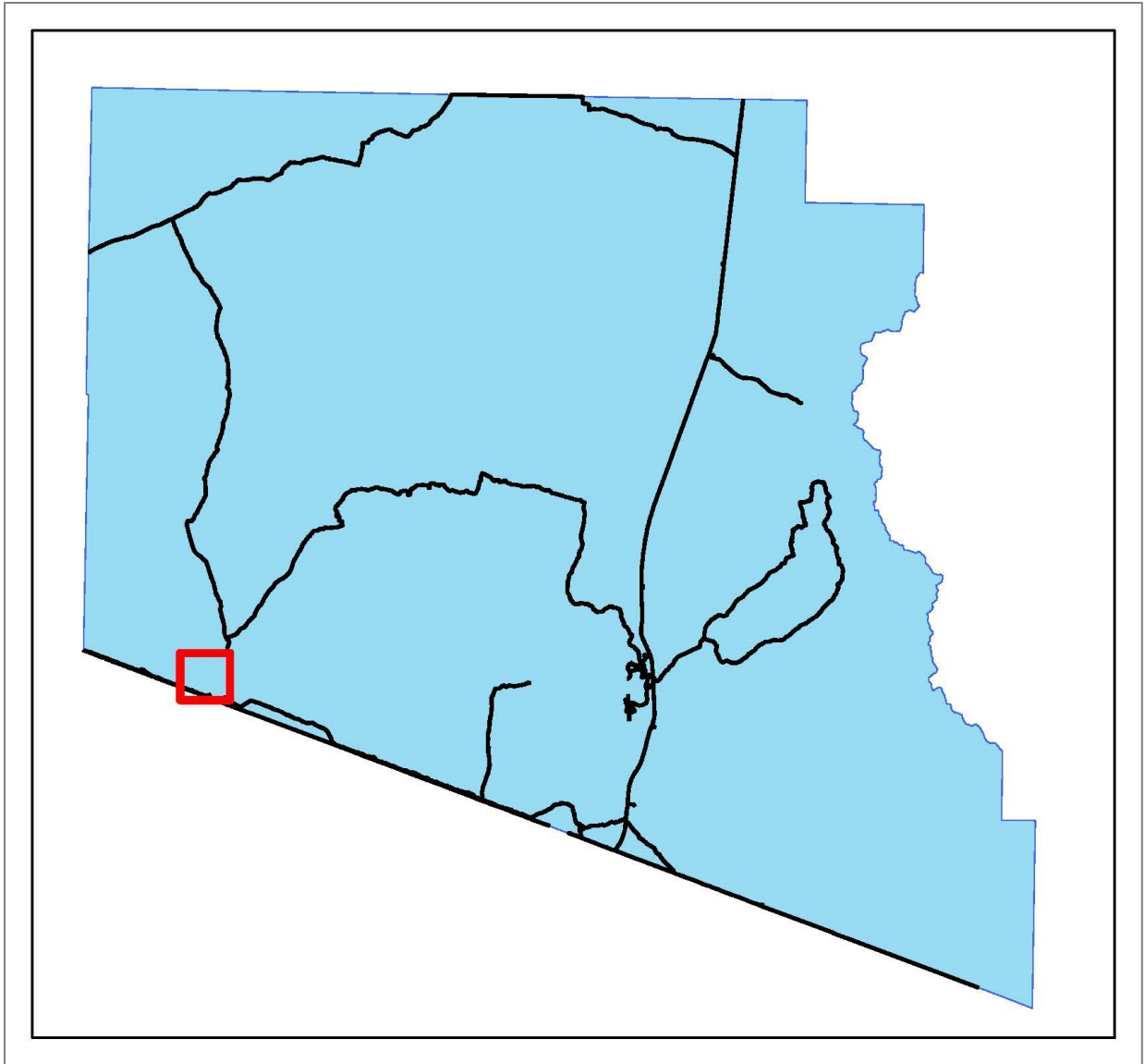


Figure 41. Map of ORPI with bounding box around the regions mapped and classified as the Alkali Goldenbush – Saltgrass Open Shrubland Association.

NPS

6. (*Parkinsonia microphylla*) / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland Association (P)

(Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association

This shrubland community is characterized by a very open (<5%) canopy (>2 m) of yellow paloverde (*Parkinsonia microphylla*) with a sub-canopy (0.5–2 m) dominated by *Larrea tridentata* (creosote) and a field stratum (<0.5 m) by *Ambrosia deltoidea* (triangle bur ragweed). This shrubland occupies the habitat between the similar *Larrea tridentata* / *Ambrosia deltoidea* shrubland, an adjacent lower-bajada community, and the upper bajada *Parkinsonia microphylla* / *Larrea tridentata* / *Ambrosia deltoidea* shrubland.

Species in the canopy strata (>2 m) are sparse (<5%) to locally absent with *Parkinsonia microphylla* (yellow paloverde) providing the most consistent cover. If present, saguaro (*Carnegiea gigantea*) provides trivial cover (<1%). *Larrea tridentata* (creosote) is the sole sub-canopy dominant, providing cover that ranges from sparsely vegetated expanses with 5% or less to dense shrublands with 20+%. Two succulents, *Cylindropuntia fulgida* (jumping cholla) and *Cylindropuntia acanthocarpa* (buckhorn cholla), can occasionally (0.48, 0.48) provide inclusions of low cover (up to 3%). The sparse field stratum is characterized by the sole dominance of *Ambrosia deltoidea* (triangle bur ragweed). Providing an average of 4% cover, this species accounts for 20% of the total cover recorded in this community. *Krameria bicolor* (white ratany) is a consistent (0.78) associate that typically contributes 1–2% cover.

This shrubland community covers about 11.7% (15,629 ha, 38,620 ac) of ORPI and is widespread throughout the middle bajada. This shrubland community spans low-angle (<5%), middle bajadas of any aspect from 300–600 m (984–1,968 ft) elevation. The dominant soil consists of very deep, somewhat excessively drained alluvium, mainly of the Growler and Antho series. The alluvium can present as fine and sandy or can be dominated by fine to coarse gravel.

Common Species: *Parkinsonia microphylla*, *Larrea tridentata*, *Ambrosia deltoidea*, *Krameria bicolor*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 42–44.



Figure 42. An example landscape photo showing the (Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

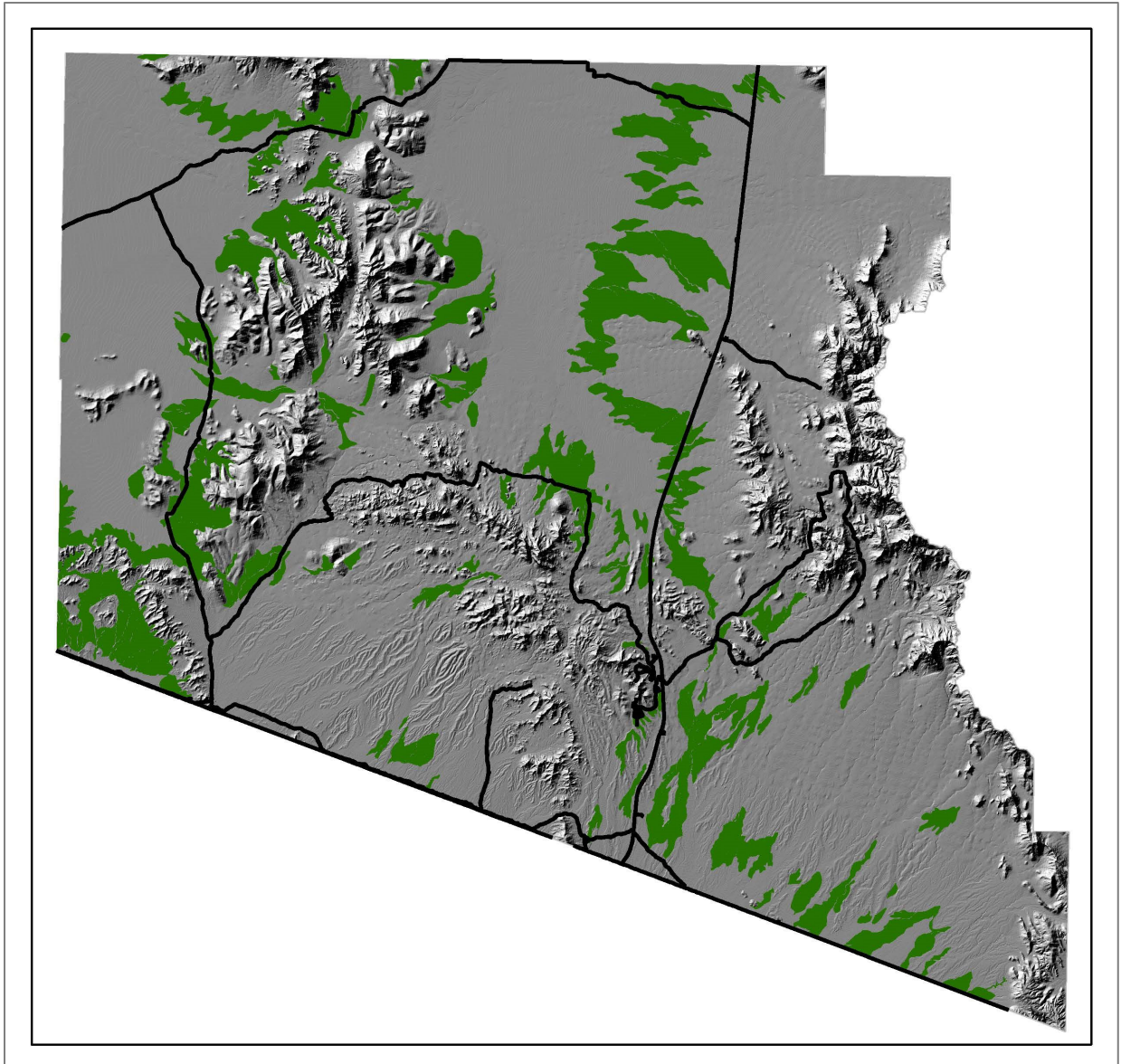


Figure 43. A distribution map, showing in green all areas mapped as (Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS



Figure 44. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (Yellow Paloverde) / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

7. *Fouquieria splendens* / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland Association (P)

***Ocotillo* / *Creosote* / *Triangle Bur Ragweed* Shrubland Association**

This shrubland community is characterized by an open (<10%) canopy (>2 m) solely dominated by *Fouquieria splendens* (ocotillo) with a sub-canopy (0.5–2 m) dominated by *Larrea tridentata* (creosote) and a field stratum (<0.5 m) by *Ambrosia deltoidea* (triangle bur ragweed). This community differs from similar adjacent communities due to the consistent dominance of *F. splendens* (ocotillo), the lack of consistent *Parkinsonia microphylla* (yellow paloverde), and lower overall cover and species diversity.

F. splendens (ocotillo) is the sole canopy dominant with consistent (1.0) cover averaging to 5% including dense patches up to 20%. The variable (5–20%) sub-canopy is solely dominated by *L. tridentata* (creosote) with a number of low-cover succulents. This consistent (1.0) species provides average cover of 11% with dense inclusions up to 20%. In many examples, this species was rather stunted with height around 0.5 m. *Cylindropuntia fulgida* (jumping cholla) and *Cylindropuntia acanthocarpa* (buckhorn cholla) are common (0.7, 0.6), low-cover associates. The sparse (5%) field stratum is solely dominated by *A. deltoidea* (triangle bur ragweed). This consistent (1.0) small shrub contributes an average of 5% cover, accounting for almost all cover in this stratum.

This shrubland community covers about 0.32% (427 ha, 1,056 ac) of ORPI, exclusively in the northern end of the Sonoyta Valley. This shrubland community spans low-angle (<5%), upper-bajadas, typically with a southern aspect from 500–650 m (1,640–2,132 ft). The surface is characterized by shallow to very shallow, well drained alluvium underlying a dominant layer of coarse gravel. This community typically occurs on the higher and more exposed interfluvies, often on a level above the more tree-dominated bajada communities

Common Species: *Fouquieria splendens*, *Larrea tridentata*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 45–48.



Figure 45. An example landscape photo showing the Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

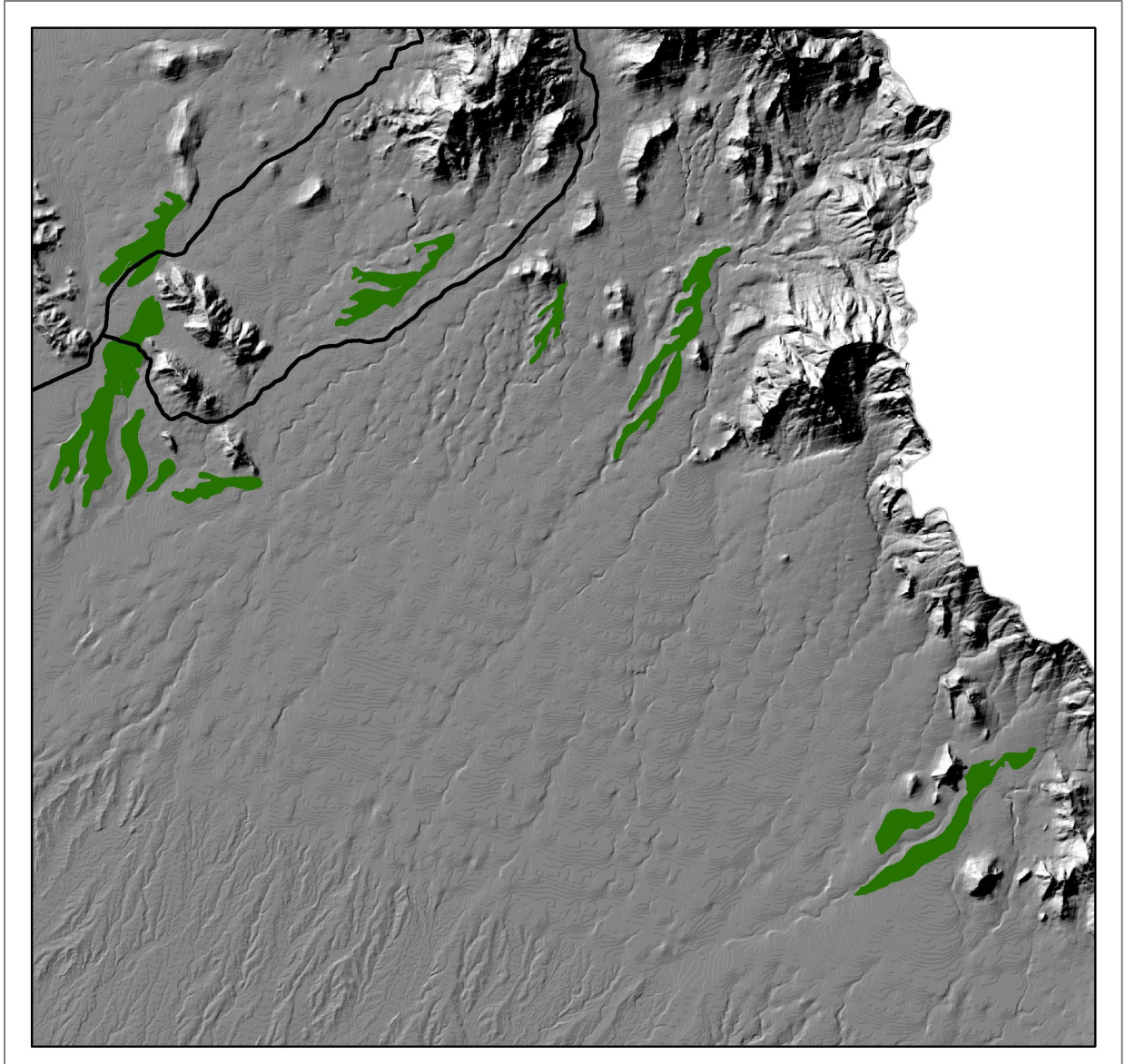


Figure 46. A distribution map, showing in green all areas mapped as Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

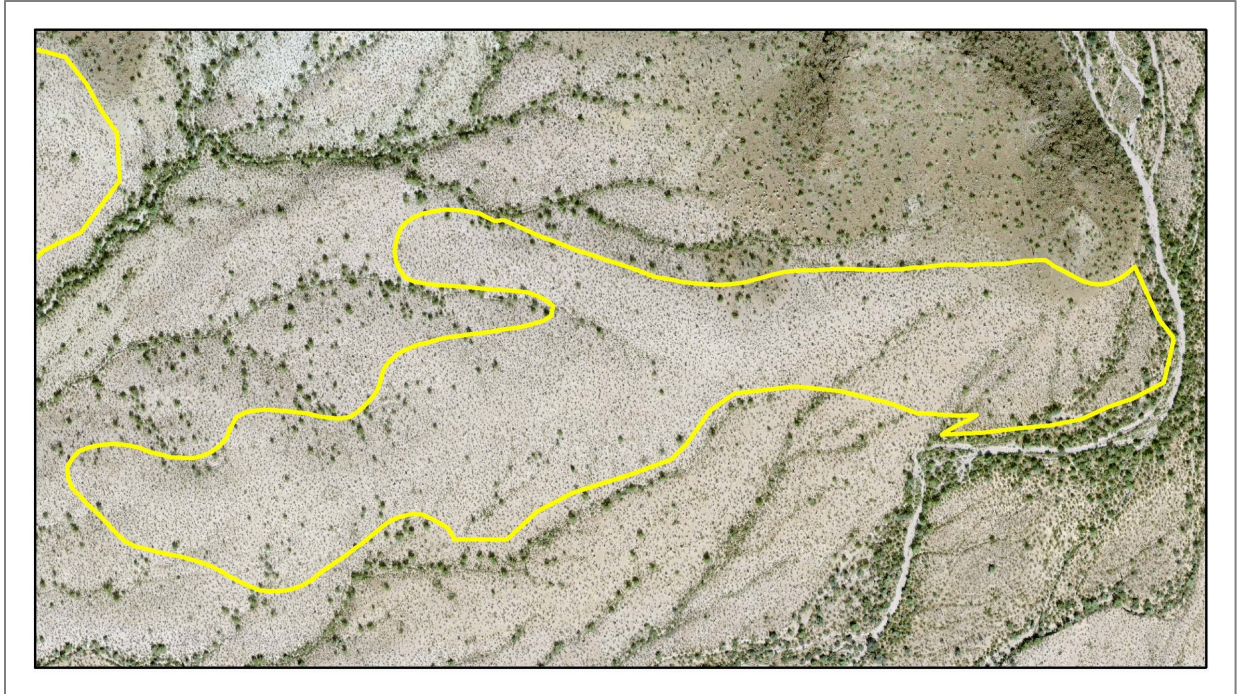


Figure 47. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

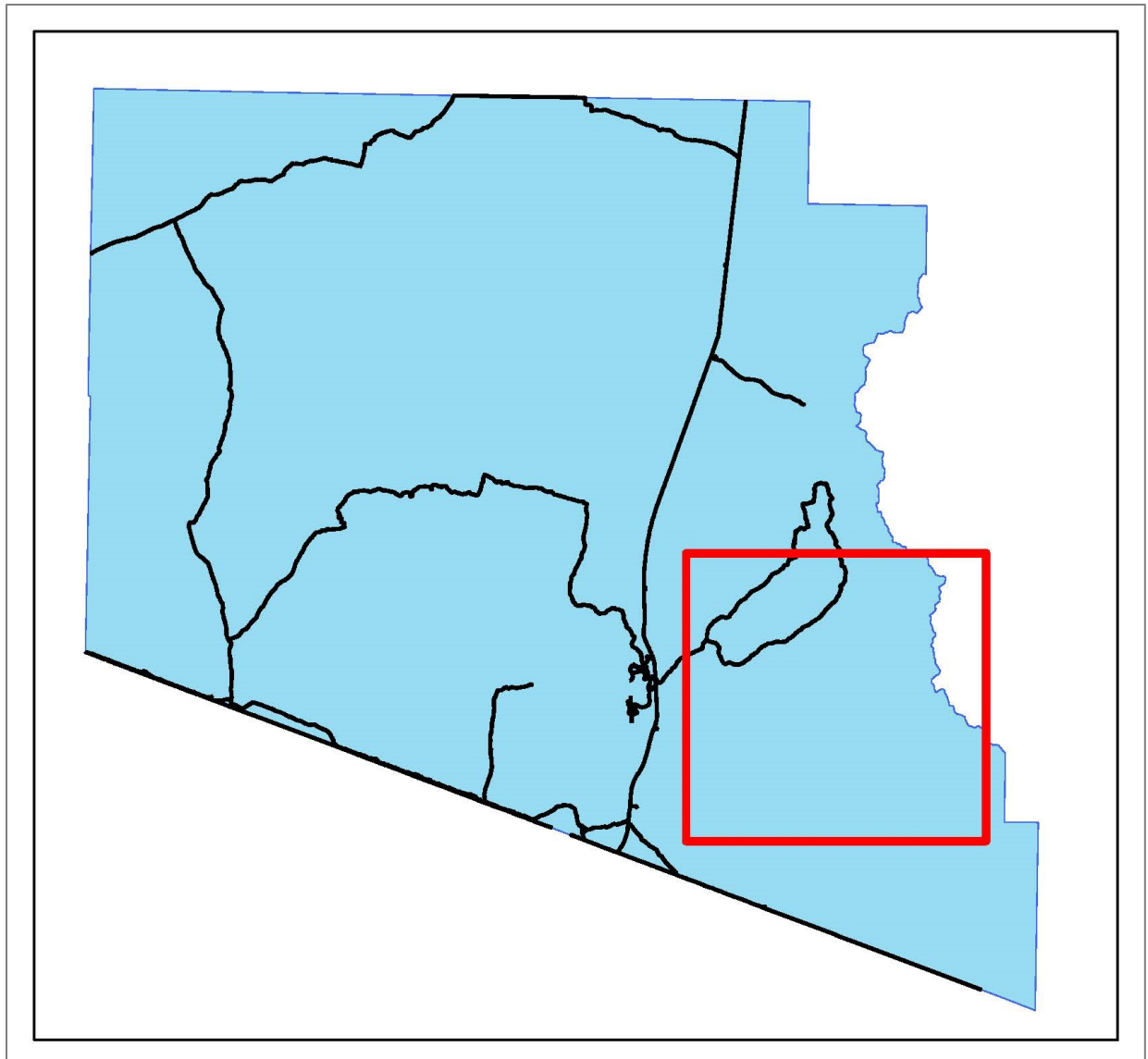


Figure 48. Map of ORPI with bounding box around the regions mapped as Ocotillo / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

8. *Parkinsonia microphylla* / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland Association (P)

***Yellow Paloverde* / *Creosote* / *Triangle Bur Ragweed* Shrubland Association**

This shrubland community is characterized by a very open (5 [10]%) canopy (>2 m) dominated by *Parkinsonia microphylla* (yellow paloverde), a variable (5–20%) sub-canopy stratum (0.5–2 m) by *Larrea tridentata* (creosote), and a sparse (<10%) field stratum (<0.5 m) by triangle bur ragweed.

The canopy (>2 m) is characterized by the consistent presence (0.95) and typical dominance of *P. microphylla* (yellow paloverde). This species is present as small (2 m), shrub-like trees to larger (3–4 m), broad-canopied trees providing average cover around 5%, including some dense inclusions approaching 10%. *Carnegiea gigantea* (saguaro) is an occasional (0.53), but lower-cover canopy species, with cover rarely surpassing 1%. The sub-canopy stratum (0.5–2 m) is characterized by the sole dominance of *L. tridentata* (creosote) with a few low-cover associate succulents and shrubs. This shrub provides the most cover of any species within this community, with an average of 8%, including dense inclusions approaching 25%. *Cylindropuntia acanthocarpa* (buckhorn cholla) and *Cylindropuntia fulgida* (jumping cholla) are occasional associates (0.70, 0.47) that, when present, rarely provide more than 1–2% cover. The sparse (10%) field stratum (<0.5 m) is characterized by the consistent presence (1.0) and typical dominance of the *Ambrosia deltoidea* (triangle bur ragweed). Across the community, cover of this species is quite variable, ranging from sparsely vegetated areas with <1% to dense inclusions with cover from 10 to 20%.

This wooded shrubland community covers about 29.0% (38,820 ha, 95,927 ac) of ORPI and is widespread throughout the middle and upper bajada. This shrubland community spans the low-angle (<15%) bajada from 350–755 m (1,148–2,577 ft). The soil consists of very deep, well drained, and gravelly alluvium.

Common Species: *Parkinsonia microphylla*, *Larrea tridentata*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 49–51.



Figure 49. An example landscape photo showing the Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

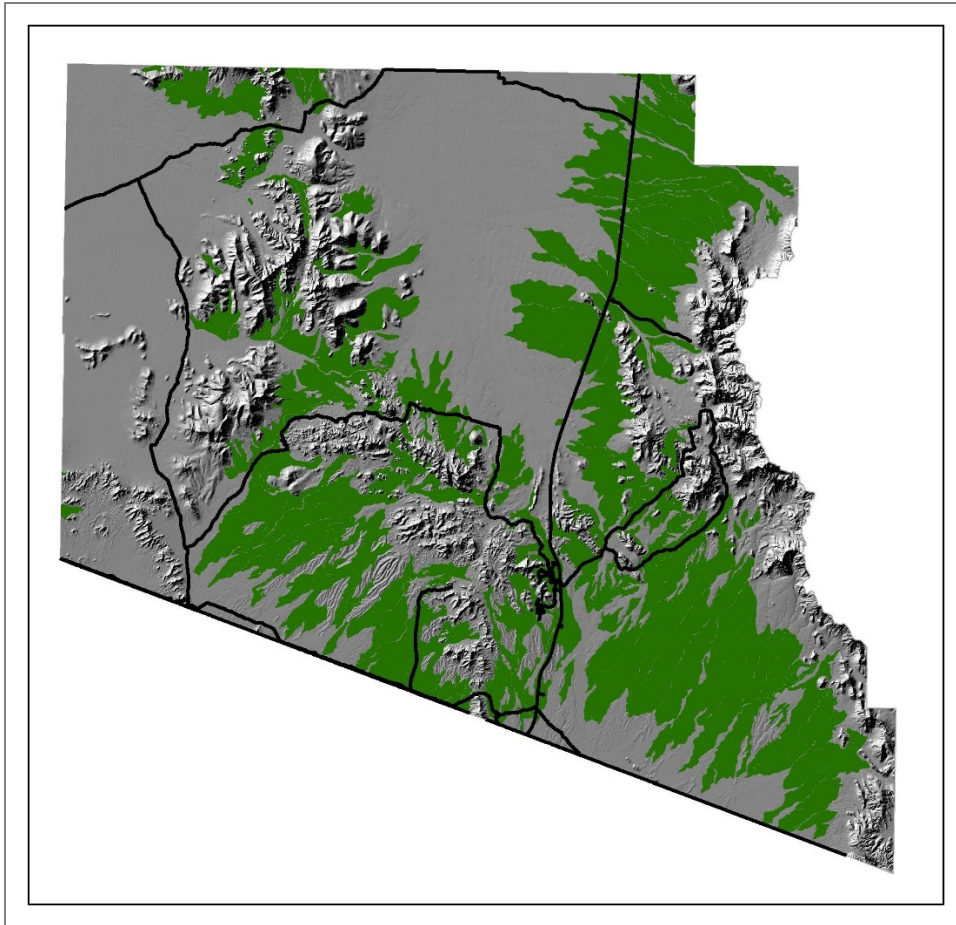


Figure 50. A distribution map, showing in green all areas mapped as Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

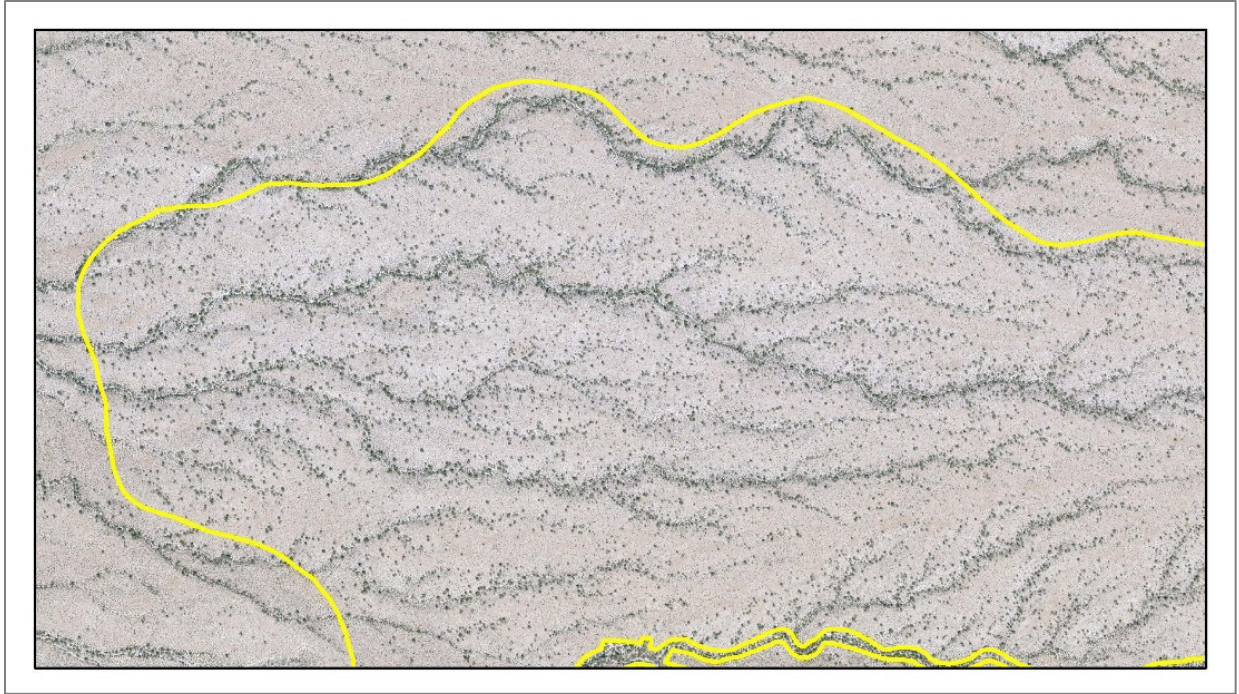


Figure 51. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

9. *Parkinsonia microphylla* – *Olneya tesota* / *Larrea tridentata* / *Ambrosia deltoidea* Wooded Shrubland Association (P)

Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association

This wooded shrubland community is characterized by an open (10%) canopy (>2 m) co-dominated by *Parkinsonia microphylla* (yellow paloverde) and *Olneya tesota* (ironwood) with an understory dominated by *Larrea tridentata* (creosote) in the sub-canopy (0.5–2 m) and *Ambrosia deltoidea* (triangle bur ragweed) in the field stratum (<0.5 m).

P. microphylla (yellow paloverde) is dominant in all examples of this community with average cover around 5%. *O. tesota* (ironwood) is a co-dominant in most examples (0.75) with cover ranging from 1 to 7%. Unlike in other bajada types, *O. tesota* (ironwood) is not restricted to washes and minor drainages but instead is distributed throughout the community. The open (<10%) sub-canopy stratum (0.5–2 m) is characterized by the sole, low-cover dominance of *L. tridentata* (creosote). On average, this species provides around 4% cover with some inclusions reaching up to 10%. The very sparse (5%) field stratum is characterized by the dominance of *A. deltoidea* (triangle bur ragweed) with only a few low-cover associates. *A. deltoidea* (triangle bur ragweed) is dominant in most examples (0.75) of this community with an average 6% cover, including a dense inclusion around 20%.

This wooded shrubland community covers about 1.36% (1,813 ha, 4,480 ac) of ORPI exclusively in the Sonoyta Valley and the Abra Plain. It spans low-angle (<15%), generally south trending bajadas from 375–525 m (1,230–1,722 ft). These areas have more variable topography than the adjacent bajada communities, often appearing as low, rolling hills. Soils consist of very deep and well-drained alluvium, typically of the Gunsight series.

Common Species: *Parkinsonia microphylla*, *Olneya tesota*, *Larrea tridentata*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 52–55.



Figure 52. An example landscape photo showing the Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

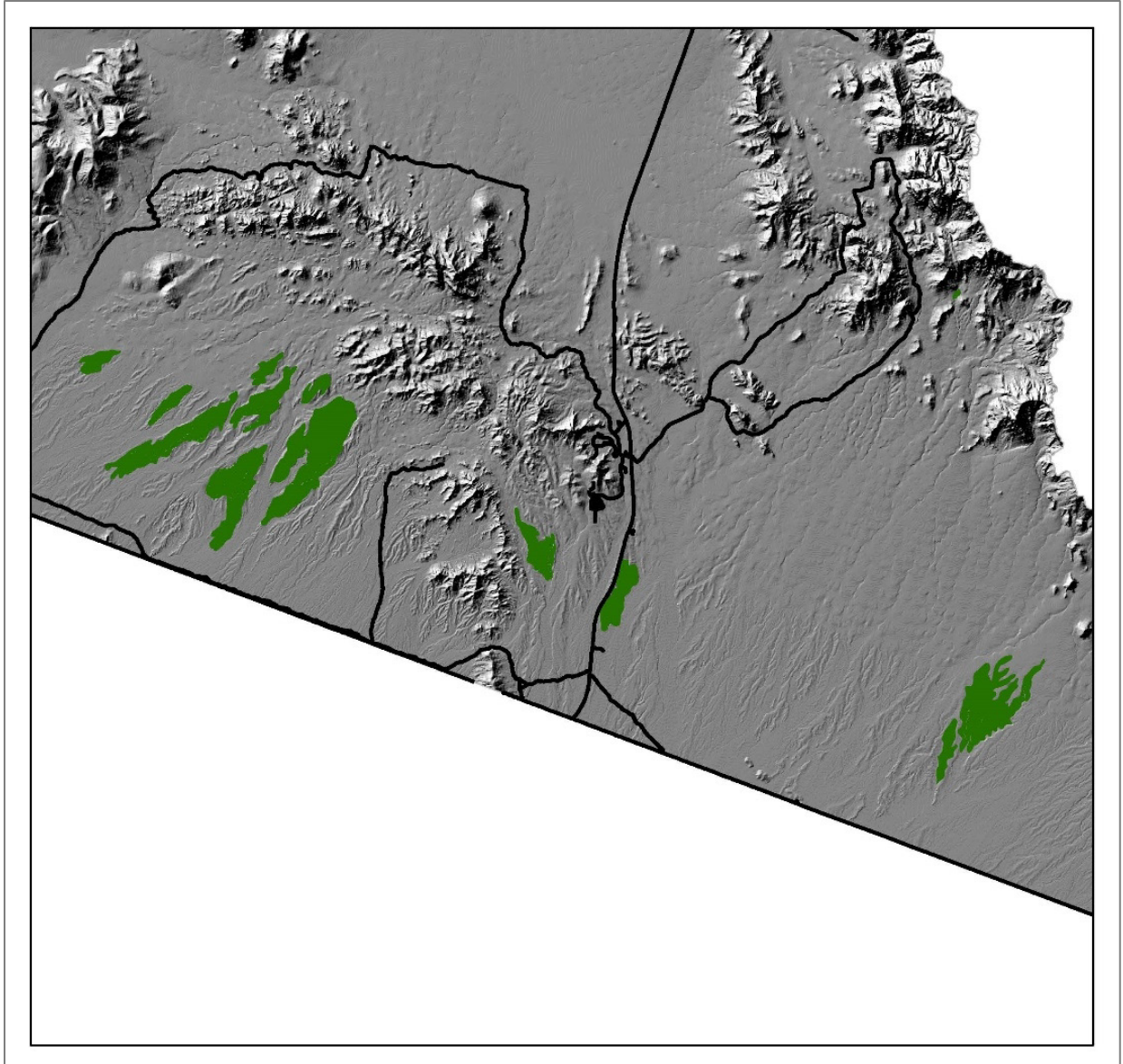


Figure 53. A distribution map, showing in green all areas mapped as Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

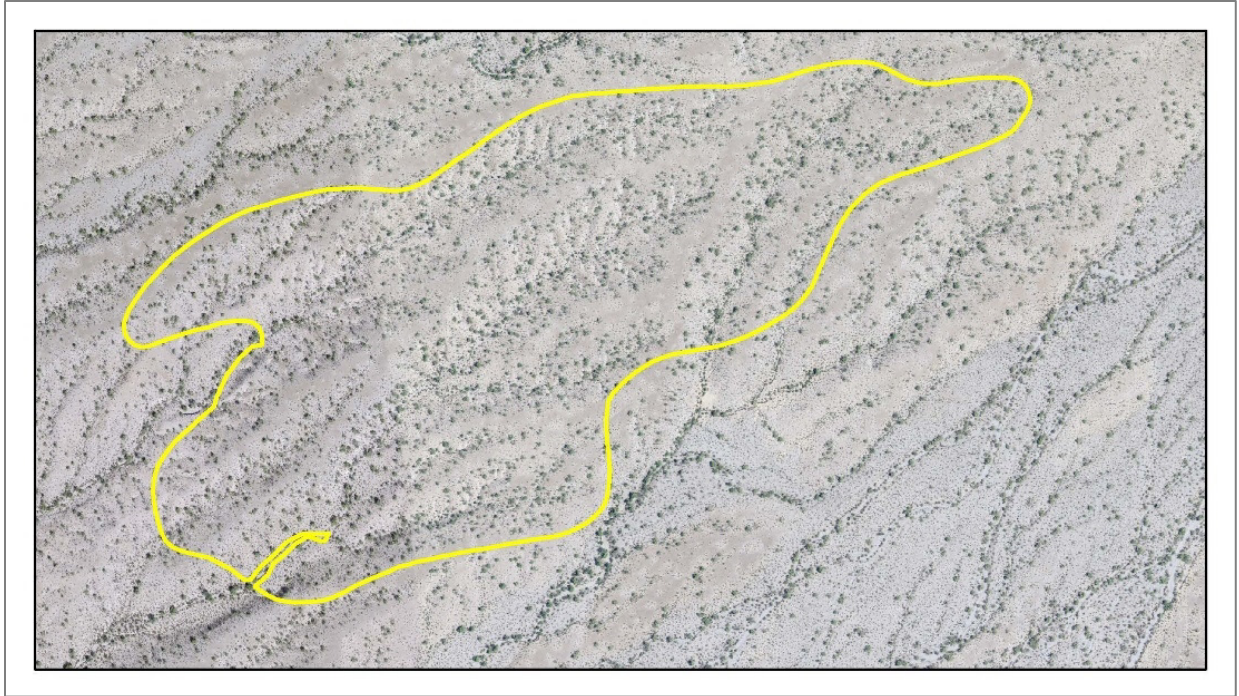


Figure 54. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Yellow Paloverde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

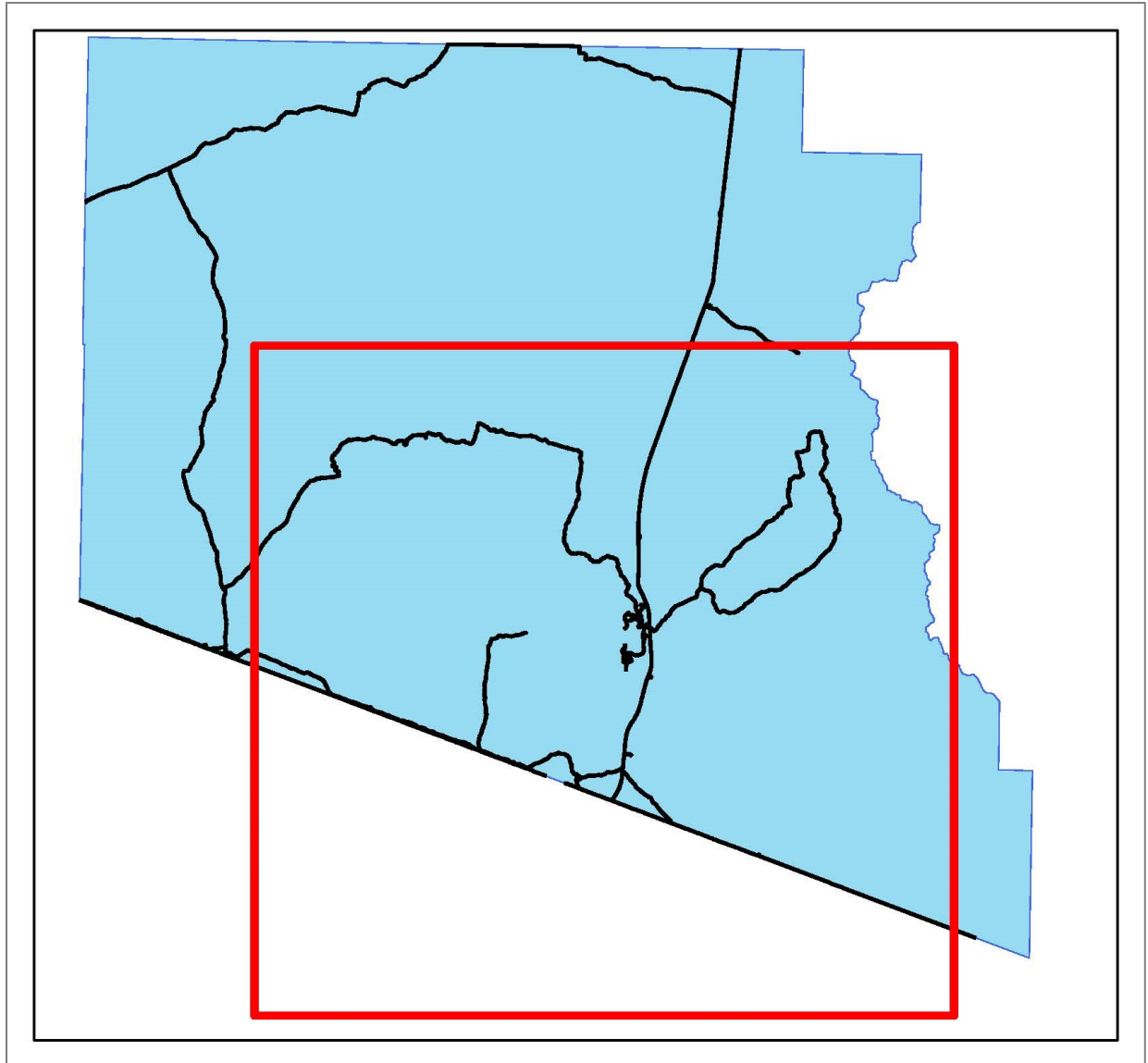


Figure 55. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Palo Verde – Ironwood / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

10. *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Larrea tridentata* / *Ambrosia deltoidea* Shrubland Association (P)

Yellow Paloverde* (*Organ Pipe Cactus*) / *Creosote* / *Triangle Bur Ragweed Shrubland Association

This shrubland community is characterized by an open (5–15%) canopy (>2 m) of yellow paloverde (*Parkinsonia microphylla*) and organ pipe cactus (*Stenocereus thurberi*), a sub-canopy (0.5–2 m) of *Larrea tridentata* (creosote), and a field stratum (<0.5 m) dominated by triangle bur ragweed (*Ambrosia deltoidea*) with a diverse suite of associate shrubs and succulents.

The canopy (>2 m) is characterized by the consistent presence (0.93) and typical dominance of *P. microphylla* (yellow paloverde). This species is present as small (2 m), shrub-like trees to larger (3–4 m), broad-canopied trees providing average cover around 5%. *Stenocereus thurberi* (organ pipe cactus) is a consistent (1.0) associate with low cover ranging from a few scattered individuals to 1–3%. This species becomes more prominent as the community transitions from upper bajadas and alluvial fans onto mountain slopes. The sub-canopy stratum (0.5–2 m) is characterized by the dominance of *L. tridentata* (creosote) with a diverse suite of associate succulents and shrubs. On average, *L. tridentata* (creosote) provides 3–4% cover with some dense inclusion up to 10%. The sparse ([5] 10–15%) field stratum (<0.5 m) is characterized by the consistent presence (1.0) and typical dominance of *Ambrosia deltoidea* (triangle bur ragweed). Across the community, cover of this species is quite variable, ranging from sparsely vegetated areas with <1% to dense inclusions with cover from 20 to 40%.

This shrubland community covers about 3.03% (4,050 ha, 10,007 ac) of ORPI and is widespread along the base of all mountainous areas, excluding the Ajo Range. This community occupies the transition between the alluvial fan and the adjacent mountain/hill slopes from 375–675 m (1,230–2,214 ft). The surface is characterized by shallow, excessively drained alluvium below a dominant layer of coarse gravel and scattered cobble.

Common Species: *Parkinsonia microphylla*, *Stenocereus thurberi*, *Carnegiea gigantea*, *Larrea tridentata*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 56–58.



Figure 56. An example landscape photo showing the Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

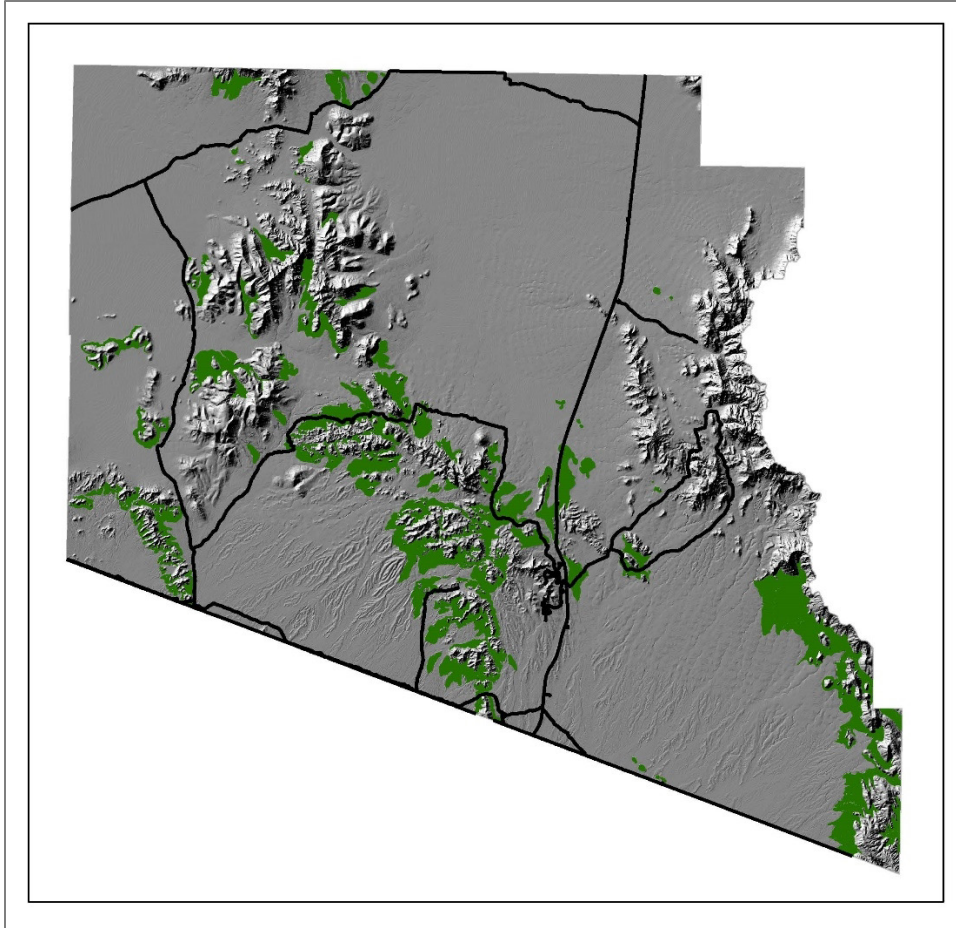


Figure 57. A distribution map, showing in green all areas mapped as Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS



Figure 58. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde (Organ Pipe Cactus) / Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

11. *Parkinsonia microphylla* – *Stenocereus thurberi* – *Pachycereus schottii* / *Larrea tridentata* / *Ambrosia deltoidea* Wooded Shrubland Association (P)

***Yellow Paloverde* – *Organ Pipe Cactus* – *Senita Cactus* / *Creosote* / *Triangle Bur Ragweed*
*Wooded Shrubland Association***

This wooded shrubland community is characterized by a canopy co-dominated by *Parkinsonia microphylla* (yellow paloverde), *Stenocereus thurberi* (organ pipe cactus), and *Pachycereus schottii* (senita cactus) with a sub-canopy (0.5–2 m) of *Larrea tridentata* (creosote) and a field (<0.5 m) of *Ambrosia deltoidea* (triangle bur ragweed).

This community differs from adjacent bajada and pediment communities due to the presence of the diagnostic species, *P. schottii* (senita cactus). *P. microphylla* (yellow paloverde) and *Olneya tesota* (desert ironwood) are consistent (1.0) canopy dominants with average cover around 5%. *S. thurberi* (organ pipe cactus) and *P. schottii* (senita cactus) are consistent (1.0), low-cover dominants that, on average, provide cover around 2% with inclusions up to 5%. *P. schottii* (senita cactus) is a diagnostic component of this community. In the sub-canopy *L. tridentata* (creosote) provides consistent (1.0) dominance with average cover around 6%. In the variable (5–20%) field stratum *A. deltoidea* (triangle bur ragweed) is a consistent (1.0) dominant that provides the most cover of any species in this community with an average around 15%.

This wooded shrubland community covers about 0.07% (87 ha, 216 ac) of ORPI exclusively in Senita Basin. This community spans low-angle (<5%), southwest-trending floodplains and alluvial fans around 500 m (1,640 ft). The surface cover is dominated by fine gravel and fine, silty soil with scattered small rocks. This community includes many narrow, braided washes.

Common Species: *Parkinsonia microphylla*, *Stenocereus thurberi*, *Pachycereus schottii*, *Olneya tesota*, *Larrea tridentata*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 59–62.



Figure 59. An example landscape photo showing the Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

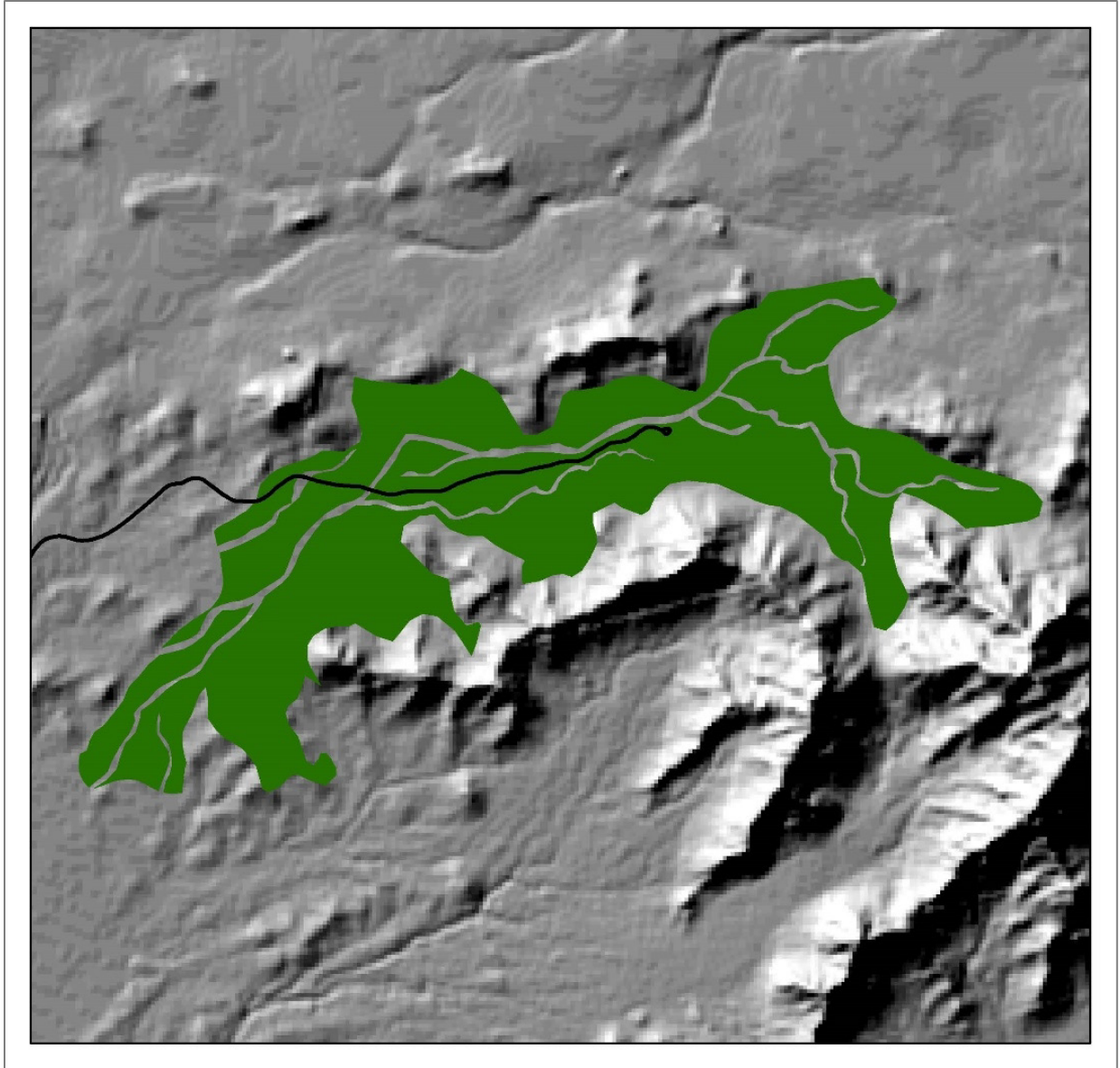


Figure 60. A distribution map, showing in green all areas mapped as Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

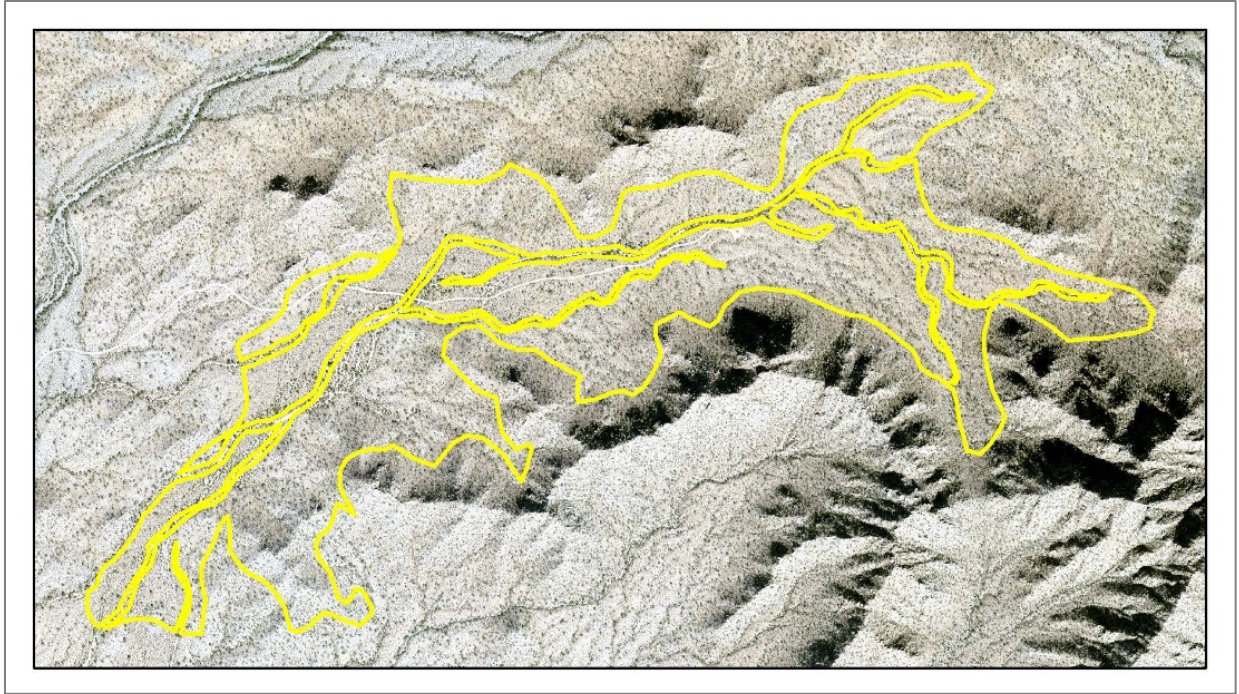


Figure 61. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

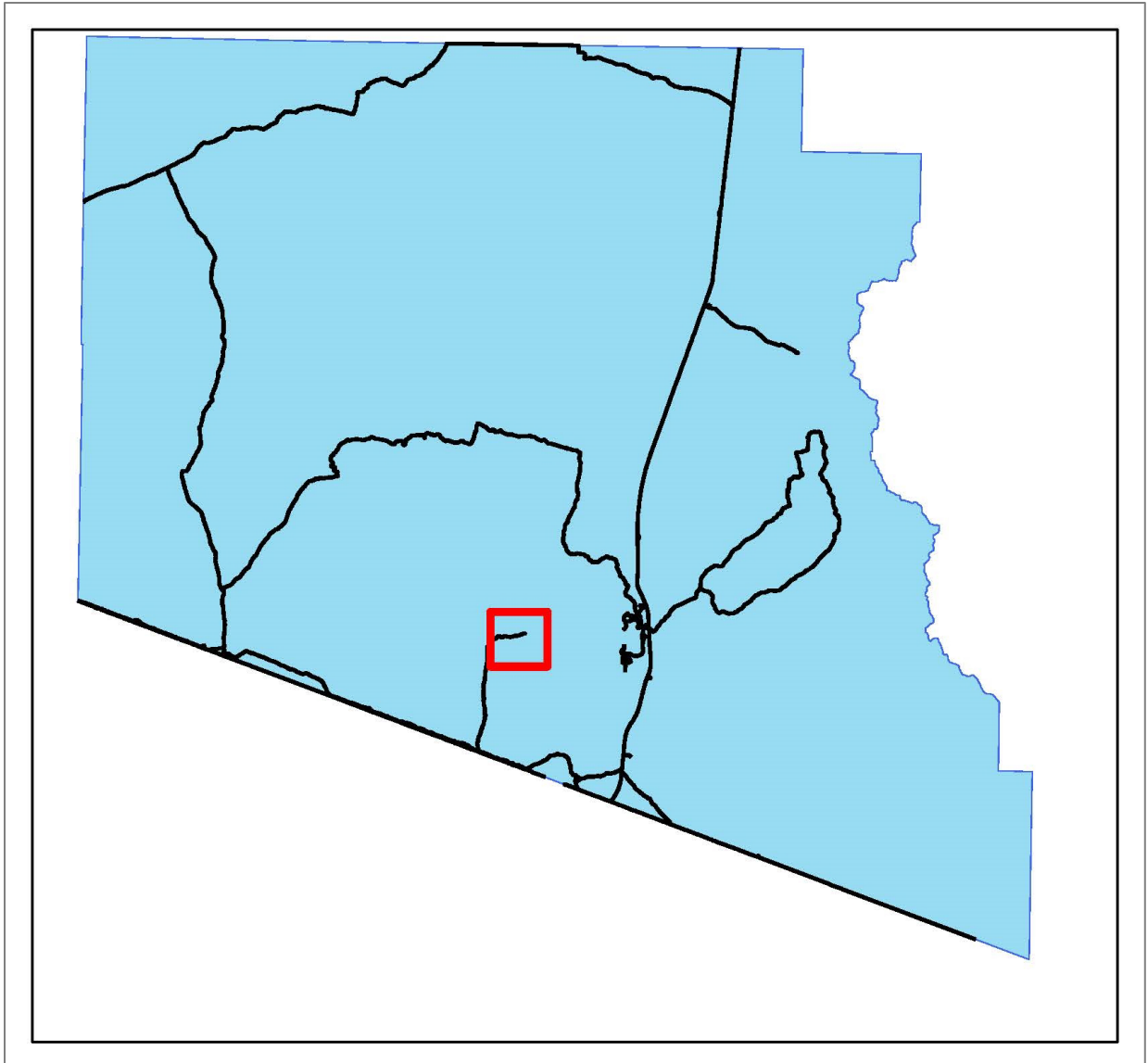


Figure 62. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Paloverde – Organ Pipe Cactus – Senita Cactus / Creosote / Triangle Bur Ragweed Wooded Shrubland Association.

NPS

12. *Fouquieria splendens* / *Selaginella arizonica* Shrubby Rock Outcrop Association (P)

***Ocotillo* / *Arizona Spikemoss* Shrubby Rock Outcrop Association**

This shrubland community is characterized by a sparse (<10%) canopy (>2 m) and sub-canopy (0.5–2 m) of *Fouquieria splendens* (ocotillo) with a field stratum (<0.5 m) dominated by *Selaginella arizonica* (Arizona spikemoss).

F. splendens (ocotillo) is a consistent (1.0) dominant that provides average cover around 5% with some areas up to 10%. Individuals of this species were relatively short statured with height around 2 m, often split between the sub-canopy (0.5–2 m) and the canopy (>2 m) strata. *P. microphylla* (yellow paloverde) is consistently present (1.0) and occasionally (0.22) dominant, with an average of 3% cover. This species was also short-statured with height rarely surpassing 2 m. The field stratum (<0.5 m) is characterized by the dominance of *S. arizonica* (Arizona spikemoss) with two common associates, *Agave schottii* (Schott's century plant) and *Bouteloua repens* (slender grama), and a diverse suite of associate subshrubs, perennial grasses, and forbs. Total cover can be quite variable, ranging from 10 to 20% where exposed bedrock/rock is prevalent to dense areas exceeding 50% cover in places with more available surface soil. *S. arizonica* (Arizona spikemoss) is by far the most dominant species in this community, accounting for an average of 26% of the total cover recorded across the community.

This shrubland community covers about 0.03% (36 ha, 90 ac) of ORPI, exclusively in the Ajo Mountain Range. This shrubland spans moderately steep (15–35%) mountain slopes or variable aspect from 780–1,050 m (2,559–3,444 ft). The surface cover is characterized by very shallow and rocky soils, typically of volcanic origin (rhyolite and dacite). Expanses of exposed bedrock and high surface rock cover were noted in all examples of this community.

Common Species: *Fouquieria splendens*, *Parkinsonia microphylla*, *Selaginella arizonica*, *Agave schottii*, *Bouteloua repens*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 63–66.



Figure 63. An example landscape photo showing the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.

NPS

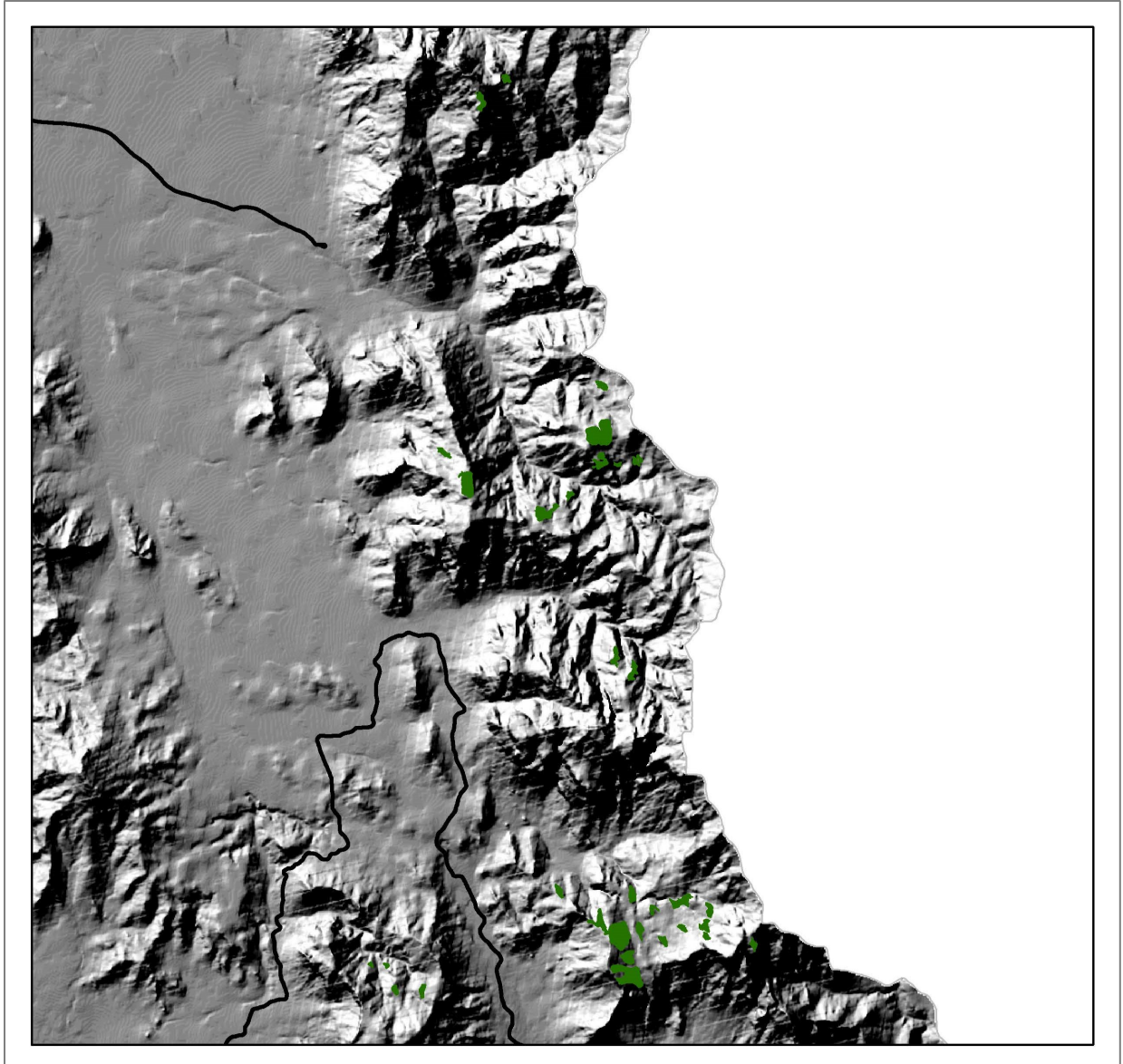


Figure 64. A distribution map, showing in green all areas mapped as the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.

NPS

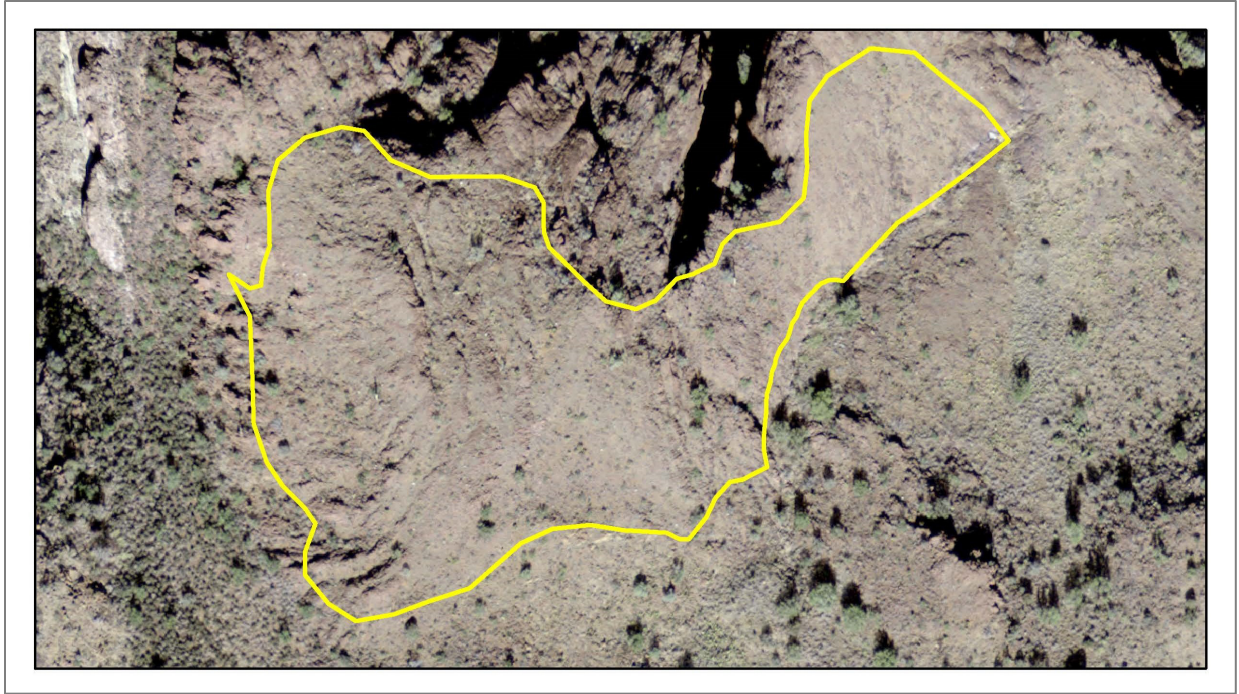


Figure 65. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.

NPS

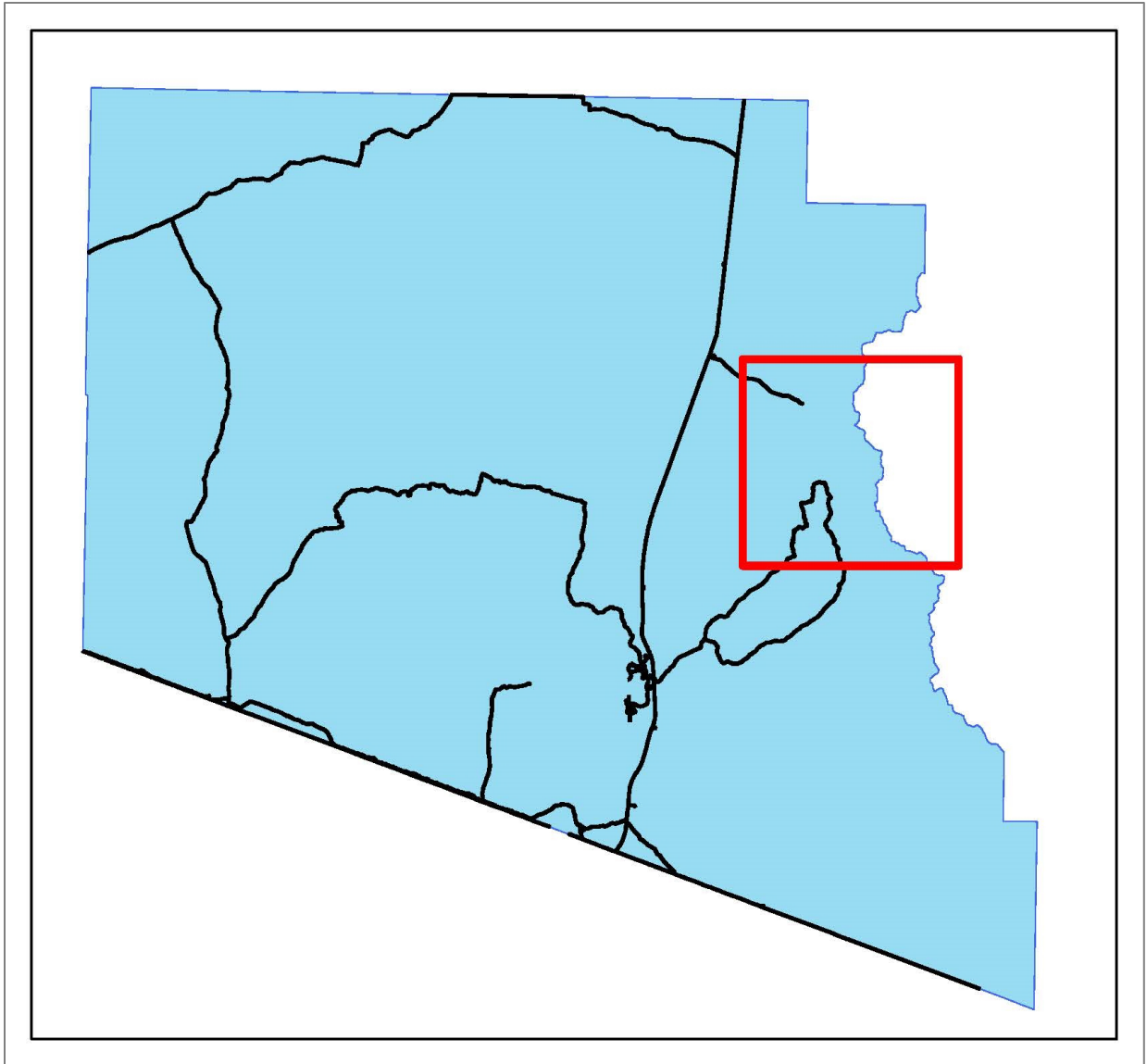


Figure 66. Map of ORPI with bounding box around the regions the Ocotillo / Arizona Spikemoss Shrubby Rock Outcrop Association.

NPS

13. *Parkinsonia microphylla* / *Jatropha cuneata* / *Encelia farinosa* Shrubland Association (P)

***Yellow Paloverde* / *Physicnut* / *Brittlebush* Shrubland Association**

This wooded shrubland community is characterized by an open (10–25%) canopy (>2 m) dominated by *Parkinsonia microphylla* (yellow paloverde), a sub-canopy (0.5–2 m) by *Jatropha cuneata* (physicnut), and a field stratum (<0.5 m) by *Encelia farinosa* (brittlebush).

P. microphylla (yellow paloverde) is a consistent (1.0) component of this community that typically presents as a dominant with average cover around 6% with some inclusions up to 15%. *Stenocereus thurberi* (organ pipe cactus) is an uncommon component of this community and is typically only present in more exposed inclusions. The relatively sparse (5–15 [25]%) sub-canopy stratum (0.5–2 m) is characterized by the consistent presence (0.80) and typical dominance of *Jatropha cuneata* (physicnut) with a mix of low-cover shrubs and succulents. When present, this species provides average cover around 4% with some dense inclusions up to 10%. *Cylindropuntia bigelovii* (teddybear cholla) is an inconsistent (0.4) associate that can occasionally become co-dominant with *J. cuneata* (physicnut) with cover approaching 10%. The sparse (<10%) field stratum (<0.5 m) is characterized by the sole dominance of *Encelia farinosa* (brittlebush) with a few sparse associates. This species generally contributes between 5–15% cover. Areas of low cover typically occur in the transitional zones between mountain slopes and the alluvial fan where *Ambrosia deltoidea* (triangle bur ragweed) begins to dominate.

This wooded shrubland community covers about 5.6% (7,446 ha, 18,400 ac) of ORPI and is widespread throughout all mountain areas excluding the Ajo Mountains. This community typically spans north-trending mountain and hills slopes of variable grade (15–50+%) from 340–1,260 m (1,115–4,133 ft). The surface cover is characterized by the dominance of coarse gravel (>2 cm) and rock with minimal exposed soil.

Common Species: *Parkinsonia microphylla*, *Jatropha cuneata*, *Encelia farinosa*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 67–69.



Figure 67. An example landscape photo showing the Yellow Paloverde / Physicnut / Brittlebush Shrubland Association.

NPS

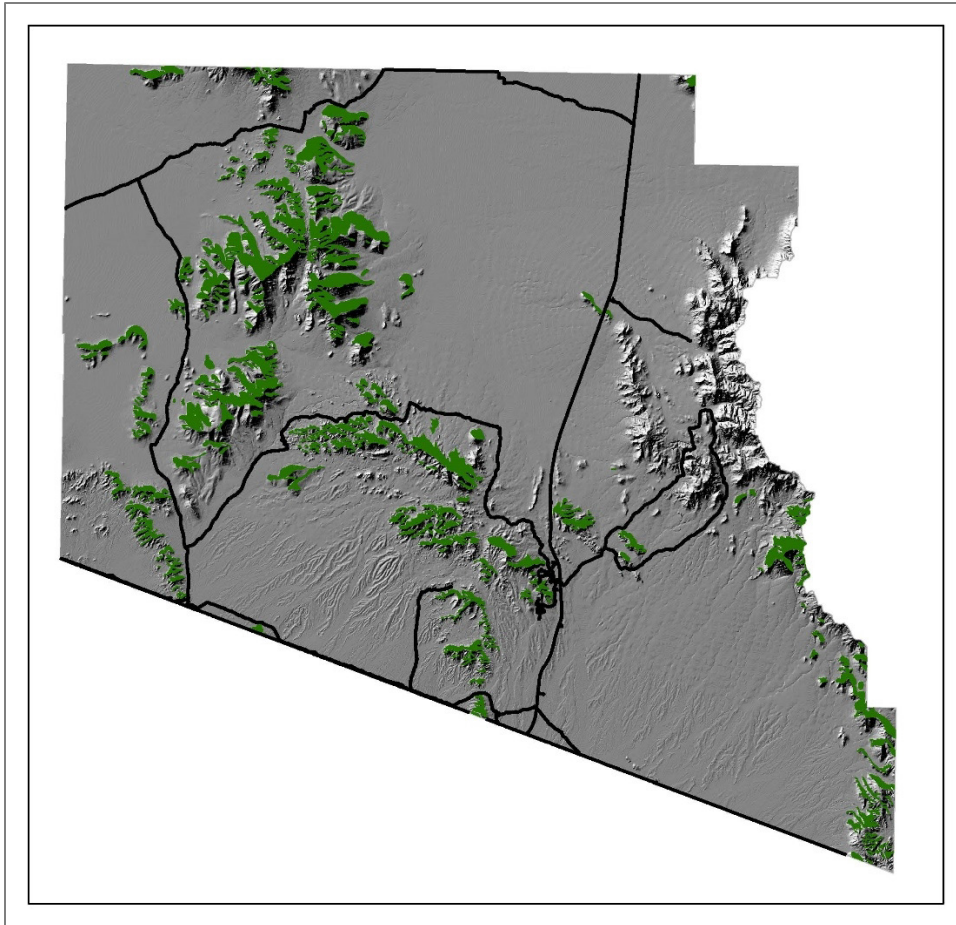


Figure 68. A distribution map, showing in green all areas mapped as Yellow Paloverde / Physicnut / Brittlebush Shrubland Association.

NPS

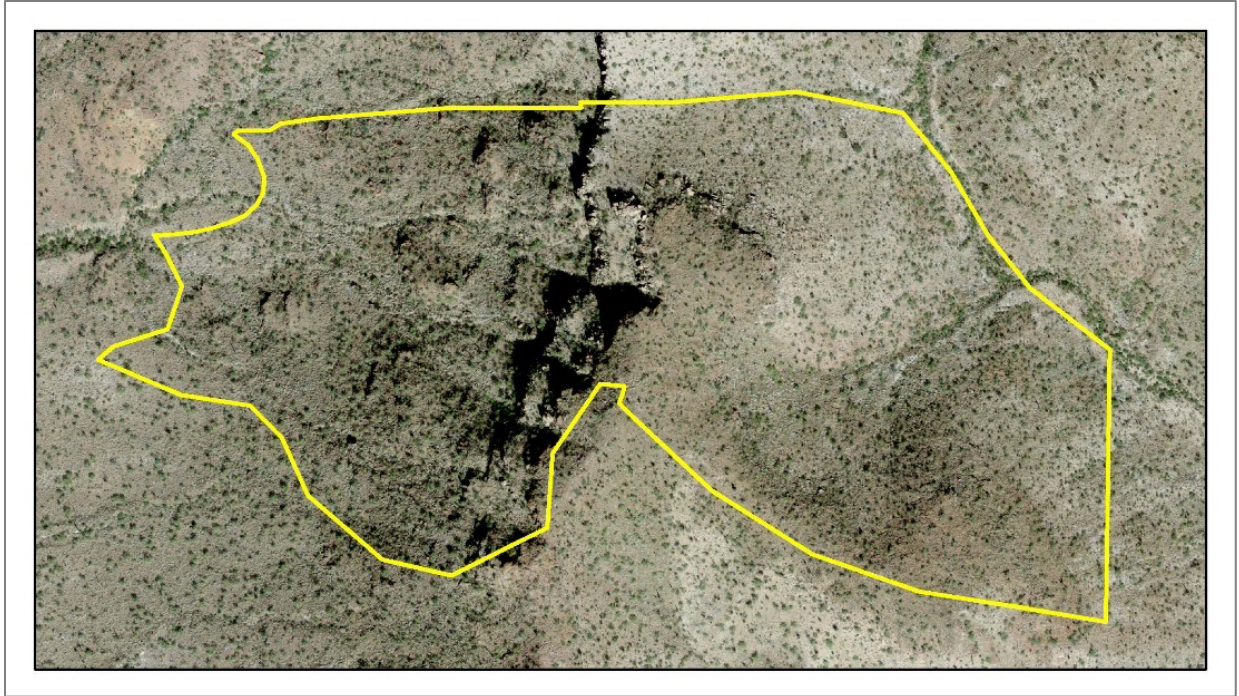


Figure 69. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde / Physicnut / Brittlebush Shrubland Association.

NPS

14. *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Jatropha cuneata* / *Encelia farinosa* Shrubland Association (P)

***Yellow Paloverde* (*Organ Pipe Cactus*) / *Physicnut* / *Brittlebush* Shrubland Association**

This shrubland community is characterized by an open (10–25%) low-canopy (2–5 m) dominated by *Parkinsonia microphylla* (yellow paloverde) with conspicuous *Stenocereus thurberi* (organ pipe cactus), a sub-canopy (0.5–2 m) by *Jatropha cuneata* (physicnut), and a field stratum (<0.5 m) by *Encelia farinosa* (brittlebush).

P. microphylla (yellow paloverde) is a consistent (1.0) component of this community that typically presents as a dominant species with average cover around 5% with some inclusions up to 15%. *S. thurberi* (organ pipe cactus) is a common (0.66) associate with heights ranging from 3–5 m. When present, this species provides average cover of 4% with rare, dense inclusions up to 15%. The relatively open (5–15 [25]%) sub-canopy stratum (0.5–2 m) is characterized by the consistent (0.88) dominance of *Jatropha cuneata* (physicnut) with a mix of low-cover shrubs and succulents. With an average of 8% cover, this species provides the highest cover of any species documented in this community. *Cylindropuntia bigelovii* (teddybear cholla) is an inconsistent (0.38) associate that can occasionally become co-dominant with *J. cuneata* (physicnut) with cover approaching 10%. The sparse (<10%) field stratum (<0.5 m) is characterized by the sole dominance of *Encelia farinosa* (brittlebush) with a few sparse associates. This species was recorded as dominant in all examples of the community with average cover ranging from 5–15%. Areas of low cover typically occur in the transitional zones between mountain slopes and the alluvial fan where *Ambrosia deltoidea* (triangle bur ragweed) begins to dominate.

This shrubland community is contained within a 2-association map class that covers about 9.61% (12,863 ha, 31,785 ac) of ORPI and is widespread throughout all mountainous areas except the Ajo Range. This shrubland community typically spans south-trending mountain and hills slopes of variable grade (15–50+%) from 300–1,219 m (984–4,000 ft). The surface cover is characterized by the dominance of coarse gravel (>2 cm) and rock with minimal exposed soil.

Common Species: *Parkinsonia microphylla*, *Stenocereus thurberi*, *Jatropha cuneata*, *Encelia farinosa*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 70–72.



Figure 70. An example landscape photo showing the Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland Association.

NPS

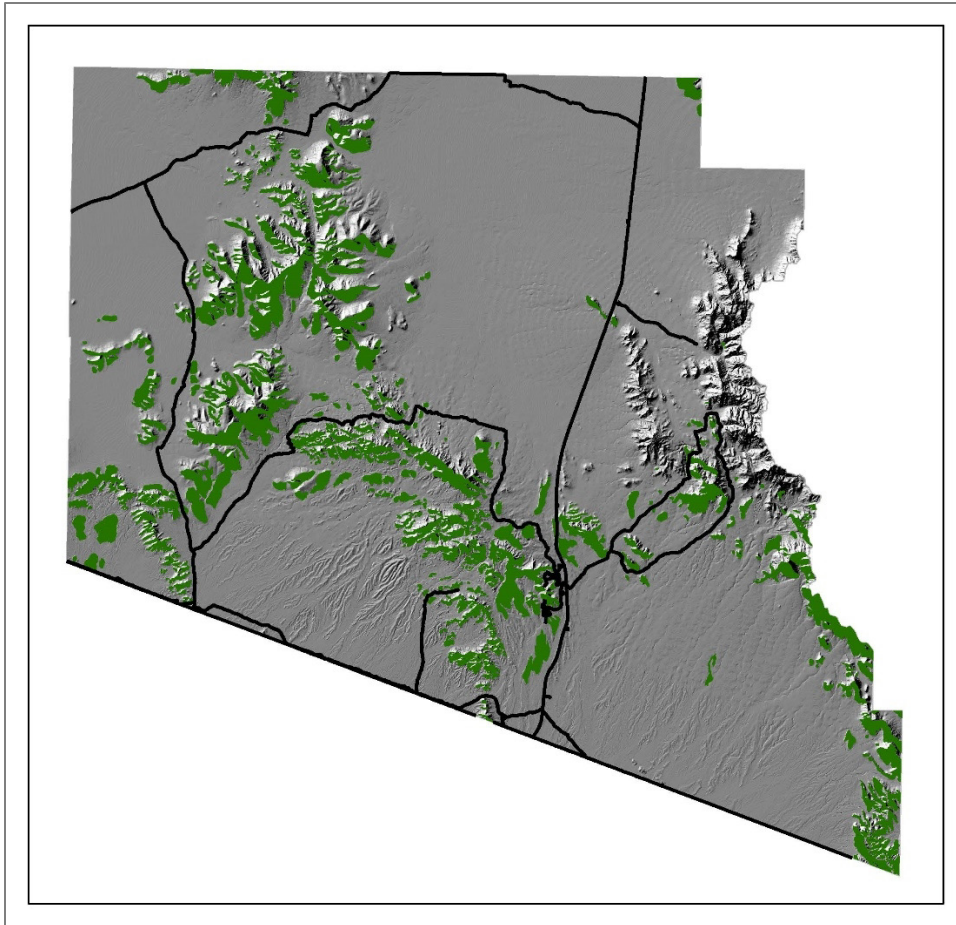


Figure 71. A distribution map, showing in green all areas mapped as Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland Association.

NPS

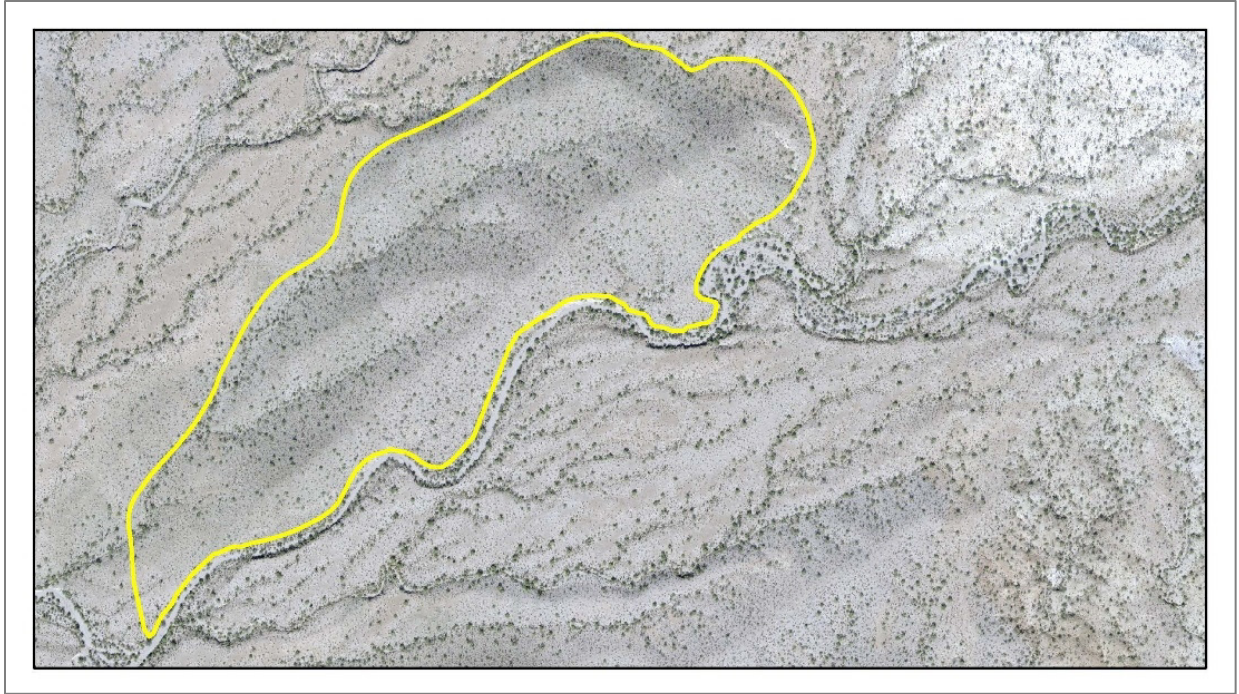


Figure 72. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde (Organ Pipe Cactus) / Physicnut / Brittlebush Shrubland Association.

NPS

15. *Parkinsonia microphylla* / *Jatropha cuneata* (*Bursera microphylla*) / *Encelia farinosa* Shrubland Association (P)

Yellow Paloverde / Physicnut (Elephant Tree) / Brittlebush Shrubland Association

This shrubland association is characterized by a canopy (2–5 m) dominated by *Parkinsonia microphylla* (yellow paloverde), a sub-canopy (0.5–2 m) by *Jatropha cuneata* (physicnut), and a field stratum (<0.5 m) by *Encelia farinosa* (brittlebush). This community is further defined by the consistent (1.0) presence, but low cover of *Bursera microphylla* (elephant tree).

The low-canopy (2–5 m) is dominated by an open (10–20%) mix of small trees and succulents most commonly dominated by *P. microphylla* (yellow paloverde). *Stenocereus thurberi* (organ pipe cactus) is a noteworthy associate with heights ranging from 3–4 m and average cover around 3%. The open (5–15%) sub-canopy (0.5–2 m) stratum is characterized by the consistent dominance (1.0) of *J. cuneata* (physicnut) with one diagnostic common associate, *B. microphylla* (elephant tree). On average, *J. cuneata* (physicnut) provides 5% cover throughout the community with some inclusions approaching 15%. *B. microphylla* (elephant tree) was documented in all examples of this community with cover that ranged from a few scattered individuals that contributed <1% to areas where it competed for dominance with *J. cuneata* (physicnut). The sparse (5–10%) field stratum is characterized by the consistent dominance of *E. farinosa* (brittlebush) with a mix of low-cover associate subshrubs and succulents. This species is the sole dominant field component in most examples of this community with average cover around 8%.

This shrubland community is contained within a 2-association map class that covers about 9.61% (12,863 ha, 31,785 ac) of ORPI and is widespread throughout all mountainous areas, excluding the Ajo Range. It is found on moderately steep (15–50+%) south-trending mountain backslopes from 473 to 1,325 m (1,551–4,347 ft). At times this community can reach down to the toeslopes where it begins to transition to upper alluvial communities. The surface cover is characterized by a shallow layer of coarse (>2 cm) gravel and rock.

Common Species: *Parkinsonia microphylla*, *Stenocereus thurberi*, *Jatropha cuneata*, *Bursera microphylla*, *Encelia farinosa*

This association is in a map class. Please see Figure 73 and refer to the previous type *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Jatropha cuneata* / *Encelia farinosa* Shrubland Association to see the shared distribution map and example imagery.



Figure 73. An example landscape photo showing the Yellow Paloverde / Physicnut (Elephant Tree) / Brittlebush Shrubland Association.

NPS

16. *Parkinsonia microphylla* / *Simmondsia chinensis* / *Ambrosia deltoidea* Shrubland Association (P)

***Yellow Paloverde* / *Jojoba* / *Triangle Bur Ragweed* Shrubland Association**

This shrubland community is characterized by an open (5–10%) canopy (>2 m) dominated by *Parkinsonia microphylla* (yellow paloverde), a sub-canopy (0.5–2 m) by *Simmondsia chinensis* (jojoba), and a field stratum (<0.5 m) by *Ambrosia deltoidea* (triangle bur ragweed).

P. microphylla (yellow paloverde) is a consistent (0.88) canopy tree that provides cover that ranges from 5–10% with an average around 4%. *Stenocereus thurberi* (organ pipe cactus) and *Olneya tesota* (ironwood) are occasional (<0.50) associates that, when present, provide cover ranging from <1 up to 3%. The open (5–15%) sub-canopy stratum (0.5–2 m) is characterized by the dominance of *S. chinensis* (jojoba) with a diverse suite of associate shrubs and succulents. *S. chinensis* (jojoba) is a very consistent dominant (1.0) that provides average cover around 8% including dense inclusions up to 20%. The field stratum (<0.5 m) provides the highest cover of any stratum, with 20–25% which is mainly dominated by *A. deltoidea* (triangle bur ragweed). This species provides consistent (1.0) dominance with cover around 12% including dense inclusions up to 25%. *Encelia farinosa* (brittlebush) is a transitional component of this community that is most prevalent where slopes increase and become more exposed.

This shrubland community covers about 3.03% (4,050 ha, 10,007 ac) of ORPI, predominantly at the foot of the Ajo Mountains. One minor example is present in the Bates Mountains, at the base of Kino Peak. This shrubland community spans low-angle (<15%) upper bajadas and mountain pediments from 650–800 m (2,123–2,624 ft). The surface is characterized by shallow to moderately deep, well-drained alluvium underlying a dominant layer of coarse gravel and cobble. Within this community, rock tends to be of volcanic origin.

Common Species: *Parkinsonia microphylla*, *Simmondsia chinensis*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 74–77.



Figure 74. An example landscape photo showing the Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.

NPS

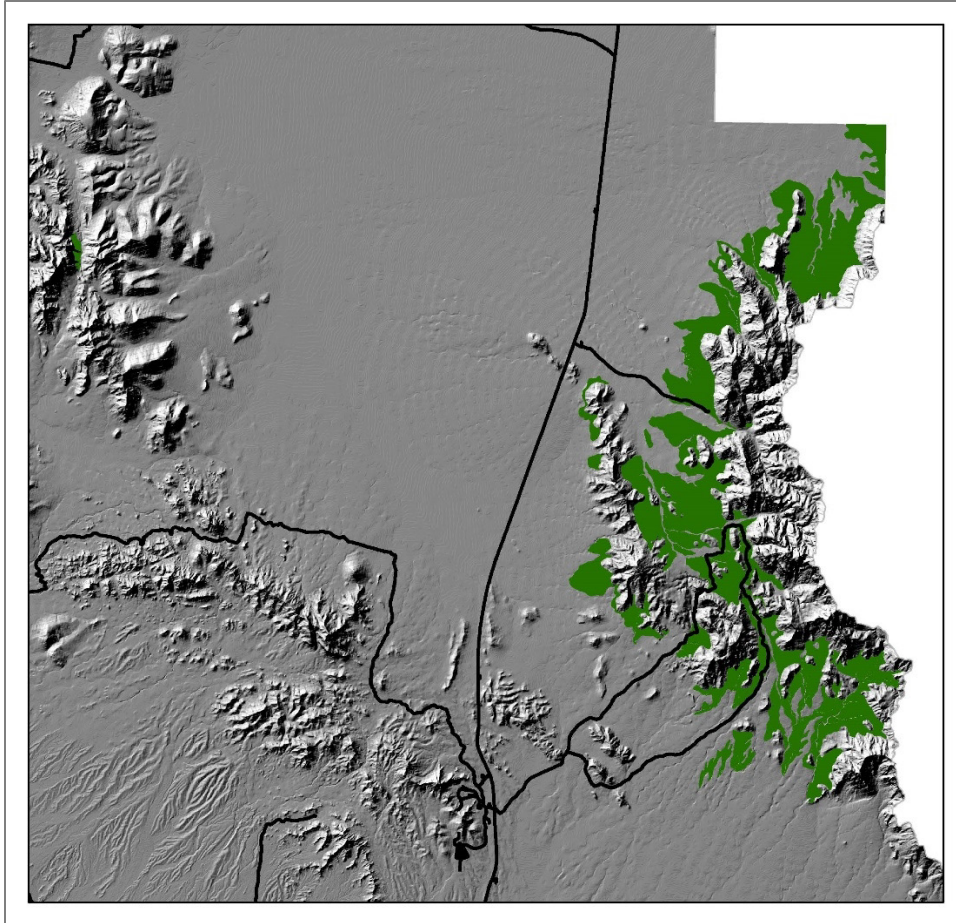


Figure 75. A distribution map, showing in green all areas mapped as Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.

NPS

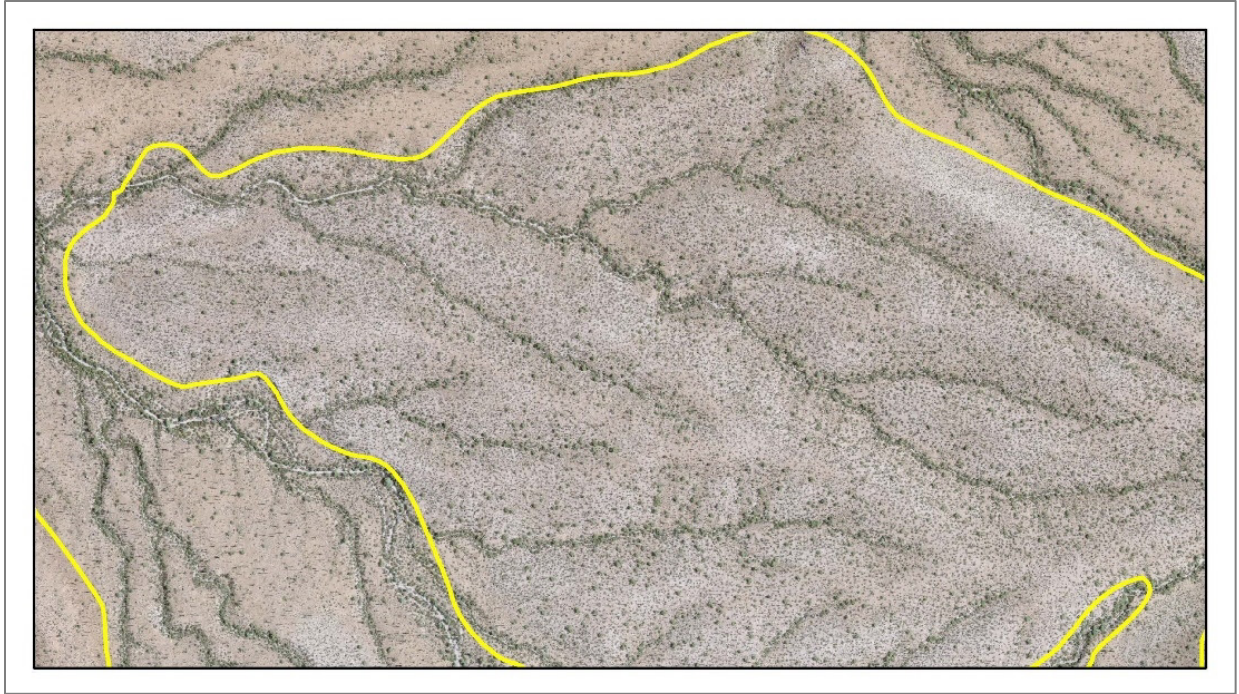


Figure 76. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.

NPS

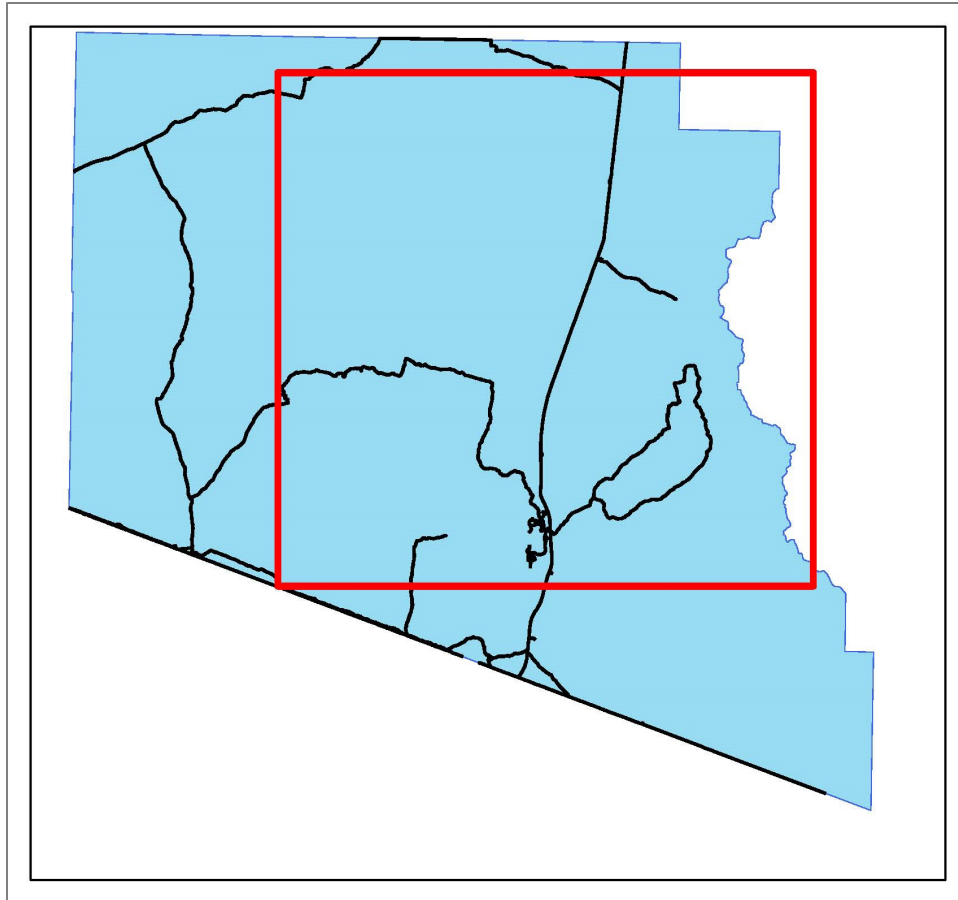


Figure 77. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Paloverde / Jojoba / Triangle Bur Ragweed Shrubland Association.

NPS

17. *Simmondsia chinensis* (*Bahiopsis parishii* – *Aloysia wrightii* – *Eriogonum fasciculatum*) Shrubland Association (P)

***Jojoba* (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland Association**

This shrubland association is characterized by a variable (10–30%) sub-canopy stratum (0.5–2 m) consistently (1.0) dominated by *Simmondsia chinensis* (jojoba) with a variable mix of sub-dominant shrubs, the most common of which include *Eriogonum fasciculatum* (Eastern Mojave buckwheat), *Bahiopsis parishii* (Parish goldeneye), and *Aloysia wrightii* (Wright’s beebrush).

Cover in the canopy strata (>2 m) is quite sparse (<5 [12]%) with only *Parkinsonia microphylla* (yellow paloverde) and *Fouquieria splendens* (ocotillo) providing conspicuous cover. The sub-canopy is defined by the consistent (1.0) dominance of *S. chinensis* (jojoba) with a variable mix of sub-dominants. Cover of this species can vary from the average of 12% to a low of 3% or as much as 50%. The variable (5–20 [30]%) field layer (<0.5 m) is dominated by a suite of low-shrubs and subshrubs, most commonly dominated by *E. fasciculatum* (Eastern Mojave buckwheat), *Bahiopsis parishii* (Parish goldeneye), and *A. wrightii* (Wright’s beebrush). These consistent (0.79–0.83) species range from sparse associates (<1%) to co-dominants with *S. chinensis* (jojoba) contributing cover up to 15%. On average, each species contributes 2–3% cover across the community. In areas of increased exposure, *Encelia farinosa* (brittlebush) may appear and occasionally become another co-dominant; however, these areas are generally small and not consistent across the community. The low-growing spikemoss, *Selaginella arizonica* (Arizona spikemoss) is an occasional component, that when present can create a sparse carpet of cover 3–5% amid the shrubs and rocks.

This shrubland community covers about 0.8% (2,127 ha, 5,257 ac) of ORPI, exclusively in the Ajo Mountains. It is found growing on slopes with north or northwest facing exposures, occasionally creeping around to the northeast as well, within the elevation range from 602 to 1,467 m (1,975–4,812 ft). Slopes are usually one face of a steep-sided canyon, with the grade ranging from 15 to >50%.

Common Species: *Simmondsia chinensis*, *Aloysia wrightii*, *Eriogonum fasciculatum*, *Bahiopsis parishii*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 78–81.



Figure 78. An example landscape photo showing the Jojoba (Parish Goldeneye – Wright's Beebrush – Eastern Mojave Buckwheat) Shrubland Association.

NPS

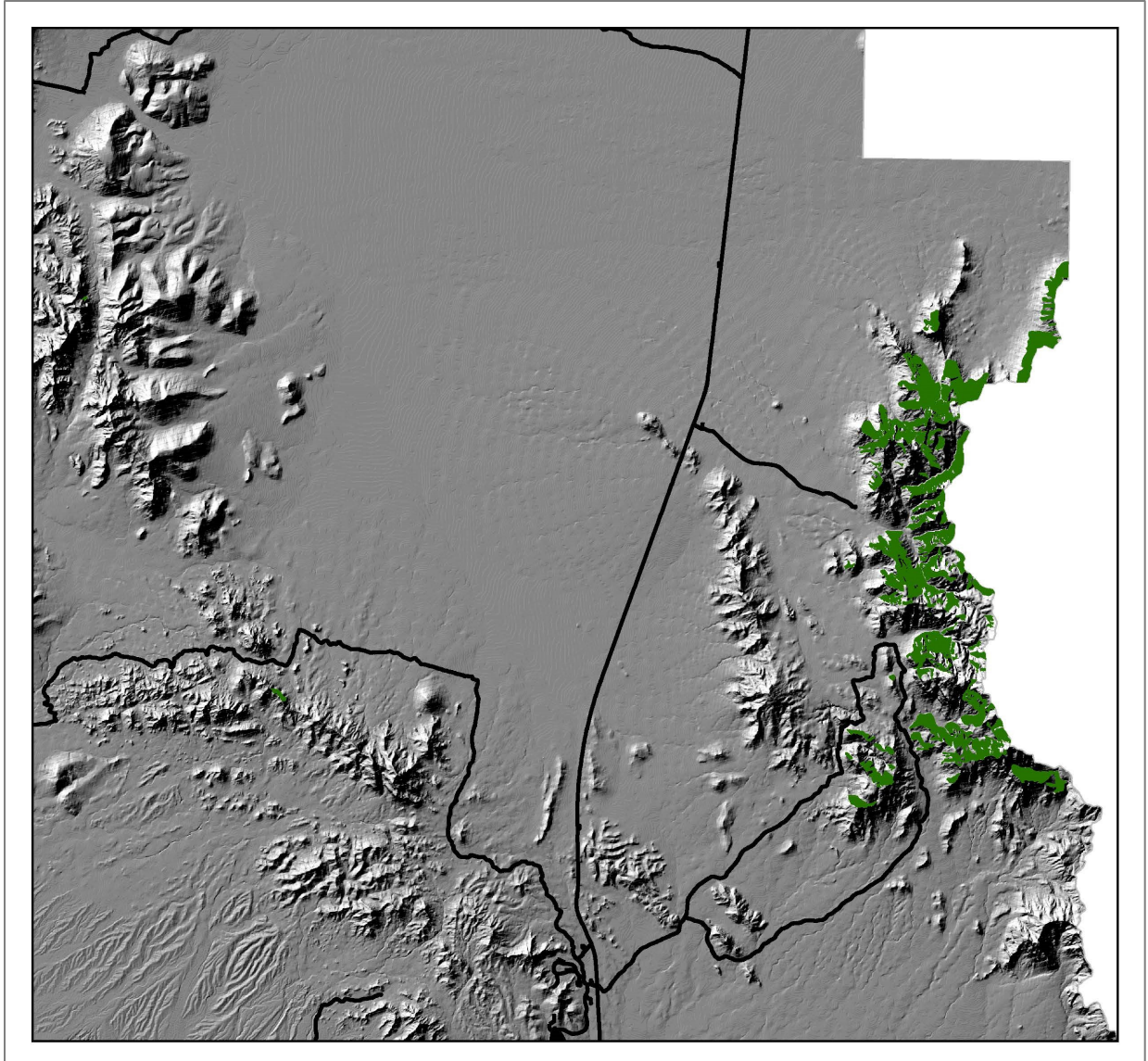


Figure 79. A distribution map, showing in green all areas mapped as Jojoba (Parish Goldeneye – Wright's Beebrush – Eastern Mojave Buckwheat) Shrubland Association.

NPS

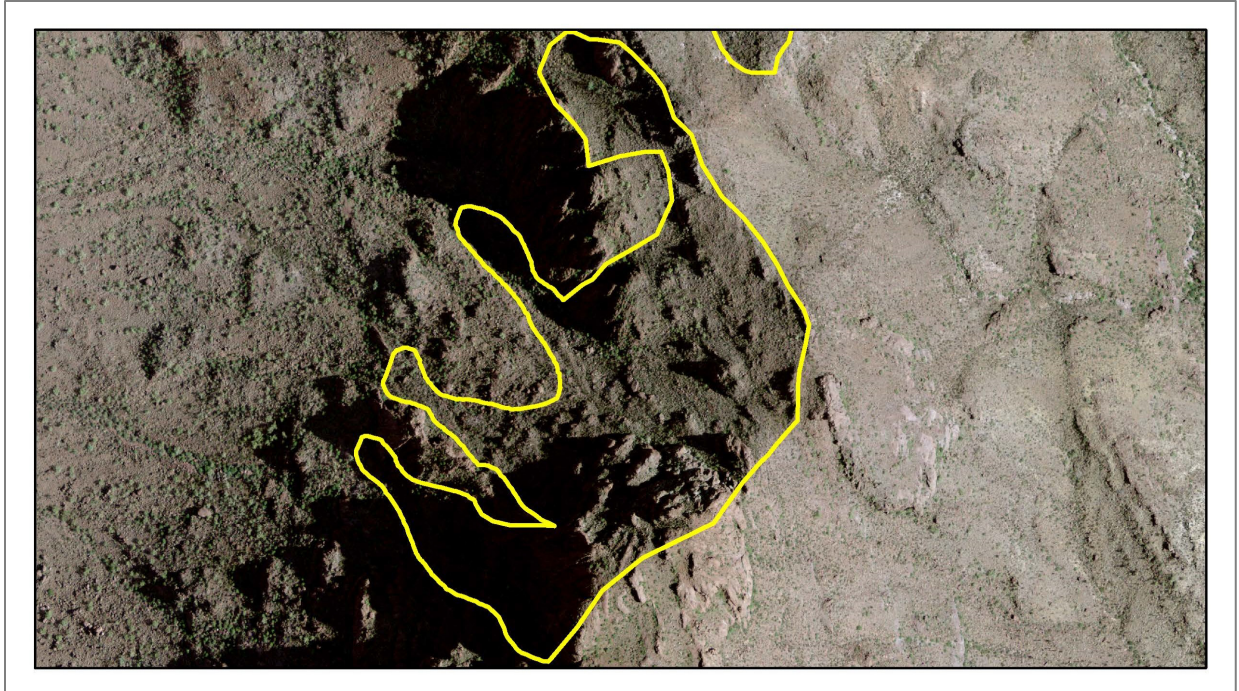


Figure 80. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Jojoba (Parish Goldeneye – Wright's Beebrush – Eastern Mojave Buckwheat) Shrubland Association.

NPS

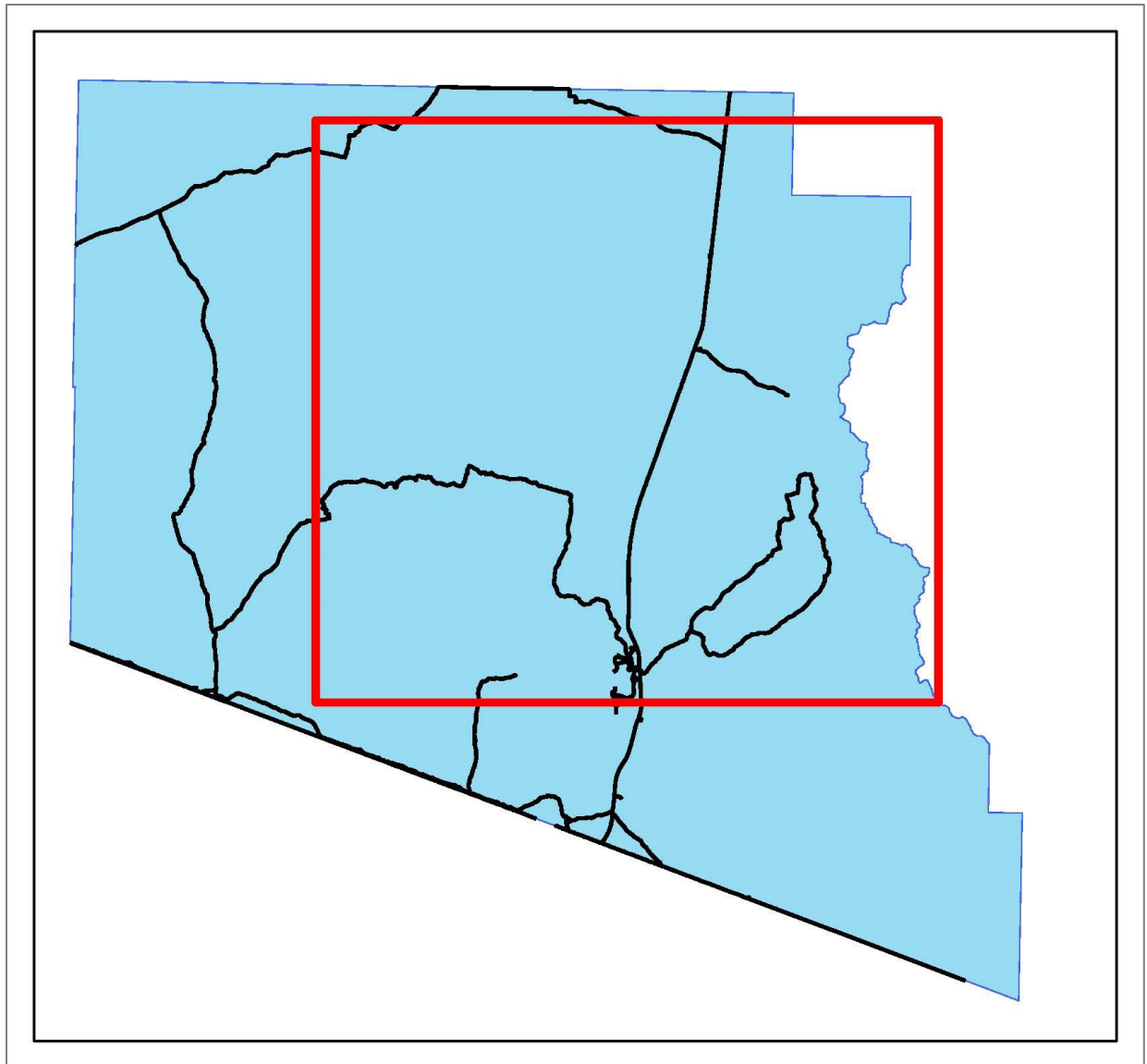


Figure 81. Map of ORPI with bounding box around the regions mapped and classified as the Jojoba (Parish Goldeneye – Wright’s Beebrush – Eastern Mojave Buckwheat) Shrubland Association.
NPS

18. *Simmondsia chinensis* – *Atriplex polycarpa* (*Encelia farinosa*) Shrubland Association (P)

***Jojoba* – *Cattle Saltbush* (*Brittlebush*) Shrubland Association**

This community is characterized by a moderately dense (20–30%) shrub layer (<2 m) co-dominated by *Simmondsia chinensis* (jojoba) and *Atriplex polycarpa* (cattle saltbush) with sporadic dominance provided by *Encelia farinosa* (brittlebush). It is often found adjacent to, or intermixed with, the similar *S. chinensis* (jojoba) – *Encelia farinosa* (brittlebush) shrubland association.

The canopy strata (>2 m) are absent to very sparse (<5%) with only *Fouquieria splendens* (ocotillo) providing conspicuous, but low (1–2%) cover. *S. chinensis* (jojoba) is a consistent (1.0) short-statured (<1 m) shrub that ranges from a sub-dominant with 2–3% cover to the primary dominant with 10–15%. *A. polycarpa* (cattle saltbush) is also a consistent (1.0) shrub, usually with cover around 10%. *Encelia farinosa* (brittlebush) is a consistent (1.0) species that provides variable cover ranging from sparse (<1%) to co-dominant with cover similar to *A. polycarpa* (cattle saltbush). High cover of this species typically occurs in the transition with the similar *S. chinensis* (jojoba) – *E. farinosa* (brittlebush) shrubland association. *Coursetia glandulosa* (rosary babybonnets) and *Lycium berlandieri* (Berlandier's wolfberry) are consistent (0.75) associates that typically contribute 1–3% cover. The remainder of the community is defined by a diverse suite of low cover (1%) and short-stature associate shrubs, subshrubs, and grasses.

This shrubland community covers about 0.08% (105 ha, 258 ac) of ORPI, exclusively in the Ajo Mountains. It spans steep (35–50+%) and south-trending backslopes from 750–1,250 m (2,460–4,104 ft). The surface cover is characterized by shallow soils underlying a layer of coarse gravel (>2 cm) and rock with areas of exposed bedrock.

Common Species: *Simmondsia chinensis*, *Atriplex polycarpa*, *Encelia farinosa*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 82–85.



Figure 82. An example landscape photo showing the Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.

NPS

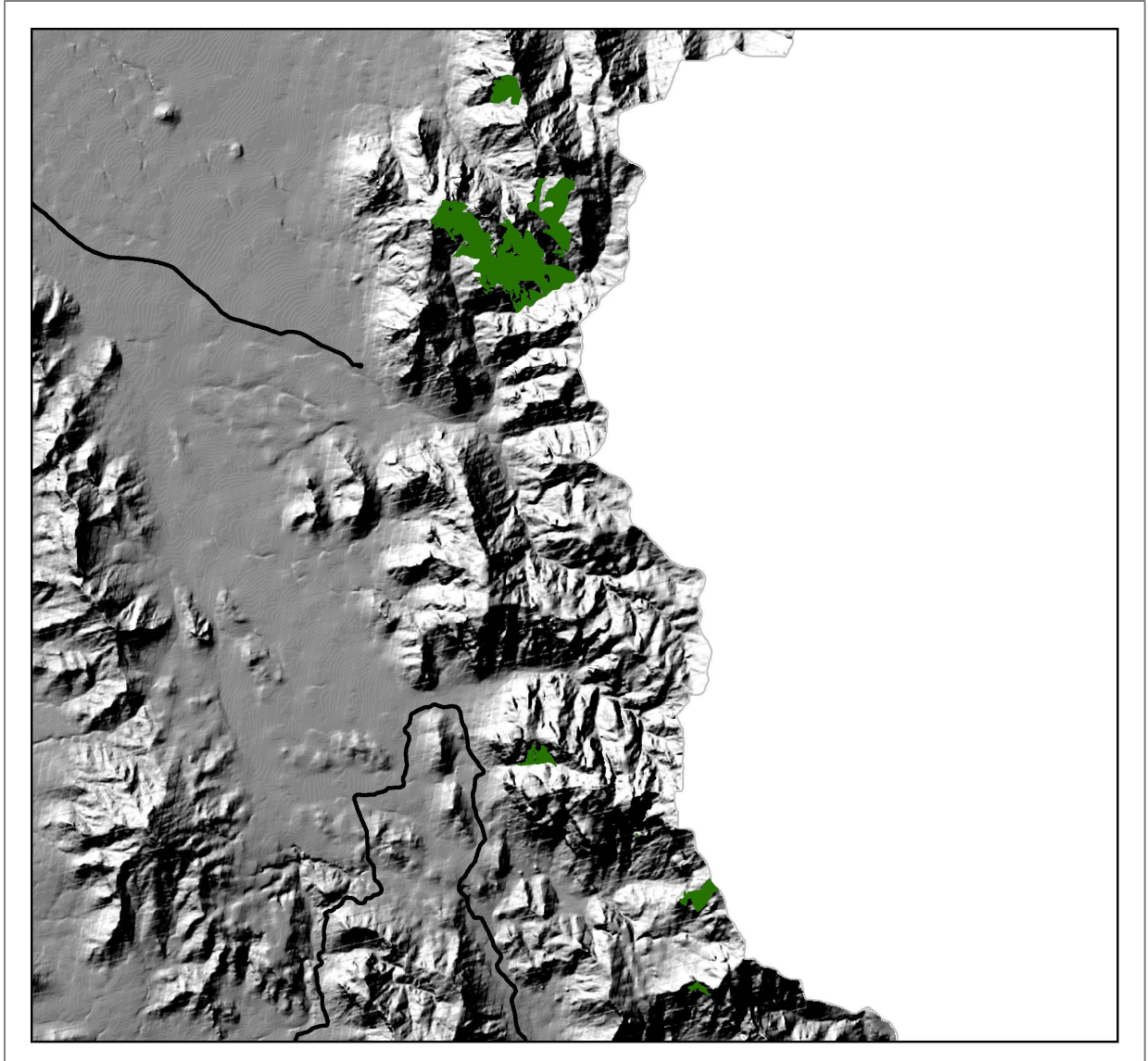


Figure 83. A distribution map, showing in green all areas mapped as Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.

NPS

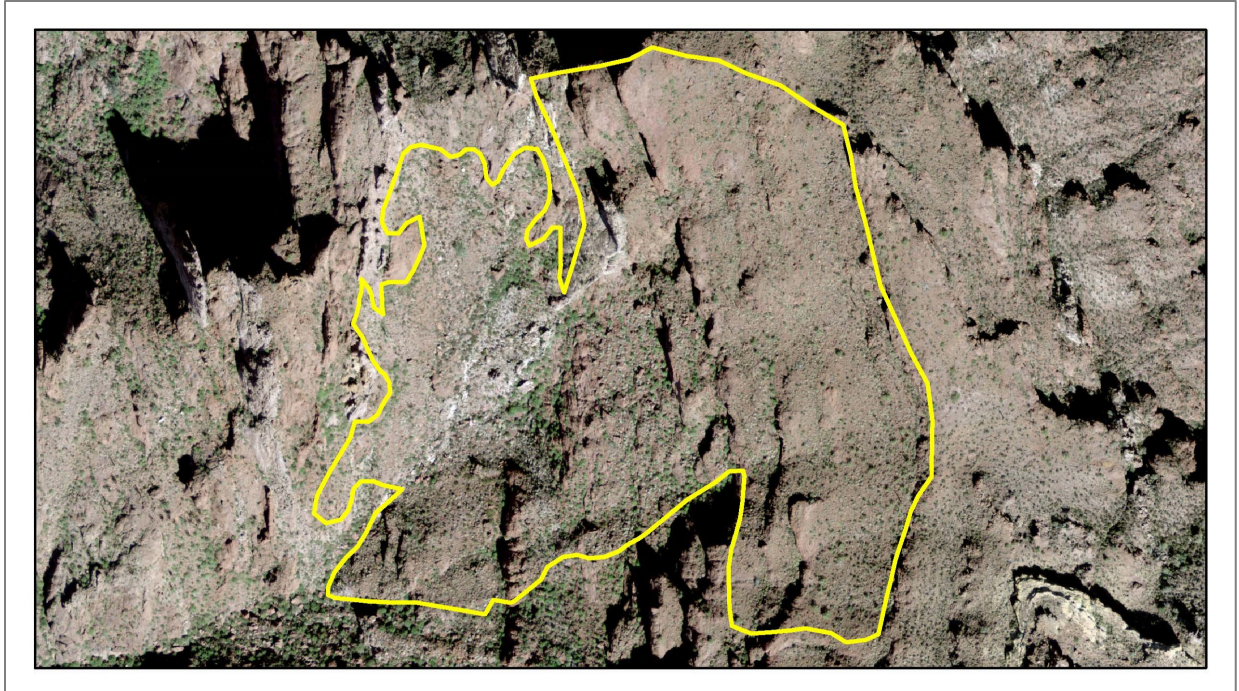


Figure 84. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.

NPS

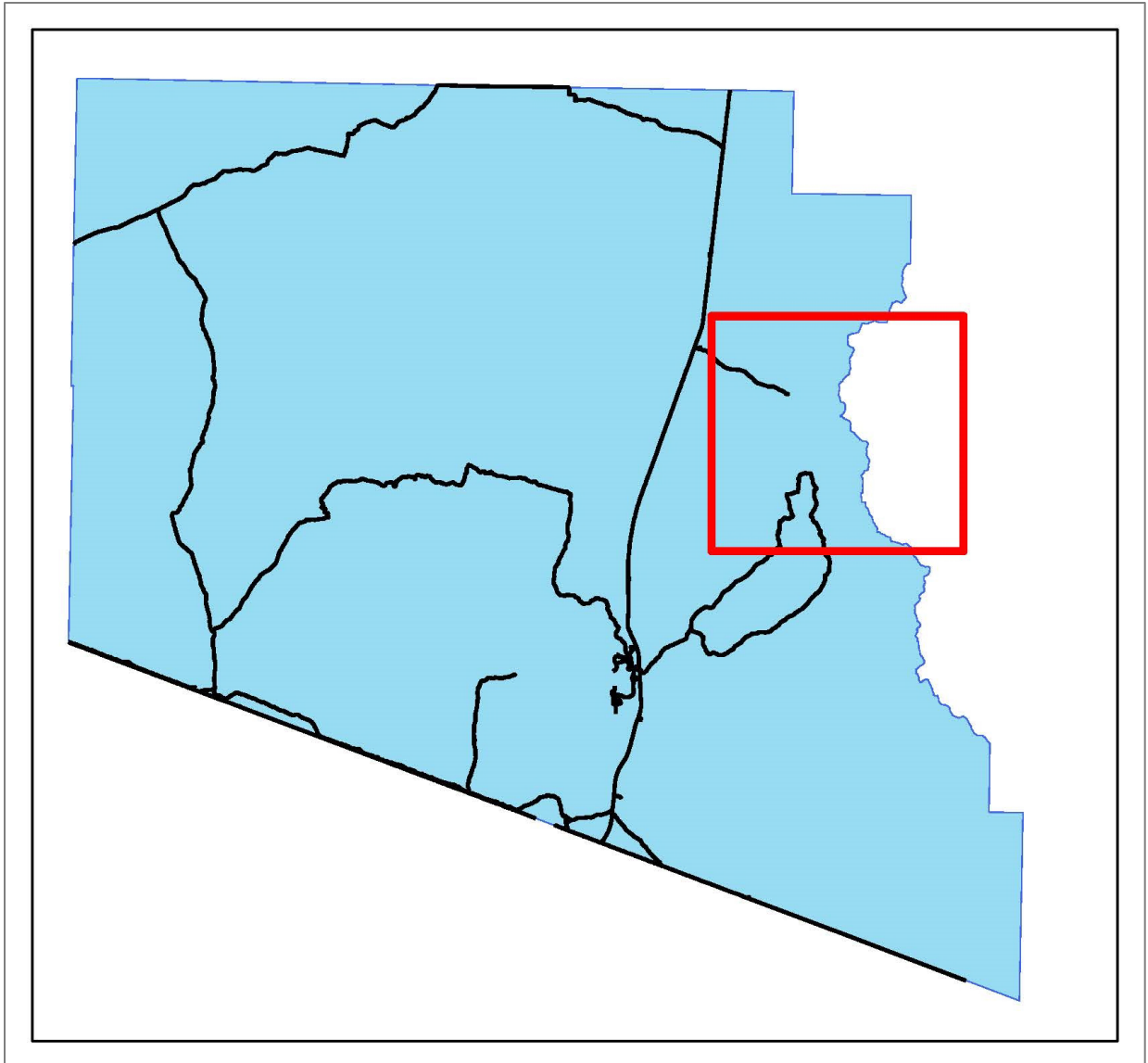


Figure 85. Map of ORPI with bounding box around the regions mapped and classified as the Jojoba – Cattle Saltbush (Brittlebush) Shrubland Association.

NPS

19. *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Simmondsia chinensis* / *Encelia farinosa* Shrubland Association (P)

Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association

This shrubland community is characterized by an open (5–15%) low-canopy (2–5 m) dominated by *Parkinsonia microphylla* (yellow paloverde) with conspicuous *Stenocereus thurberi* (organ pipe cactus), a sub-canopy (0.5–2 m) by *Simmondsia chinensis* (jojoba), and a field stratum (<0.5) by *Encelia farinosa* (brittlebush).

P. microphylla (yellow paloverde) is a consistent (1.0) component of this community that typically presents as a dominant species with average cover around 5% with some inclusions up to 15%. *S. thurberi* (organ pipe cactus) is a common (0.66) associate between 3–5 m in height. When present, this species provides average cover of 4% with rare, dense inclusions up to 15%. The relatively open (5–15 [25]%) sub-canopy stratum (0.5–2 m) is characterized by the consistent (0.88) dominance of *S. chinensis* (jojoba) with a mix of low-cover shrubs and succulents. With an average of 10% cover, this species provides the highest cover of any species documented in this community. *Cylindropuntia bigelovii* (teddybear cholla) is an inconsistent (1.0) associate that can occasionally become co-dominant with, or sub-dominant to, *S. chinensis* (jojoba) with cover approaching 10%. The sparse (<10%) field stratum (<0.5) is characterized by the sole dominance of *Encelia farinosa* (brittlebush) with a few sparse associates. This species was recorded as dominant in all examples of the community with average cover ranging from 5–15%.

This shrubland community is contained within a 2-association map class that covers about 1.0% (1,294 ha, 3,196 ac) of ORPI, exclusively in the Ajo Mountain Range. It typically spans south-trending mountain and hills slopes of variable grade (15–50+%) from 300–1,219 m (984–4,000). The surface cover is characterized by the dominance of coarse gravel (>2 cm) and rock with minimal exposed soil.

Common Species: *Parkinsonia microphylla*, *Stenocereus thurberi*, *Simmondsia chinensis*, *Encelia farinosa*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 86–89.



Figure 86. An example landscape photo showing the Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.

NPS

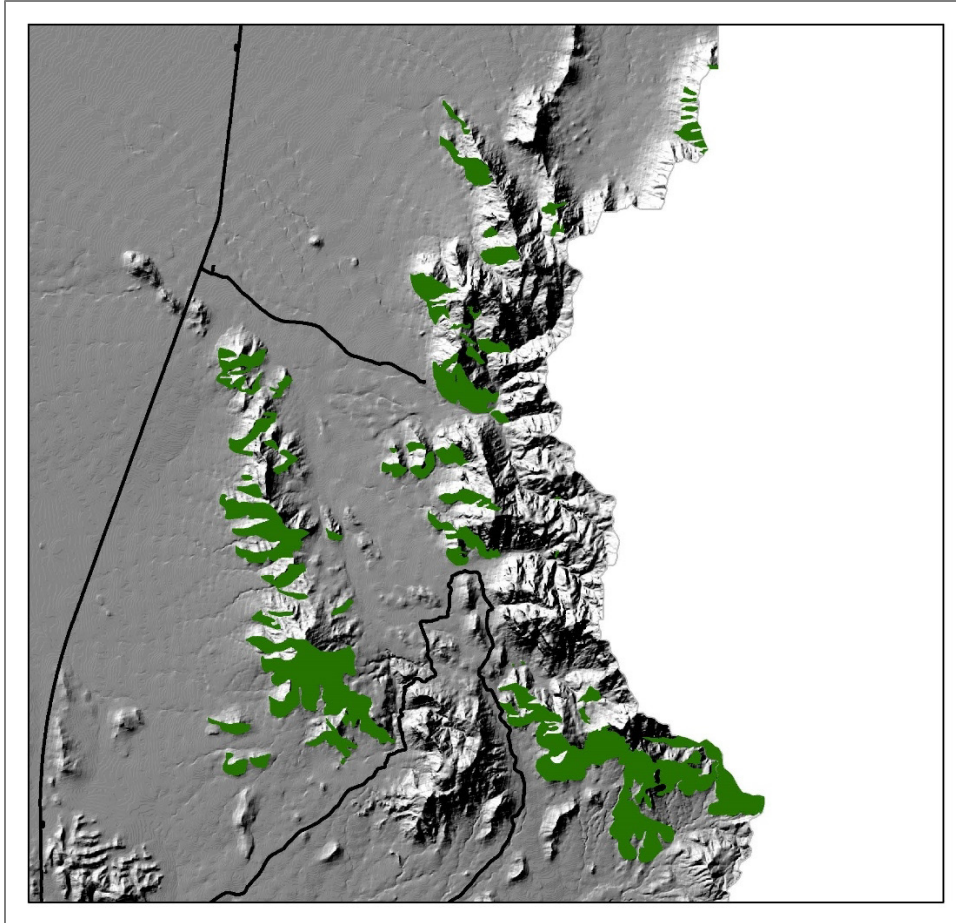


Figure 87. A distribution map, showing in green all areas mapped as Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.

NPS

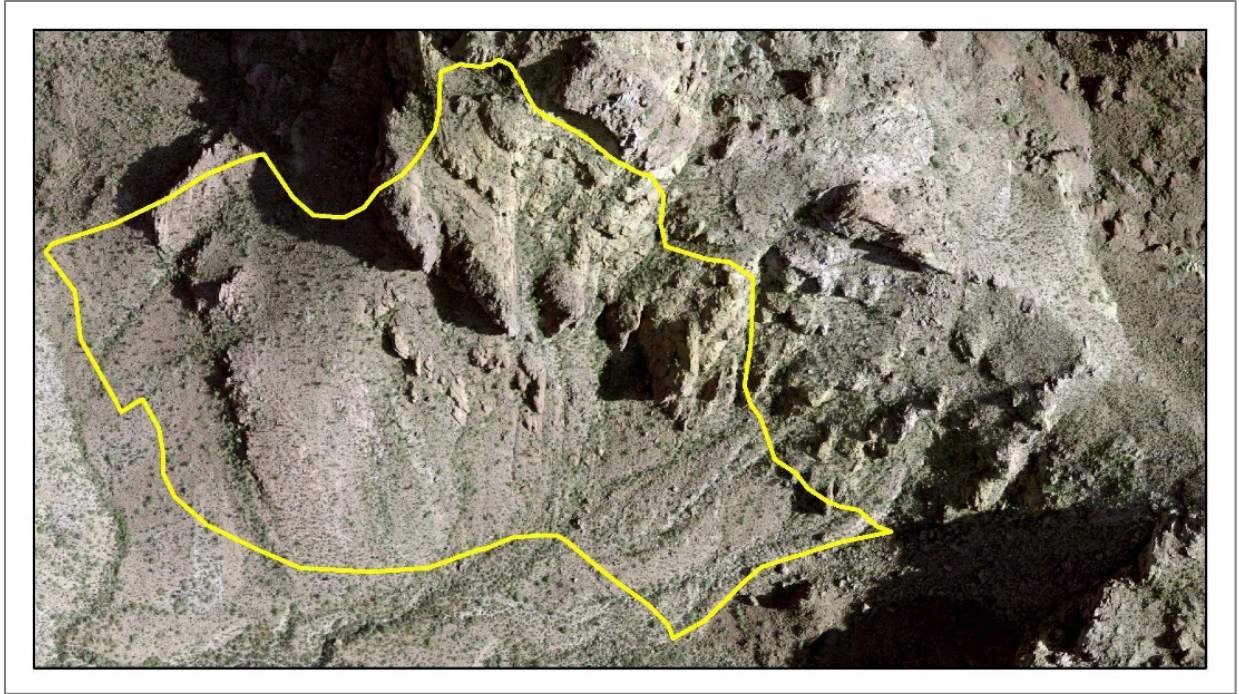


Figure 88. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.
NPS

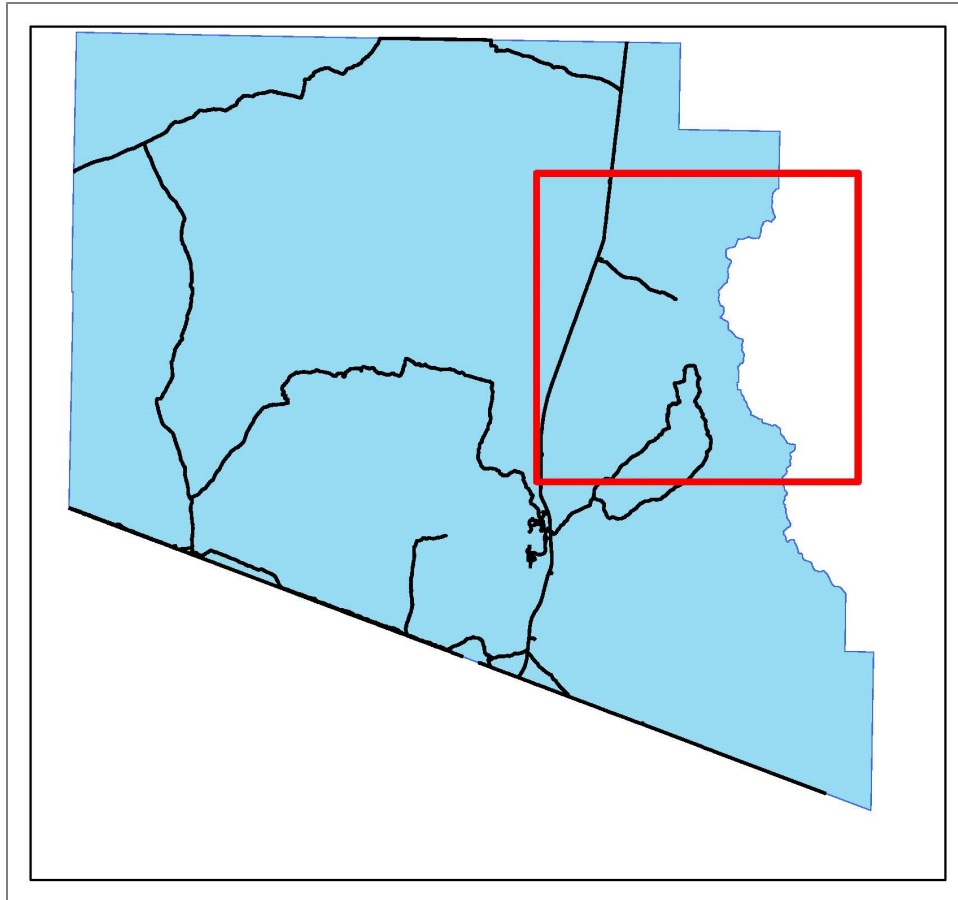


Figure 89. Map of ORPI with bounding box around the regions mapped and classified as the Yellow Paloverde (Organ Pipe Cactus) / Jojoba / Brittlebush Shrubland Association.

NPS

20. (*Parkinsonia microphylla*) *Fouquieria splendens* / *Simmondsia chinensis* (*Bursera microphylla*) / *Encelia farinosa* Shrubland Association (P)

(Yellow Paloverde) Ocotillo / Jojoba (Elephant Tree) / Brittlebush Shrubland Association

This shrubland community is characterized by an open (5–15%) canopy (>2 m) dominated by *Fouquieria splendens* (ocotillo) and *Stenocereus thurberi* (organ pipe cactus), a sub-canopy by *Simmondsia chinensis* (jojoba) and *Bursera microphylla* (elephant tree), and a field stratum *Encelia farinosa* (brittlebush).

F. splendens (ocotillo) is a consistent (1.0) canopy dominant with average cover around 10% including some areas that range up to 15%. *S. thurberi* (organ pipe cactus) provides consistent (1.0) cover, that typically ranges from 2 to 8% with an average around 7%. *Parkinsonia microphylla* (yellow paloverde) was the only additional species documented within the canopy, with consistent (0.8) low cover (<5%). The co-occurrence of *S. chinensis* (jojoba) and *B. microphylla* (elephant tree) is diagnostic of this community. These species are typically present as low-cover, co-dominants with each species contributing around 3–5 [7]% cover. The open (10–15%) field stratum (<0.5) is characterized by the consistent (1.0) dominance of *Encelia farinosa* (brittlebush) with a variable mix of low-cover associates. On average, *E. farinosa* (brittlebush) provides cover around 10%.

This shrubland community is contained within a 2-association map class that covers about 1.0% (1,294 ha, 3,196 ac) of ORPI, exclusively in the Ajo Mountain Range. It is found on moderately steep (15–50+%) south-trending mountain backslopes from 473 to 1,325 m (1,551–4,347 ft). At times this community can reach down to the toeslopes where it begins to transition to upper alluvial communities. The surface cover is characterized by a shallow layer of coarse (>2 cm) gravel and rock.

Common Species: *Fouquieria splendens*, *Stenocereus thurberi*, *Simmondsia chinensis*, *Bursera microphylla*, *Encelia farinosa*

This association is in a map class. Please see Figure 90 and refer to the previous type *Parkinsonia microphylla* (*Stenocereus thurberi*) / *Simmondsia chinensis* / *Encelia farinosa* Shrubland Association to see the shared distribution map and example imagery.



Figure 90. An example landscape photo showing the (Yellow Paloverde) Ocotillo / Jojoba (Elephant Tree) / Brittlebush Shrubland Association.

NPS

21. (*Parkinsonia microphylla*) / *Simmondsia chinensis* / *Encelia farinosa* Shrubland Association (P)

(Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association

This shrubland association is characterized by a sparse (<10%) canopy (>2 m) of *Parkinsonia microphylla* (yellow paloverde), a variable (10–30 [40]%) sub-canopy (0.5–2 m) dominated by *Simmondsia chinensis* (jojoba), and a variable ([<5] 10–30%) field stratum (<0.5 m) dominated by *Encelia farinosa* (brittlebush).

P. microphylla (yellow paloverde) is a common (0.69) associate that, when present, provides average cover around 5%. The sub-canopy (0.5–2 m) is characterized by the consistent presence (1.0) and typical dominance (0.67) of *S. chinensis* (jojoba). Cover of this species is quite variable, ranging from less than 5% to 20%, with an average around 9%. *Coursetia glandulosa* (rosary babybonnets) is a consistent (0.73) low cover (1–2%) associate that can rarely provide inclusions of co-dominance with *S. chinensis* (jojoba). *Larrea tridentata* (creosote) is a patchy (0.57) associate that, when present, provides cover equal to that of *S. chinensis* (jojoba). This species is most common on lower-angle slopes (<15%) where the mountain slopes transition into the alluvial fan. The field stratum (<0.5) is characterized by the sole dominance of *Encelia farinosa* (brittlebush) with a mix of low-cover associate subshrubs. On average, *E. farinosa* (brittlebush) provides cover around 13% with some inclusions approaching 30%. Areas of low cover typically coincide with a shift to a more sheltered, northern aspect.

This shrubland community covers about 1.6% (2,127 ha, 5,257 ac) of ORPI, exclusively in the Ajo Mountains. It typically spans south-trending mountain backslopes of variable grade (15–50%) from 600–1,150 m (1,968–3,772). At times, this community may appear on lower angle (5–15%) north to northwest-trending slopes. The surface cover is characterized by the dominance of coarse gravel (>2 cm) and rock with minimal exposed soil.

Common Species: *Parkinsonia microphylla*, *Simmondsia chinensis*, *Larrea tridentata*, *Encelia farinosa*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 91–94



Figure 91. An example landscape photo showing the (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.

NPS

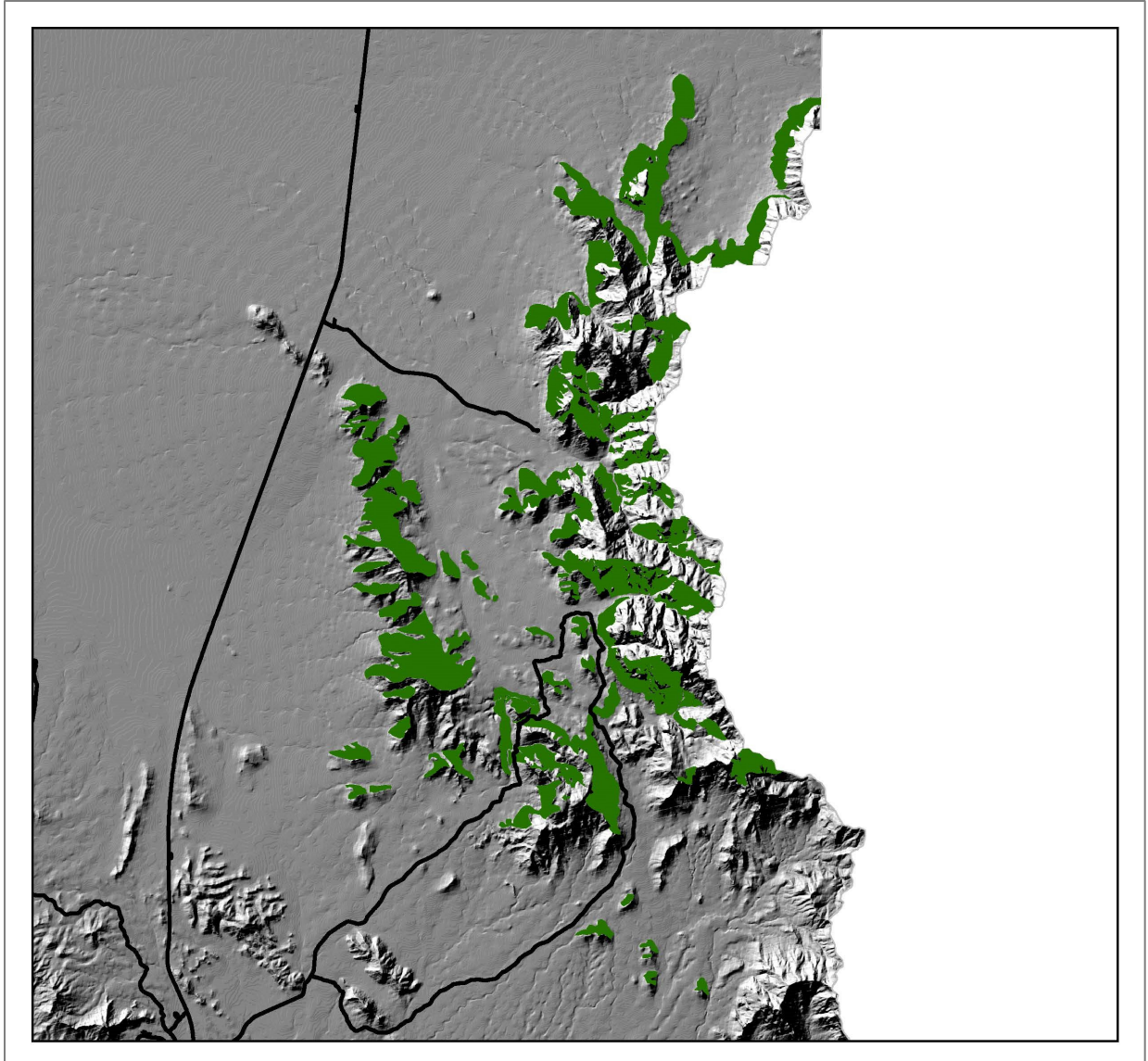


Figure 92. A distribution map, showing in green all areas mapped as (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.

NPS



Figure 93. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.

NPS

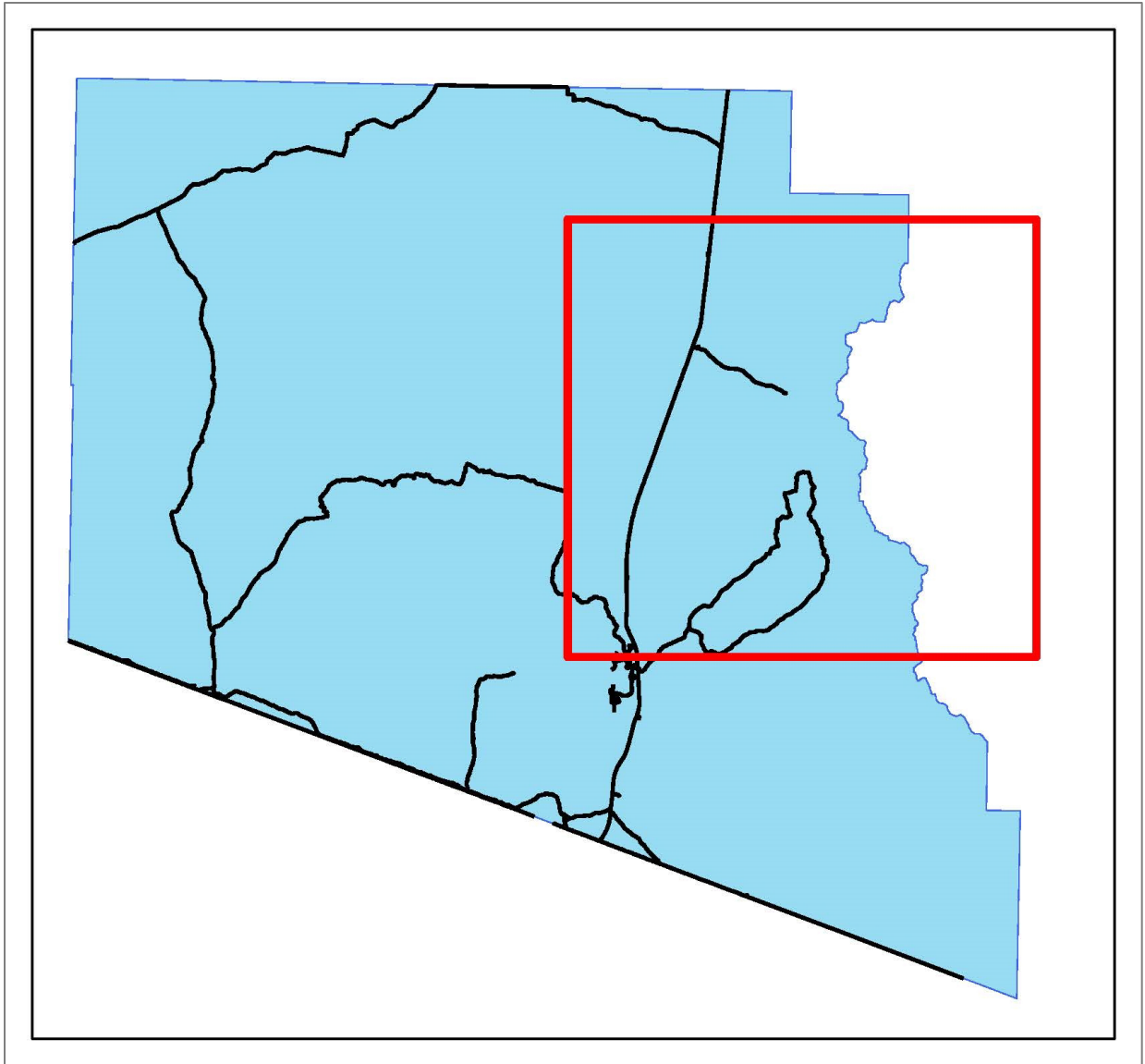


Figure 94. Map of ORPI with bounding box around the regions mapped and classified as the (Yellow Paloverde) / Jojoba / Brittlebush Shrubland Association.

NPS

22. *Larrea tridentata* / *Ambrosia deltoidea* Shrubland Association (P)

Creosote / Triangle Bur Ragweed Shrubland Association

This shrubland community is characterized by an open (5–15%) sub-canopy (0.5–2 m) dominated by *Larrea tridentata* (creosote) and a field stratum (<0.5 m) by *Ambrosia deltoidea* (triangle bur ragweed). This community is often intermixed with the similar *L. tridentata* (creosote) / *Ambrosia dumosa* (burrobush) shrubland association.

The sparse (<1%) canopy stratum (>2 m) contains a few low cover associates that are usually associated with minor washes or depressions. *Prosopis velutina* (velvet mesquite) is the most common tree species, but yellow paloverde (*Parkinsonia microphylla*) may also be present. The open (5–15%) sub-canopy stratum is characterized by the consistent (1.0) and sole dominance of *L. tridentata* (creosote). This species provides the highest cover within the community with an average around 7% with some inclusions of up to 20%. *Cylindropuntia fulgida* (jumping cholla) and *Cylindropuntia acanthocarpa* (buckhorn cholla) are the only other sub-canopy species documented in this shrubland. The sparse (<5%) field stratum (<0.5 m) is characterized by the dominance of *A. deltoidea* (triangle bur ragweed) with a few very low cover (<1%) associates. This species is a consistent (1.0) dominant with average cover around 4% and may be evenly distributed across the community or densely clustered around minor hydrologic features. *A. dumosa* (burrobush) is an occasional (0.31), low cover (1%) associate that never outcompetes *A. deltoidea* (triangle bur ragweed).

This shrubland community is contained within a 2-association map class that covers about 10.6% (14,185 ha, 35,051 ac) of ORPI and is widespread throughout the lower bajada. This shrubland community spans north-trending, low-angle (<5%) upper fans from 325 to 550 m (1,066–1,804 ft). The substrate is characterized by very deep and well drained mixed alluvium below a surface layer of fine gravel.

Common Species: *Larrea tridentata*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 95–97.



Figure 95. An example landscape photo showing the Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

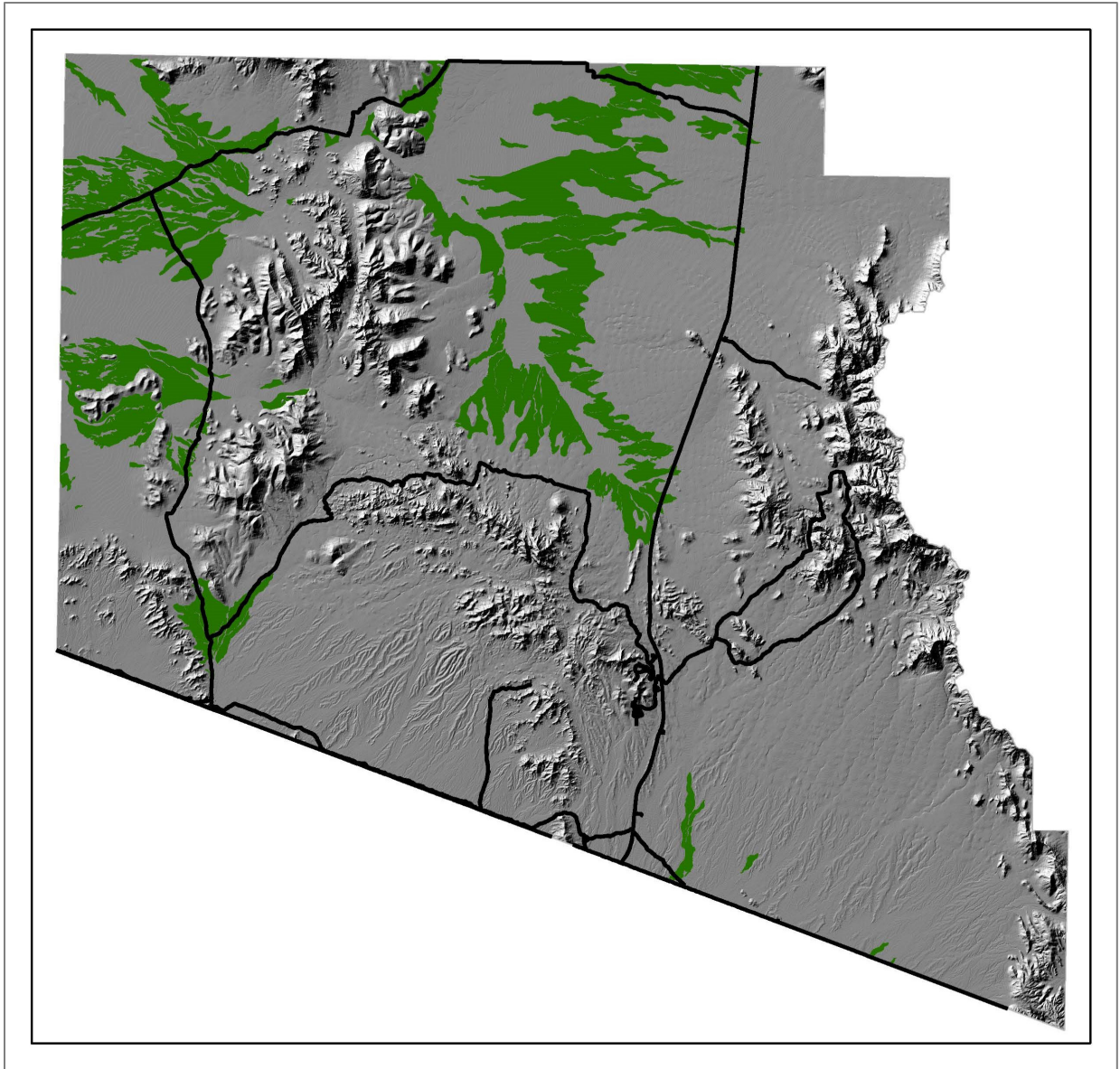


Figure 96. A distribution map, showing in green all areas mapped as the Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

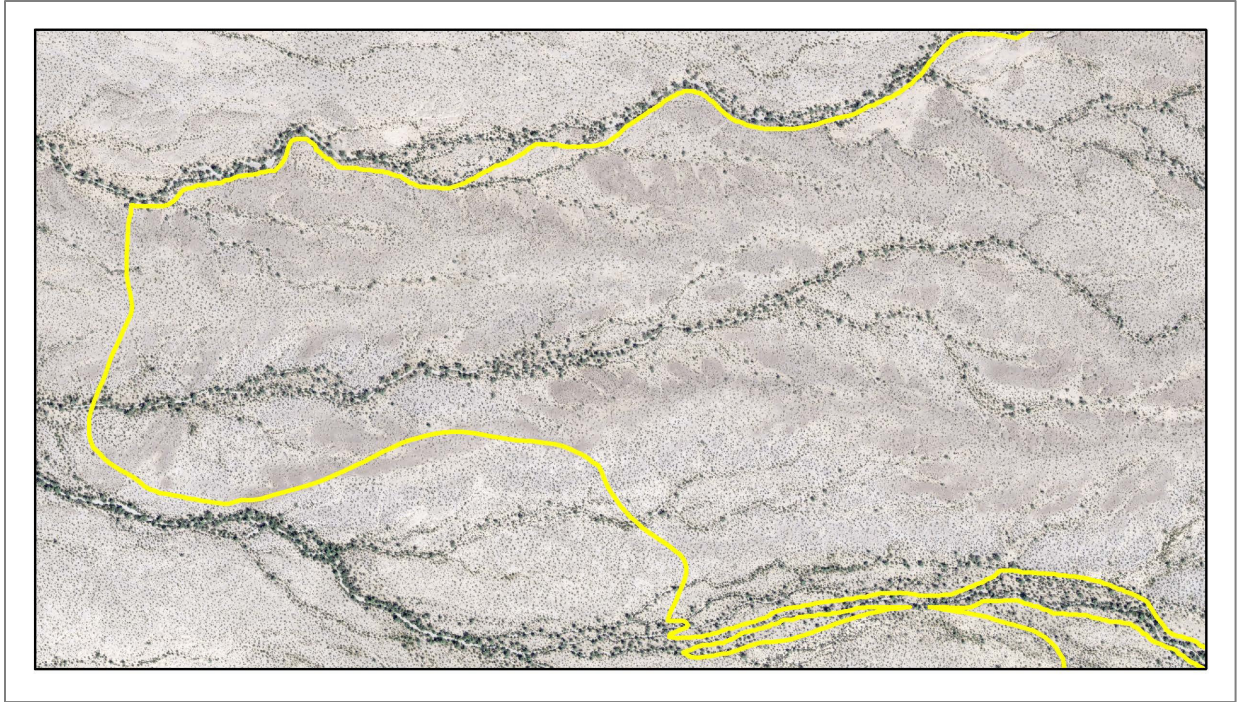


Figure 97. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Creosote / Triangle Bur Ragweed Shrubland Association.

NPS

23. *Larrea tridentata* / *Ambrosia dumosa* Shrubland Association

Creosote / Burrobush Shrubland Association

This shrubland community is characterized by an open (5–15%) sub-canopy (0.5–2 m) dominated by *Larrea tridentata* (creosote) and a field stratum (<0.5 m) by *Ambrosia dumosa* (burrobush). This community is often intermixed with the similar *L. tridentata* (creosote) / *Ambrosia deltoidea* (triangle bur ragweed) shrubland association.

The sparse (<1%) canopy stratum (>2 m) contains a few low cover associates that are usually associated with minor washes or depressions. The open (5–15%) sub-canopy stratum is characterized by the consistent (1.0) and sole dominance of *L. tridentata* (creosote). This species provides the highest cover within the community with an average around 8%. *Cylindropuntia fulgida* (jumping cholla) was the only other species documented in this shrubland. The sparse (<5%) field stratum (<0.5 m) is characterized by the dominance of *A. dumosa* (burrobush) with a few very low cover (<1%) associates. *A. dumosa* (burrobush) is a consistent (1.0) dominant with average cover around 4%. *A. deltoidea* (triangle bur ragweed) is a patchy (0.33), low cover associate species (<1%) that never outcompetes *A. dumosa* (burrobush).

This shrubland community is contained within a 2-association map class that covers about 10.6% (14,185 ha, 35,051 ac) of ORPI and is widespread throughout the lower bajada. This shrubland community spans north-trending, low-angle (<5%) alluvial fans from 325 to 550 m (1,066–1,804 ft). The substrate is characterized by very deep and well drained mixed alluvium below a surface layer of fine gravel.

Common Species: *Larrea tridentata*, *Ambrosia dumosa*

This association is in a map class. Please see Figure 98 and refer to the previous type *Larrea tridentata* / *Ambrosia deltoidea* Shrubland Association to see the shared distribution map and example imagery.



Figure 98. An example landscape photo showing the Creosote / Burrobush Shrubland Association.
NPS

24. *Larrea tridentata* Shrubland Association

Creosote Shrubland Association

This shrubland community is characterized by the sole dominance of *Larrea tridentata* (creosote) with seasonal contributions from a suite of annual forbs.

The canopy strata (>2 m) are generally absent with only a few instances with documented species, such as *Olneya tesota* (ironwood) and *Prosopis velutina* (velvet mesquite). These species typically appear along minor included washes and/or floodplains. *L. tridentata* (creosote) consistently (1.0) dominates the sub-canopy stratum (0.5–2 m) with average cover around 11% including some dense inclusions up to 30%. A couple of very inconsistent and low cover (<1%) associate shrubs and succulents may be present including *Lycium andersonii* (water jacket), *Senegalia greggii* (catclaw acacia), and *Cylindropuntia fulgida* (jumping cholla). The field stratum (<0.5 m) is characterized by the seasonal dominance of annual forbs with a mix of very low-cover subshrubs.

This shrubland community covers about 6.35% (8,494 ha, 20,988 ac) of ORPI, with the largest examples occurring in the Growler, Ajo, and San Cristóbal Valleys. This shrubland community spans low-angle (<5%) bajadas from 620–1,140 m (2,034–3,740 ft). The soil is characterized by very deep, well drained stream alluvium underlying a layer of dominant fine gravel (<0.5 cm) and bare soil. Biological soil crusts are widespread throughout this community.

Common Species: *Larrea tridentata*, *Annual Forbs*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 99–101.



Figure 99. An example landscape photo showing the Creosote Shrubland Association.

NPS

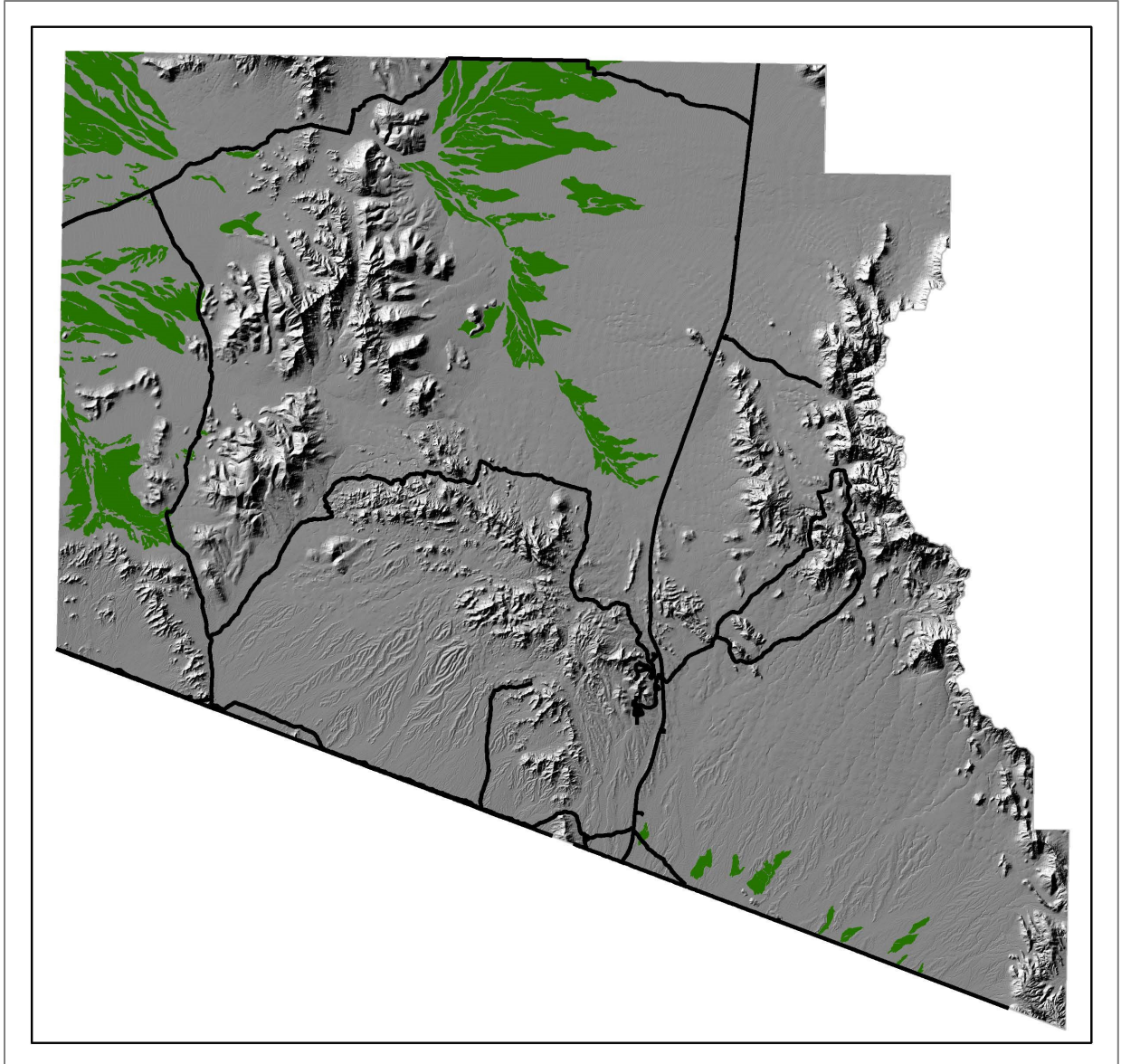


Figure 100. A distribution map, showing in green all areas mapped as Creosote Shrubland Association.
NPS

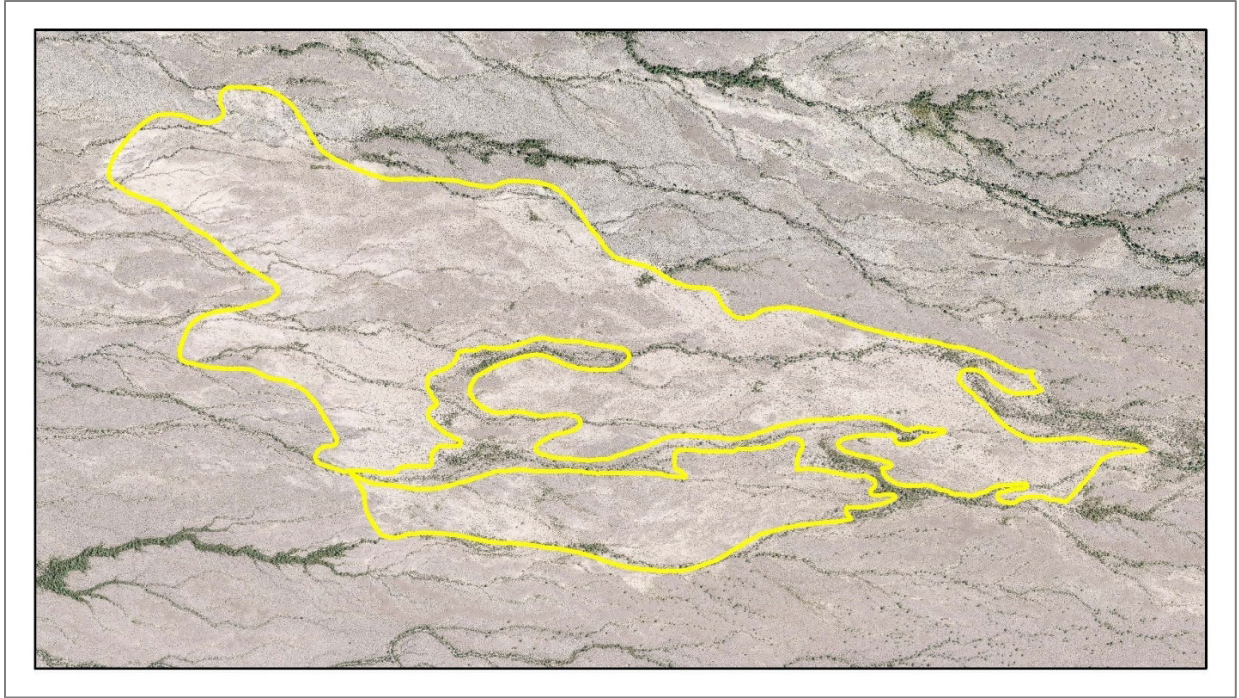


Figure 101. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Creosote Shrubland Association.

NPS

25. *Fouquieria splendens* / *Larrea tridentata* / *Ambrosia dumosa* Shrubland Association

***Ocotillo* / *Creosote* / *Burrobush* Shrubland Association**

This shrubland community is characterized by an open (10–15%) canopy (>2 m) dominated by *Fouquieria splendens* (ocotillo), a sub-canopy (0.5–2 m) by *Larrea tridentata* (creosote), and a field stratum (<0.5 m) by *Ambrosia dumosa* (burrobush) and/or *Ambrosia deltoidea* (triangle bur ragweed).

F. splendens (ocotillo) is a consistent (1.0) canopy dominant with cover that typically ranges from 5–10%. *Parkinsonia microphylla* (yellow paloverde) is a common (0.80) associate that, when present, provides cover similar to *F. splendens* (ocotillo). The open (5–15%) sub-canopy stratum (0.5–2 m) is characterized by the consistent (1.0) dominance of *L. tridentata* (creosote) with a few occasional sub-dominants. Across the community *L. tridentata* (creosote) provides cover ranging from [1] 5–10%. Both *Cylindropuntia fulgida* (jumping cholla) and *Jatropha cuneata* (physicnut) were present as co-dominants or sub-dominants in one example of this community. The open (5–15%) field stratum (<0.5 m) is characterized by the dominance of *A. dumosa* (burrobush) and/or *A. deltoidea* (triangle bur ragweed). These species provided average cover around 5% with some inclusions up to 10%. *Encelia farinosa* (brittlebush) is a consistent (1.0), but low cover (1%) associate that rarely outcompetes *Ambrosia* spp. (ragweed).

This shrubland community covers about 0.66% (882 ha, 2,179 ac) of ORPI, exclusively in the Bates Mountain and the Cipriano Hills. Within these areas the community spans low-angle (<10%) slopes of variable aspect from 350–850 m (1,150–2,788 ft). Often, this community is found around the summits of small hills, spanning all aspects. The surface cover is defined by very rocky soil, typically of volcanic origin, that presents as a dense layer of coarse gravel with scattered cobbles.

Common Species: *Fouquieria splendens*, *Parkinsonia microphylla*, *Larrea tridentata*, *Ambrosia dumosa*, *Ambrosia deltoidea*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 102–105.



Figure 102. An example landscape photo showing the Ocotillo / Creosote / Burrobush Shrubland Association.

NPS

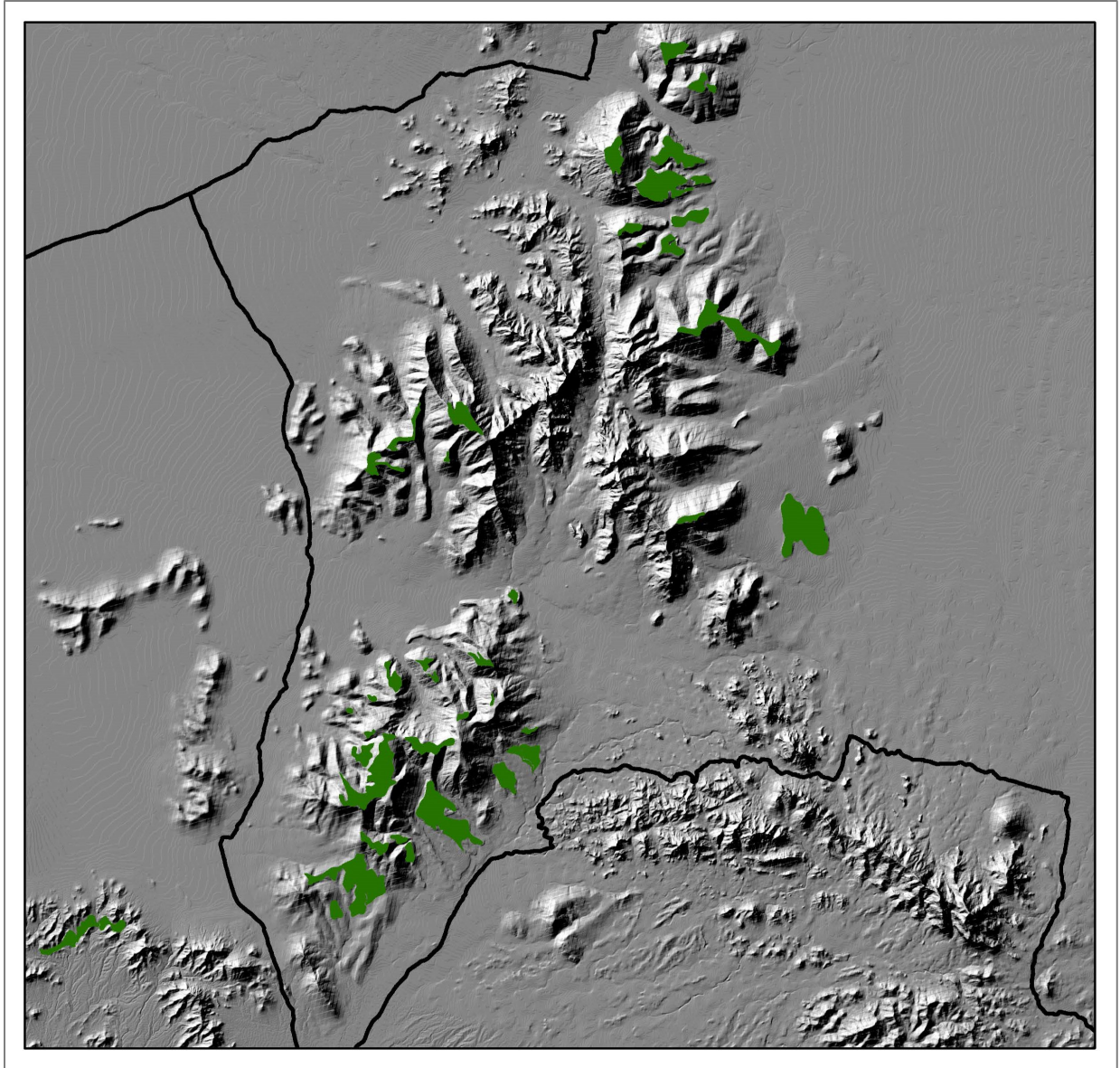


Figure 103. A distribution map, showing in green all areas mapped as Ocotillo / Creosote / Burrobush Shrubland Association.

NPS

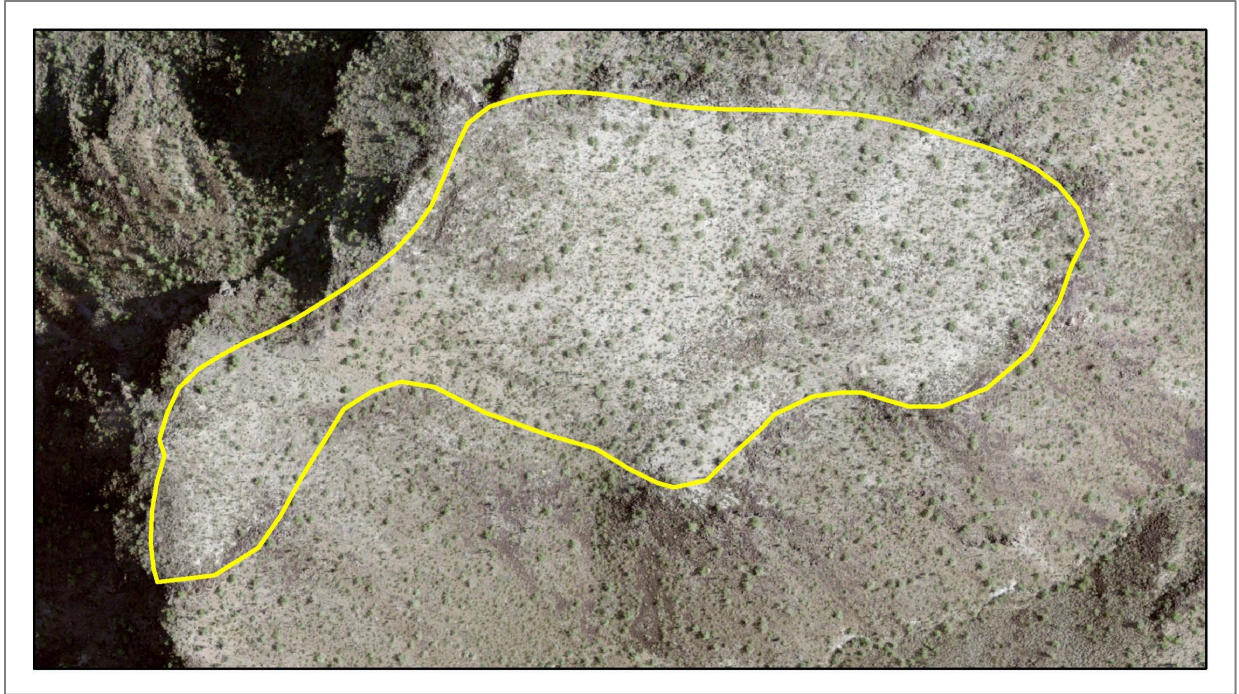


Figure 104. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Ocotillo / Creosote / Burrobush Shrubland Association.

NPS

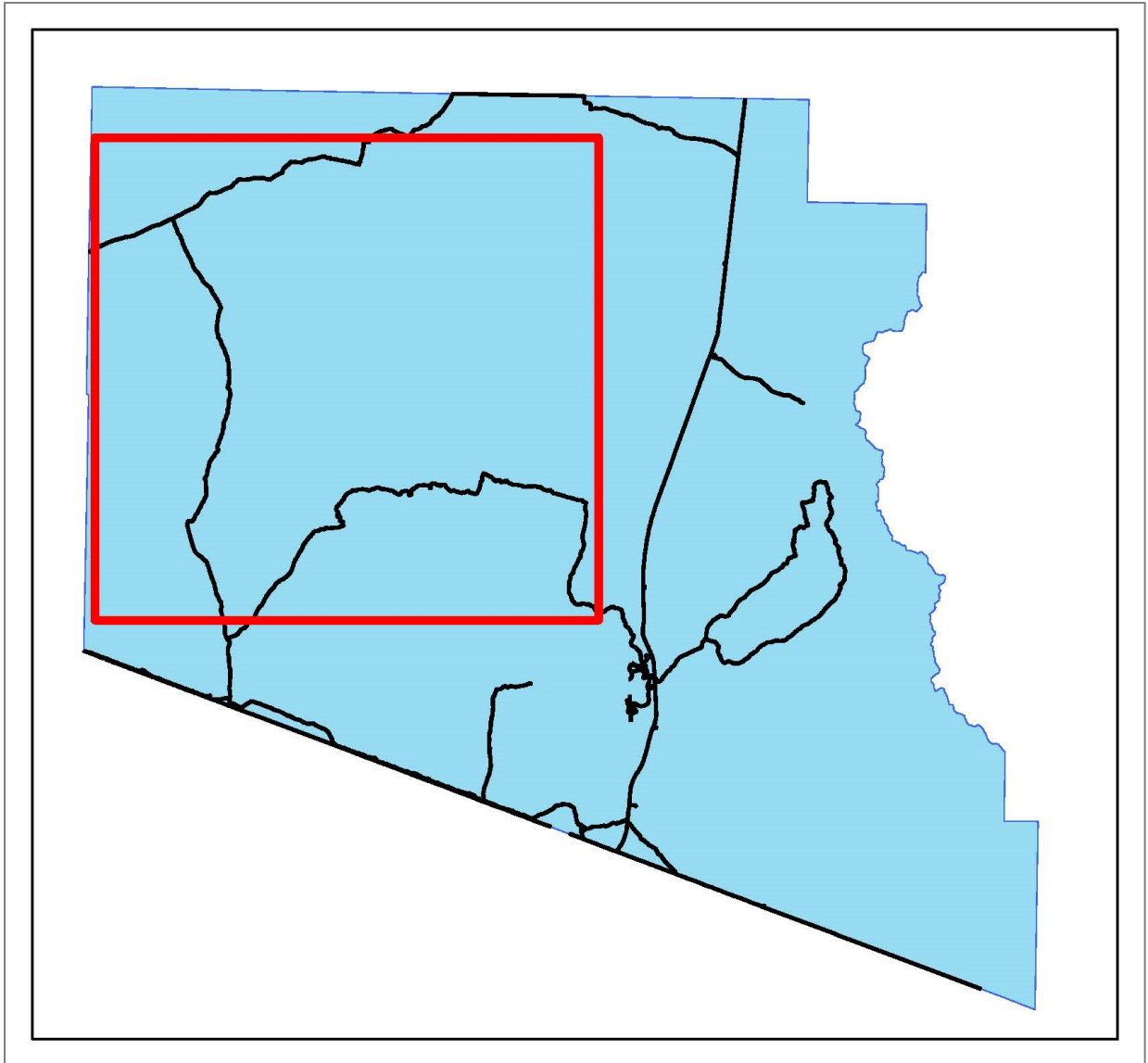


Figure 105. Map of ORPI with bounding box around the regions mapped as Ocotillo / Creosote / Burrobush Shrubland Association.

NPS

26. *Larrea tridentata* – *Atriplex polycarpa* Shrubland Association

Creosote – Cattle Saltbush Shrubland Association

This shrubland community is characterized by an open (10%) sub-canopy stratum (0.5–2 m) dominated by *Larrea tridentata* (creosote) with a field stratum (<0.5 m) dominated by *Atriplex* spp. (saltbush), mainly *Atriplex polycarpa* (cattle saltbush).

The canopy strata (>2 m) are very sparse (1%) with only *Prosopis velutina* (velvet mesquite) and *Parkinsonia microphylla* (yellow paloverde) documented in this community. The sub-canopy is defined by the consistent (0.89) dominance of *L. tridentata* (creosote). When present, this species typically provides cover ranging from 5–10%; however, dense (25%) and sparse (1%) examples may occur throughout. Cover in the field stratum is quite variable, ranging from sparse inclusions down to 3% and dense patches reaching up to 30% with an average around 10%. *A. polycarpa* (cattle saltbush) accounts for the majority of this cover with an average around 8%, including dense inclusions up to 30%. In most examples (0.80) of the community, this species provides sole dominance in the field; however, in a few instances *A. linearis* (thinleaf fourwing saltbush) became a co-dominant. This species provides patchy (0.75) cover that, when present, ranges from 1 to 3%. A broad gradient exists between this association and the similar and often adjacent *L. tridentata* (creosote bush) shrubland association. In this gradient, *Atriplex* spp. (saltbush) gradually decreases in cover and consistency until *L. tridentata* (creosote bush) is the sole dominant.

This shrubland community covers about 1.9% (2,590 ha, 6,400 ac) of ORPI, exclusively along the southern boundary of the monument. This shrubland community spans very low-angle (1%) south-trending lower-bajadas from 300–500 m (984–1,640 ft). The soil is composed of very deep, well-drained alluvium, often underlying a dense layer of sorted gravel. The surface often presents as desert pavement.

Common Species: *Larrea tridentata*, *Atriplex polycarpa*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 106–109.



Figure 106. An example landscape photo showing the Creosote – Cattle Saltbush Shrubland Association.

NPS

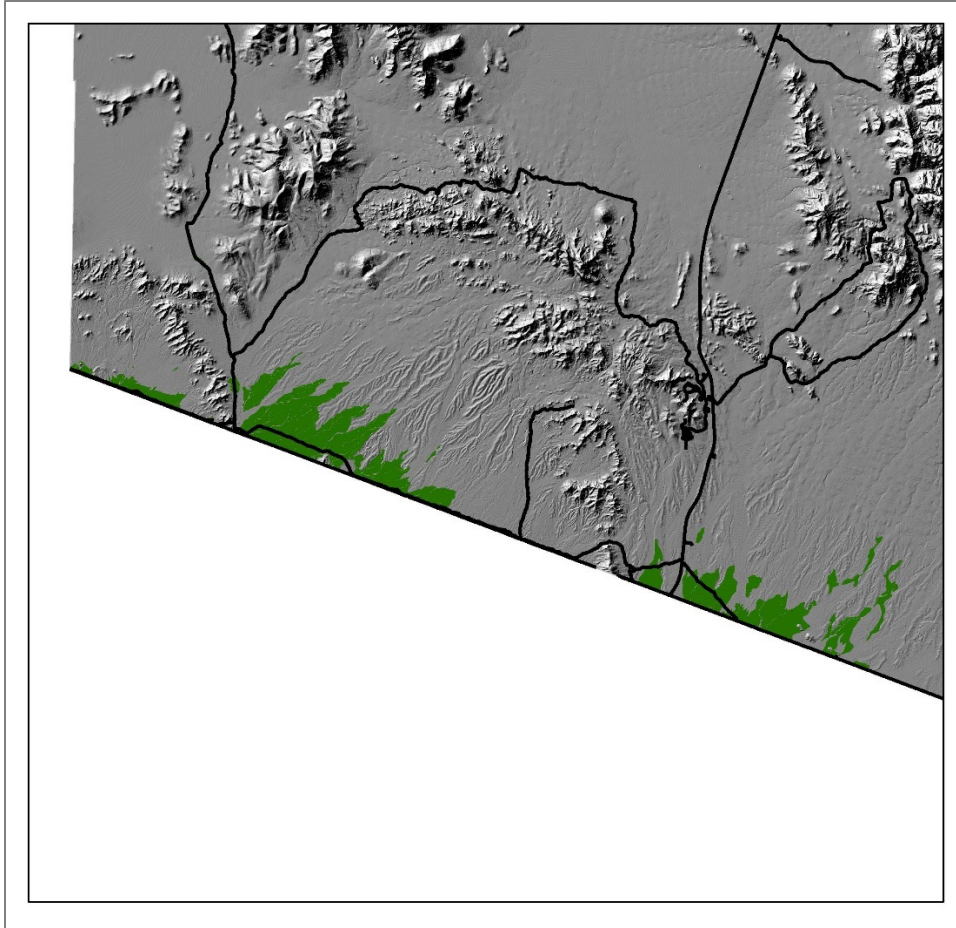


Figure 107. A distribution map, showing in green all areas mapped as the Creosote – Cattle Saltbush Shrubland Association.

NPS

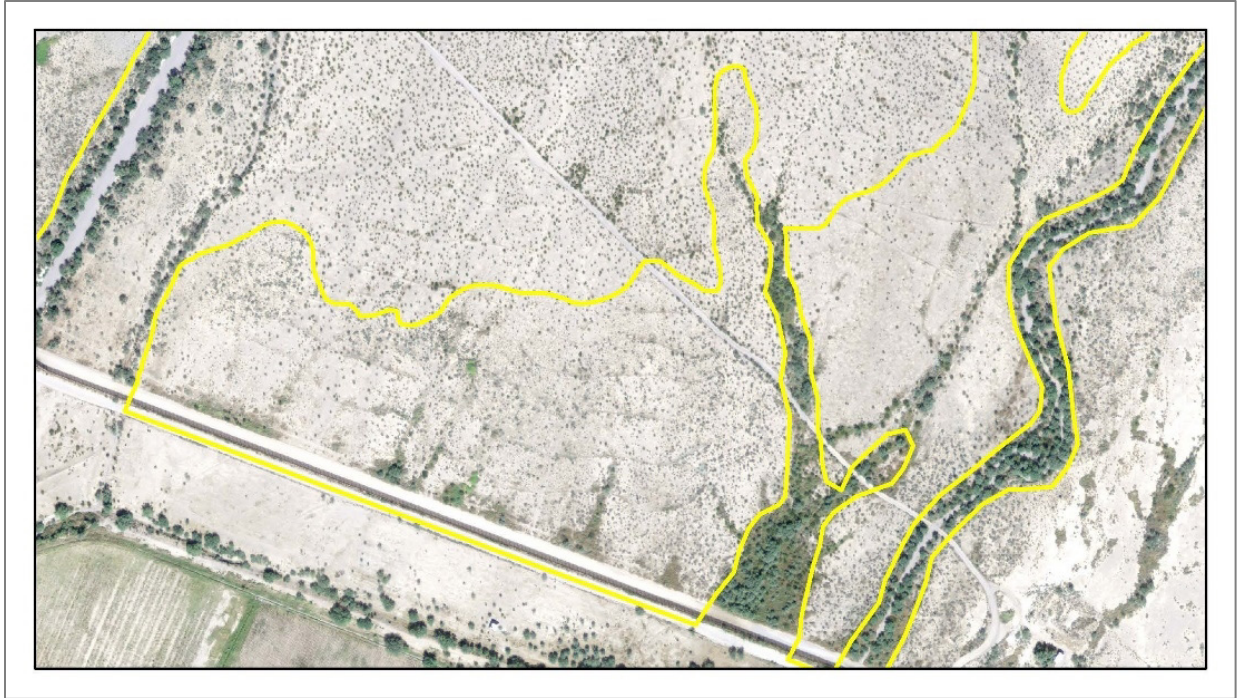


Figure 108. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Creosote – Cattle Saltbush Shrubland Association.

NPS

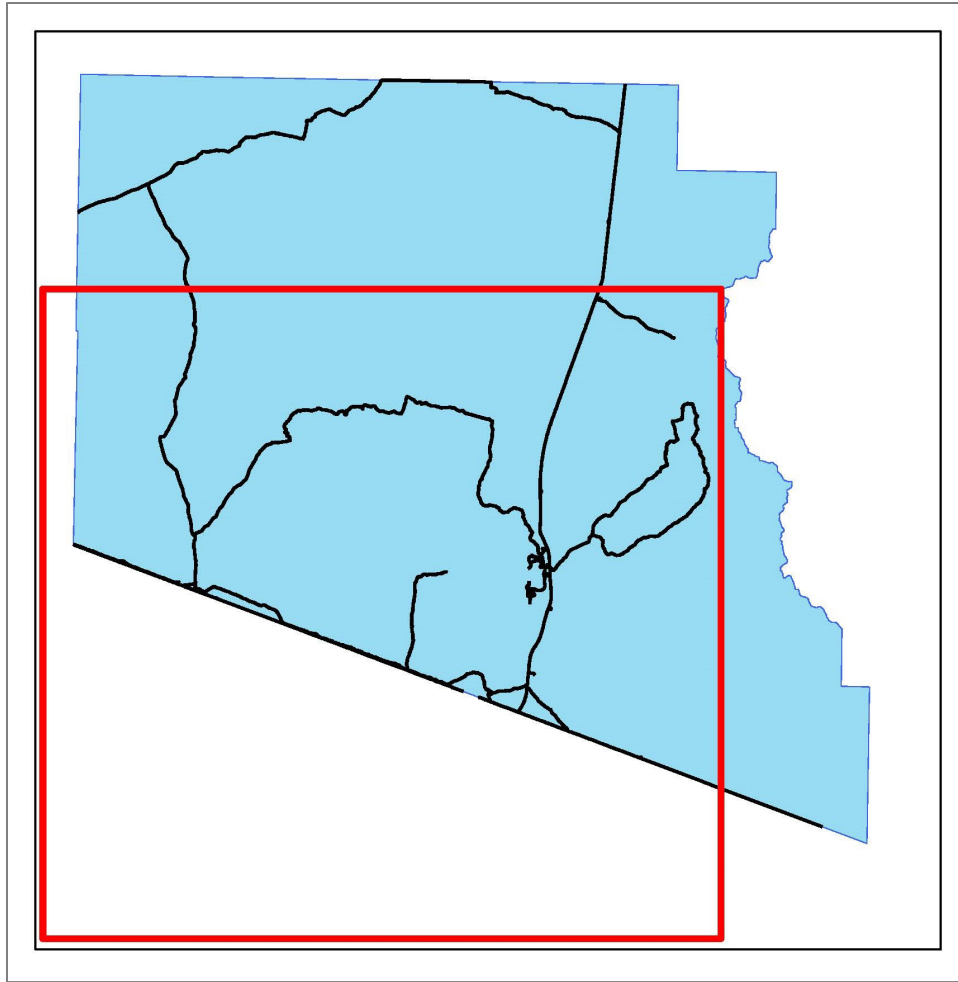


Figure 109. Map of ORPI with a bounding box around the regions mapped and classified as the Creosote – Cattle Saltbush Shrubland Association.

NPS

27. *Atriplex polycarpa* – *Suaeda nigra* Shrubland Association (P)

Cattle Saltbush – Mojave Seablite Shrubland Association

This shrubland community is characterized by an open (10–15%) sub-canopy (0.5–2 m) dominated by *Suaeda nigra* (Mojave seablite) and *Atriplex polycarpa* (cattle saltbush).

The canopy strata (>2 m) are very sparse (1%) with only *Prosopis velutina* (velvet mesquite) documented in this community. The sub-canopy is defined by the consistent (1.0) co-dominance of *S. nigra* (Mojave seablite) and *A. polycarpa* (cattle saltbush). These species account for the vast majority of cover documented in this community. On average, each of these species contributes from 5–10% cover throughout. Other documented sub-canopy species include *Larrea tridentata* (creosote), *Lycium* spp. (desert-thorn), *Atriplex linearis* (narrowleaf fourwing saltbush), and *Cylindropuntia fulgida* (jumping cholla). This community is very similar to the often-adjacent *Larrea tridentata* – *Atriplex polycarpa* shrubland community. The sole difference is the codominance of *S. nigra* (Mojave seablite) and lower *L. tridentata* (creosote).

This shrubland community covers about 0.02% (33 ha, 81 ac) of ORPI, exclusively in the immediate vicinity of Quitobaquito Spring. The community spans low-angle (1%) floodplains around 330 m (1,066 ft). The soil is characterized as deep and well-drained, fine silty loam often supporting a robust community of biological soil crusts.

Common Species: *Atriplex polycarpa*, *Suaeda nigra*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 110–113.



Figure 110. An example landscape photo showing the Cattle Saltbush – Mojave Seablite Shrubland Association.

NPS

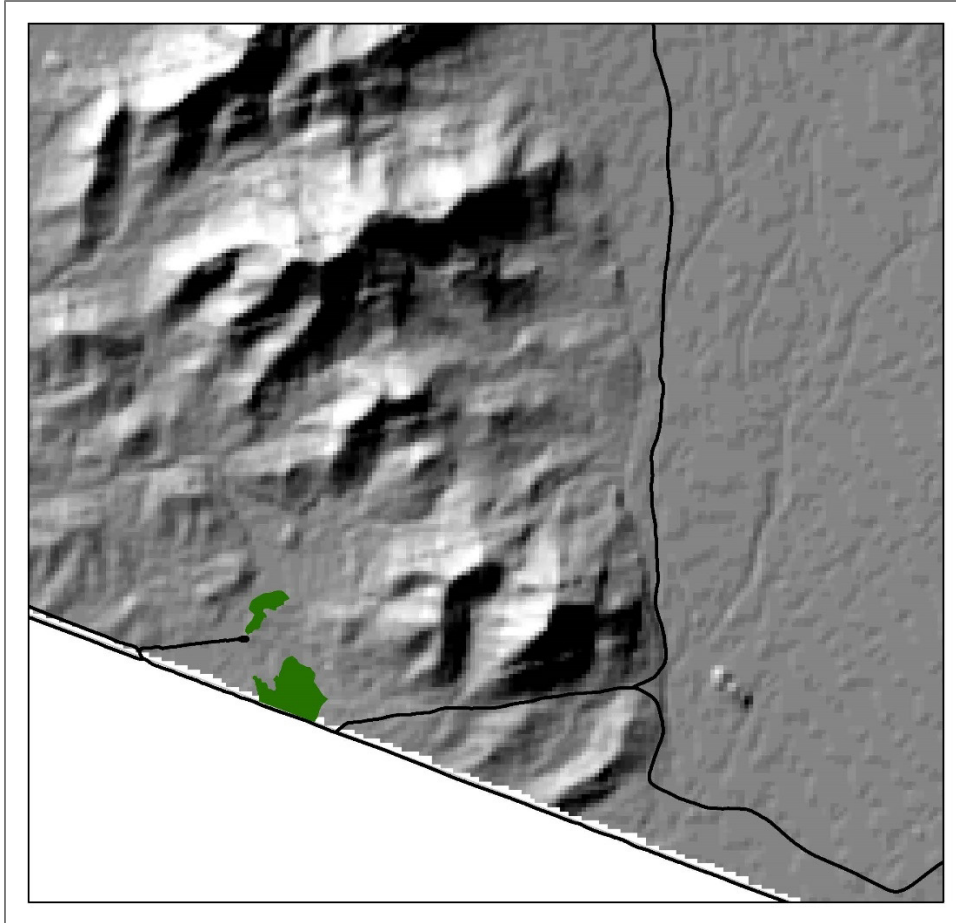


Figure 111. A distribution map, showing in green all areas mapped as Cattle Saltbush – Mojave Seablite Shrubland Association.

NPS

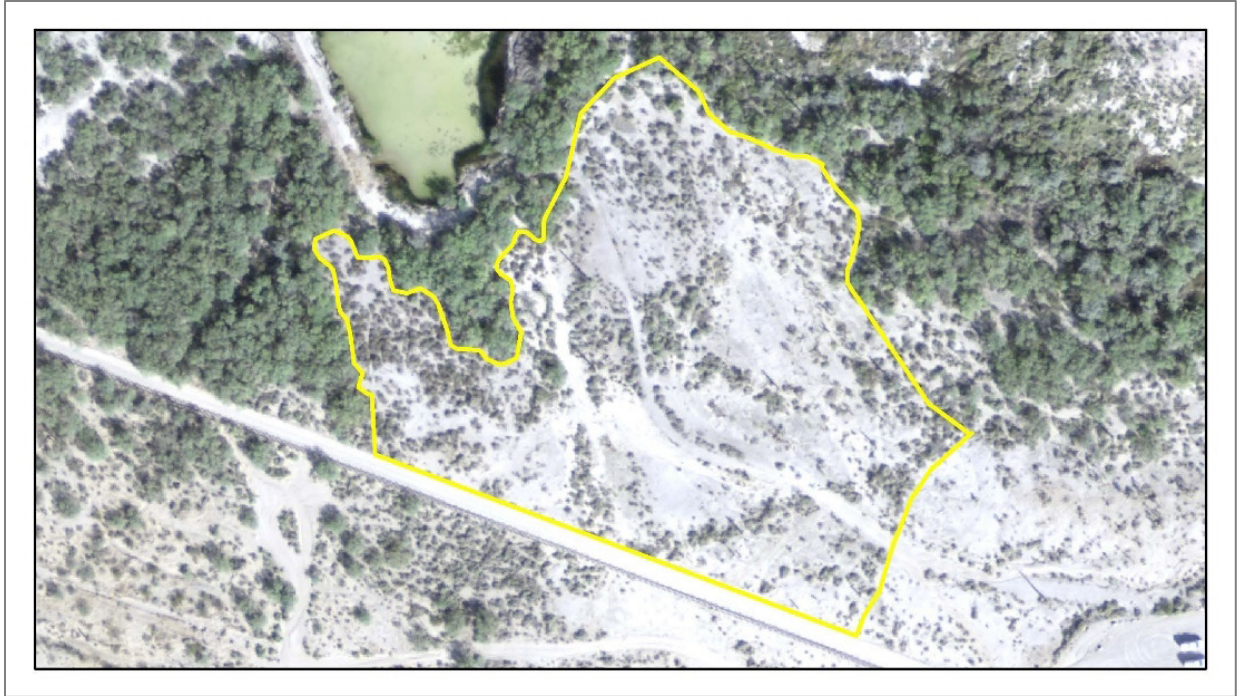


Figure 112. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Cattle Saltbush – Mojave Seablite Shrubland Association.

NPS

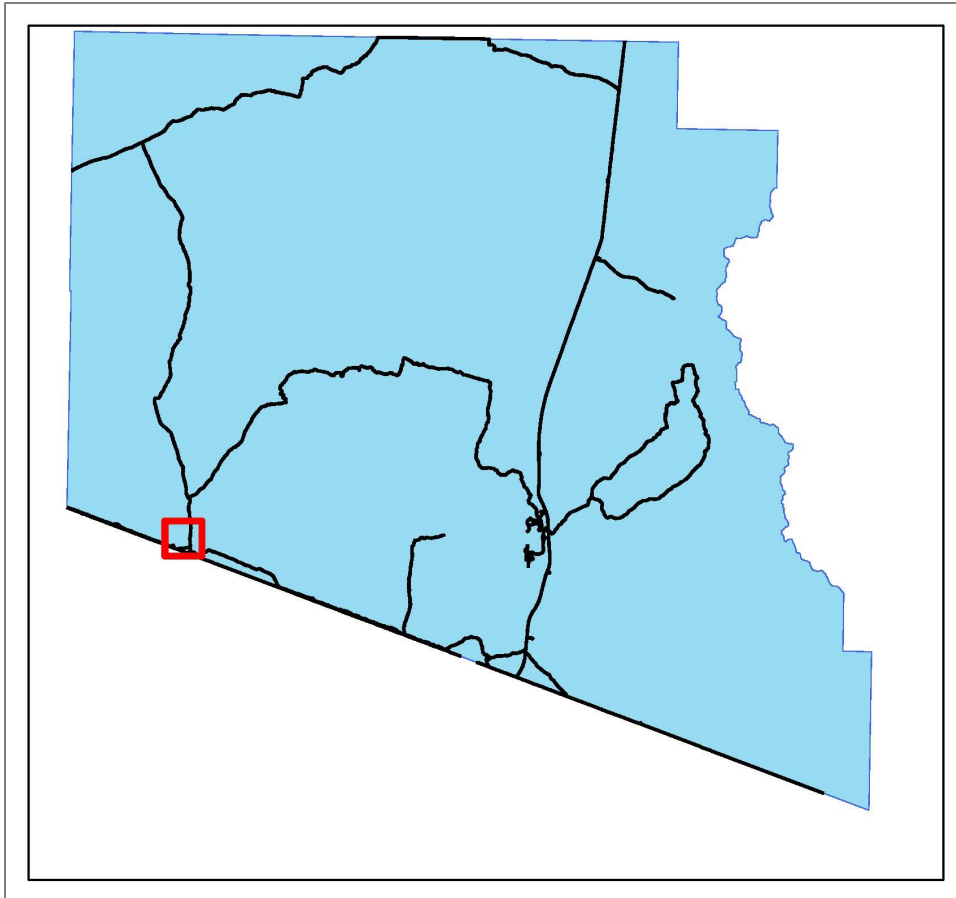


Figure 113. Map of ORPI with bounding box around the regions mapped and classified as the Cattle Saltbush – Mojave Seablite Shrubland Association.

NPS

28. *Prosopis velutina* / *Larrea tridentata* – *Atriplex polycarpa* Floodplain Association (P)

***Velvet Mesquite* / *Creosote* – *Cattle Saltbush* Floodplain Association**

This shrubland community is characterized by a very open (5%) canopy (>2 m) of *Prosopis velutina* (velvet mesquite) and an open (15%) sub-canopy (0.5–2 m) dominated by *Atriplex polycarpa* (cattle saltbush) and *Larrea tridentata* (creosote).

In the canopy strata, *P. velutina* (velvet mesquite) is a consistent (1.0) tree species that provides variable cover that ranges from 2 to 10%. Individuals present as short (2–3 m) trees, typically on the floodplain, to tall (4–5 m) wide-canopied trees when present on alluvial terraces. The sub-canopy stratum is characterized by the consistent presence (1.0) and typical dominance of both *A. polycarpa* (cattle saltbush) and *L. tridentata* (creosote). *A. polycarpa* (cattle saltbush) is a diagnostic species of this community and provides the highest cover with an average around 8%. At times, this species can become intermixed with the closely associated *Atriplex linearis* (thinleaf fourwing saltbush), occasionally becoming a co-dominant. The field stratum (<0.5) is variable depending upon the season and associated precipitation. When conditions are conducive to a flush of annual species, cover can easily surpass 20%. In drier times of the year, when seasonal precipitation is low, cover will be sparse (1%) and typically consists of species associated with adjacent uplands habitats.

This shrubland community covers about 0.10% (132 ha, 325 ac) of ORPI, exclusively along the southern boundary of the monument. This community spans low-angle (<5%) floodplains and alluvial terraces from 320–450 m (1,049–1,476 ft). The soil is characterized as very deep and excessively drained, fine sandy loam often with a robust assemblage of biological soil crusts. Surface gravel and rock tend to be absent to sparse.

Common Species: *Prosopis velutina*, *Atriplex polycarpa*, *Larrea tridentata*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 114–117.



Figure 114. An example landscape photo showing the Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.

NPS

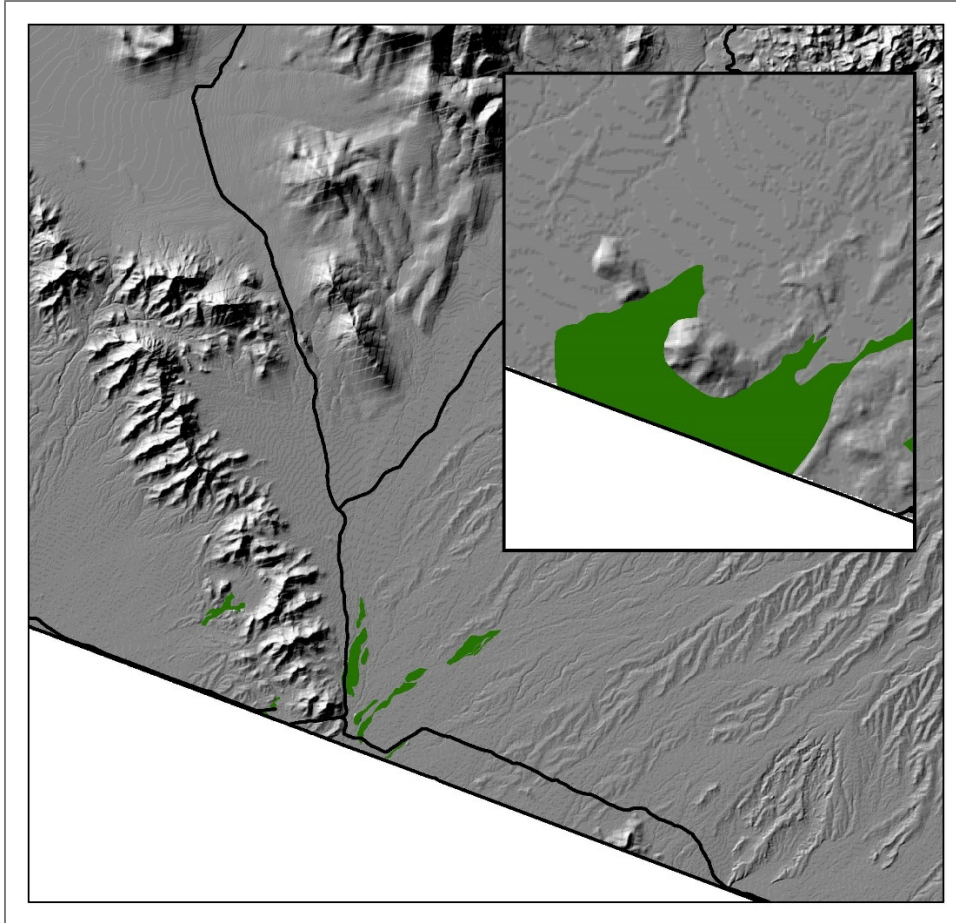


Figure 115. A distribution map, showing in green all areas mapped as Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.

NPS

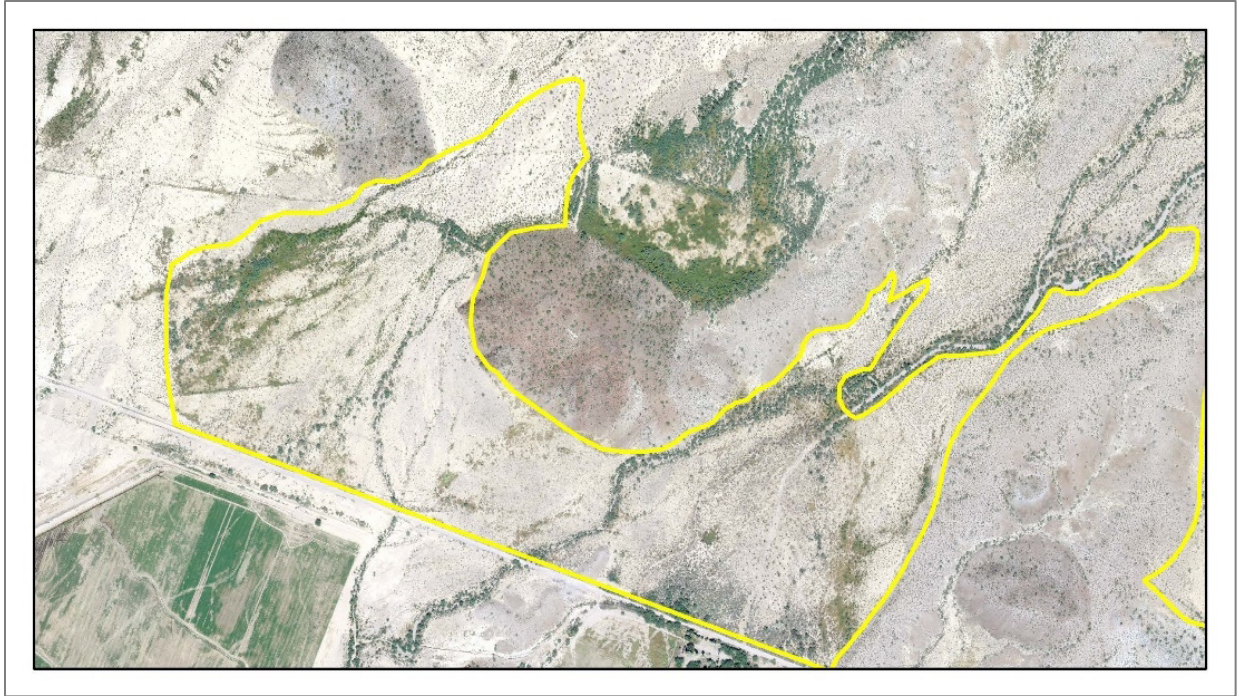


Figure 116. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.

NPS

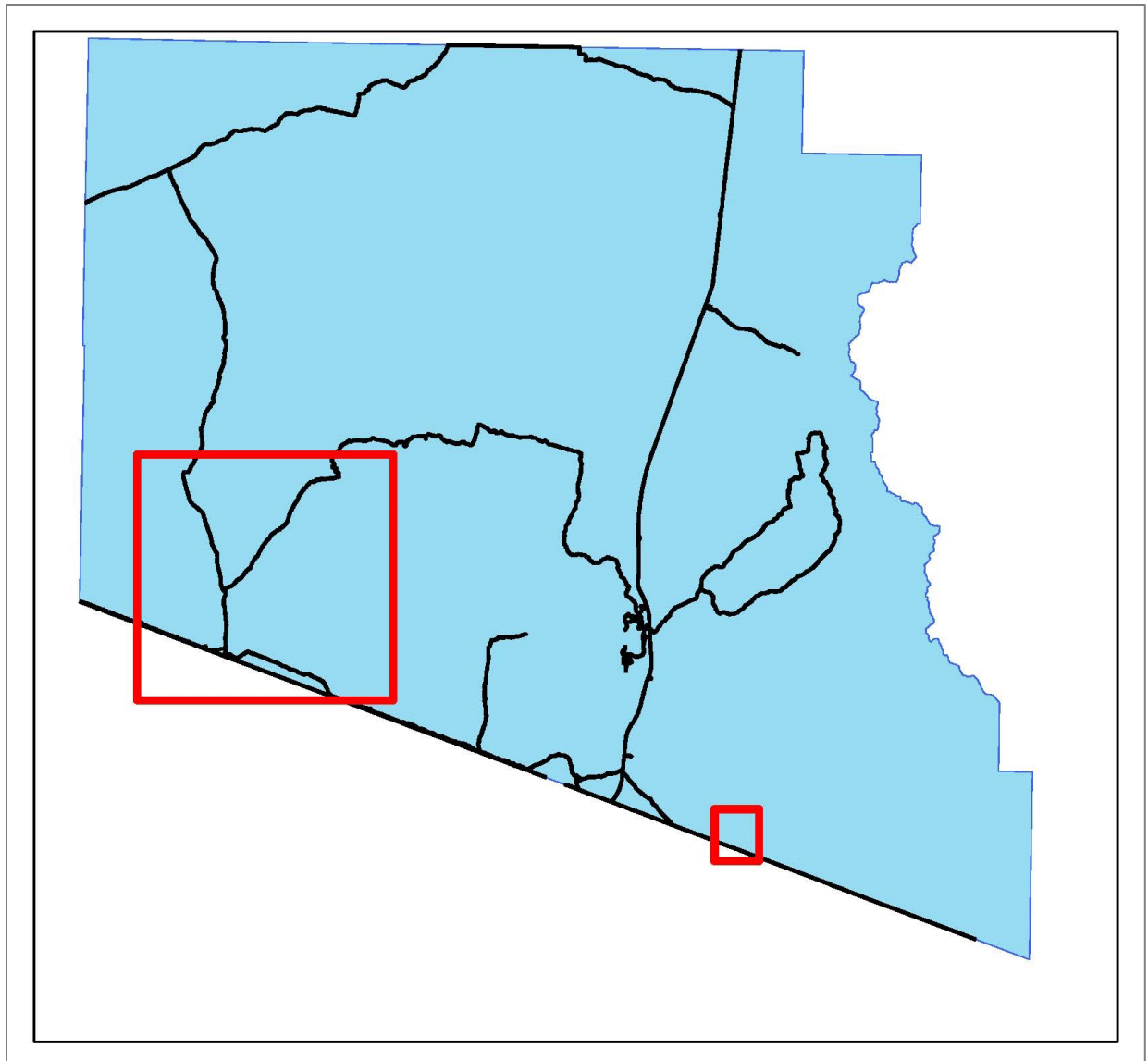


Figure 117. Map of ORPI with bounding boxes around the regions mapped and classified as the Velvet Mesquite / Creosote – Cattle Saltbush Floodplain Association.

NPS

29. (*Prosopis velutina*) / *Larrea tridentata* / *Hilaria rigida* Shrubland Association (P)

(Velvet Mesquite) / Creosote / Big Galleta Shrubland Association

This floodplain community is characterized by a sparse (<10%) canopy (>2 m) of *Prosopis velutina* (velvet mesquite), a sub-canopy (0.5–2 m) dominated by *Larrea tridentata* (creosote), and a field stratum (<0.5 m) of patchy *Hilaria rigida* (big galleta). This community has considerable species overlap with adjacent ones and is mainly defined by the presence of *H. rigida* and its location on a floodplain.

P. velutina is a consistent (0.81), low-cover common associate. Cover of this species is quite variable, ranging from scattered individuals contributing <5% to dense patches with cover above 10%. Areas of high cover (>10%) tend to coincide with small, braided washes or with depressions that collect surface flow. *L. tridentata* is the most consistent (1.0) dominant in the community with cover that typically ranges from 5–15% with some areas reaching above 20%. *Lycium* spp. (wolfberry), typically *Lycium andersonii* (water jacket) and *Lycium fremontii* (Fremont's desert thorn), are occasional (0.68) associates that, when present, provide cover around 1%, or rarely up to 3%. *Castela emoryi* (crucifixion thorn) is a rare associate documented in only one example of this community, in the lower reach of the Valley of the Ajo, near Growler Canyon.

The field stratum (<0.5 m) is characterized by a low cover (<5%) mix of shrubs and grasses, most commonly dominated by *H. rigida*. This species provides consistent (1.0), low cover that rarely surpasses 5%. This species tends to cluster in dense, irregularly distributed patches. Other noteworthy species include: *Ambrosia deltoidea* (triangle bur ragweed), *Ambrosia dumosa* (burrobush), and a suite of annual forbs.

This shrubland community is contained within a 2-association map class that covers about 3.3% (4,456 ha, 11,011 ac) of ORPI, predominantly in the Growler, Ajo, Sonoyta, and San Cristobal Valleys. It spans very low-angle (<5%) floodplains included within the low-bajada from 320–640 m (1,049–2,099 ft). The soil is characterized by deep, well drained alluvium often with patches of biological and physical crusts.

Common Species: *Prosopis velutina*, *Larrea tridentata*, *Hilaria rigida*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 118–120.



Figure 118. An example landscape photo showing the (Velvet Mesquite) / Creosote / Big Galleta Shrubland Association.

NPS

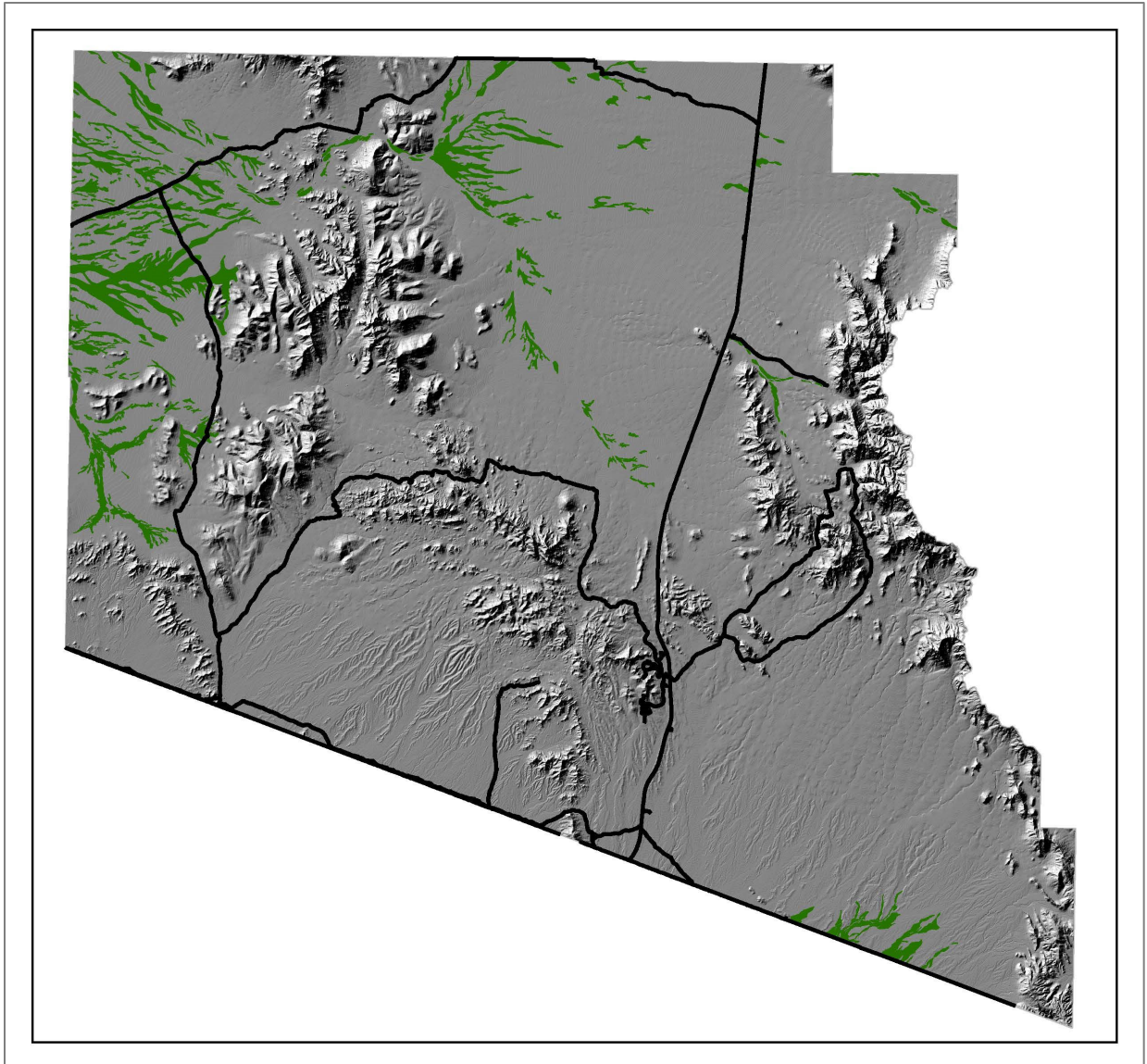


Figure 119. A distribution map, showing in green all areas mapped as the (Velvet Mesquite) / Creosote / Big Galleta Shrubland Association.

NPS

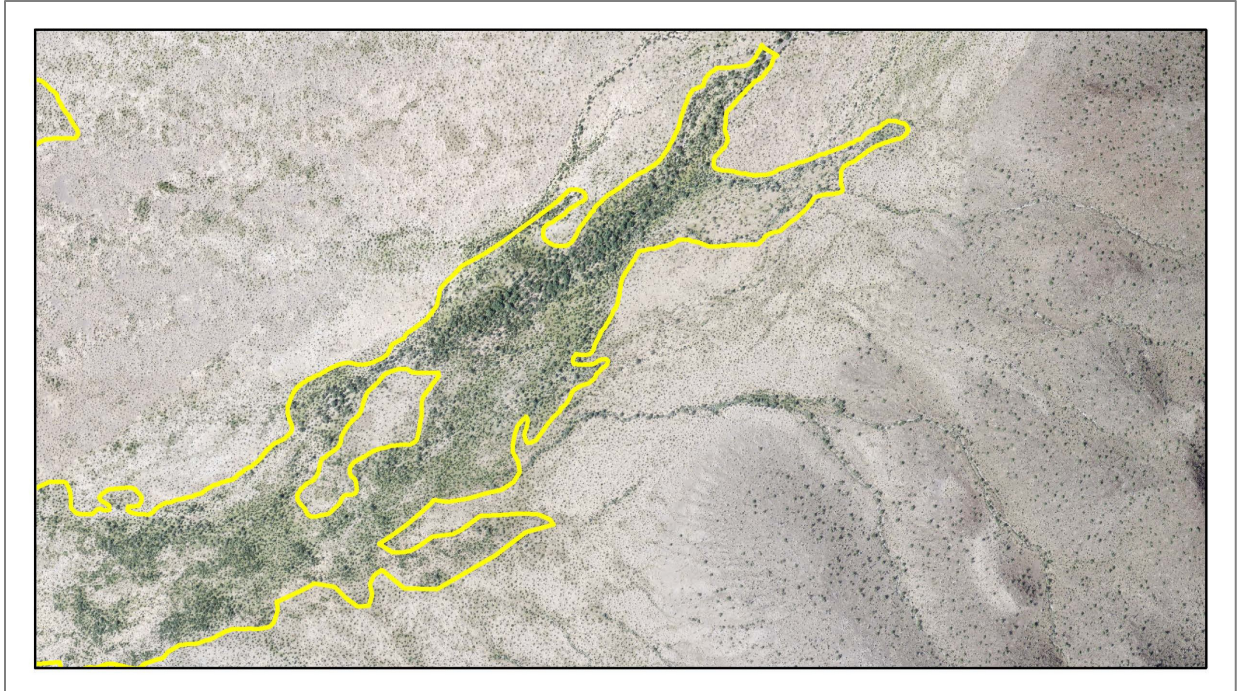


Figure 120. An example area showing the texture and appearance of aerial imagery that was classified and mapped as (Velvet Mesquite) / Creosote / Big Galleta Shrubland Association.

NPS

30. (*Prosopis velutina*) / *Larrea tridentata* Shrubland Association (P)

(Velvet Mesquite) / Creosote Shrubland Association

This floodplain community is characterized by a sparse (<10 [20]%) canopy (>2 m) of *Prosopis velutina* (velvet mesquite) and a sub-canopy (0.5–2 m) dominated by *Larrea tridentata* (creosote). This community has considerable species overlap with adjacent ones and is mainly defined by its location on a floodplain, dominance of *P. velutina* (velvet mesquite), and lack of *Hilaria rigida* (big galleta).

P. velutina (velvet mesquite) is a consistent (0.90) tree species that provides variable cover that ranges from scattered individuals contributing <5% to dense patches with cover above 10%. Areas of high cover (>10%) tend to coincide with small, braided washes or with depressions that collect surface flow. *L. tridentata* (creosote) is the most consistent (1.0) dominant in the community with cover that typically ranges from 5–15% with some areas reaching above 20%. *Lycium* spp. (wolfberry), typically *Lycium andersonii* (water jacket) and *Lycium fremontii* (Fremont's desert thorn), are uncommon (0.40) associates that, when present, provide cover around 1%, or rarely up to 3%. The composition of the field stratum (<0.5 m) varies based on season and recent precipitation. In drier years, this stratum is very sparse (<5%) with only *Ambrosia deltoidea* (triangle bur ragweed) providing noteworthy cover.

This shrubland community is contained within a 2-association map class that covers about 3.3% (4,456 ha, 11,011 ac) of ORPI, predominantly in the Growler, Ajo, Sonoyta, and San Cristobal Valleys. It spans very low-angle (<5%) floodplains included within the low-bajada from 320–640 m (1,049–2,099 ft). Soils consist of deep, well drained alluvium often with patches of biological and physical crusts.

Common Species: *Prosopis velutina*, *Larrea tridentata*

This association is in a map class. Please see Figure 121 and refer to the previous type (*Prosopis velutina*) / *Larrea tridentata* / *Hilaria rigida* Shrubland Association to see the shared distribution map and example imagery.



Figure 121. An example landscape photo showing the (Velvet Mesquite) / Creosote Shrubland Association.

NPS

31. *Prosopis velutina* / *Senegalia greggii* – *Larrea tridentata* Intermittently Flooded Shrubland Association (P)

Velvet Mesquite* / *Catclaw Acacia* – *Creosote Intermittently Flooded Shrubland Association

This intermittently flooded shrubland is characterized by an open (10%) canopy (>2 m) of *Prosopis velutina* (velvet mesquite) and a dense (30–60%) understory (<2 m) of mixed shrubs and forbs, most commonly dominated by *Senegalia greggii* (catclaw acacia) and *Larrea tridentata* (creosote). This community bisects most of the upland communities present throughout the monument and can be interspersed with many other riparian communities.

A mix of several tree species, most commonly *Prosopis velutina* (velvet mesquite), occupies the open canopy (>2 m). This species provides consistent (0.91) cover that ranges up to 20%, with an average around 6%. A mix of shrubs, most dominated by *Senegalia greggii* (catclaw acacia) composes the variably dense (20–40%) sub-canopy stratum. *S. greggii* (catclaw acacia) is a consistent (0.91) dominant, providing average cover around 12% with inclusions up to 25%. *Larrea tridentata* (creosote) is the next most abundant shrub, with consistent (0.91) cover with an average around 4%, including some examples up to 15%. A mix of subshrubs and forbs, most dominated by *Ambrosia ambrosioides* (ambrosia leaf bur ragweed) and/or *Bebbia juncea* (sweetbush) dominate the patchy field stratum. Cover within this stratum is highly variable and depends on the overstory shrub and tree density, the width of the wash, and number of channels.

This intermittently flooded shrubland community covers about 4.2% (5,624 ha, 13,896 ac) of ORPI. It spans low-angle (<5%) washes from 300–900 m (984–2,952 ft). The soil is composed of deep and well-drained alluvium.

Common Species: *Prosopis velutina*, *Senegalia greggii*, *Larrea tridentata*, *Ambrosia ambrosioides*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 122–124.



Figure 122. An example landscape photo showing the Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland Association.

NPS

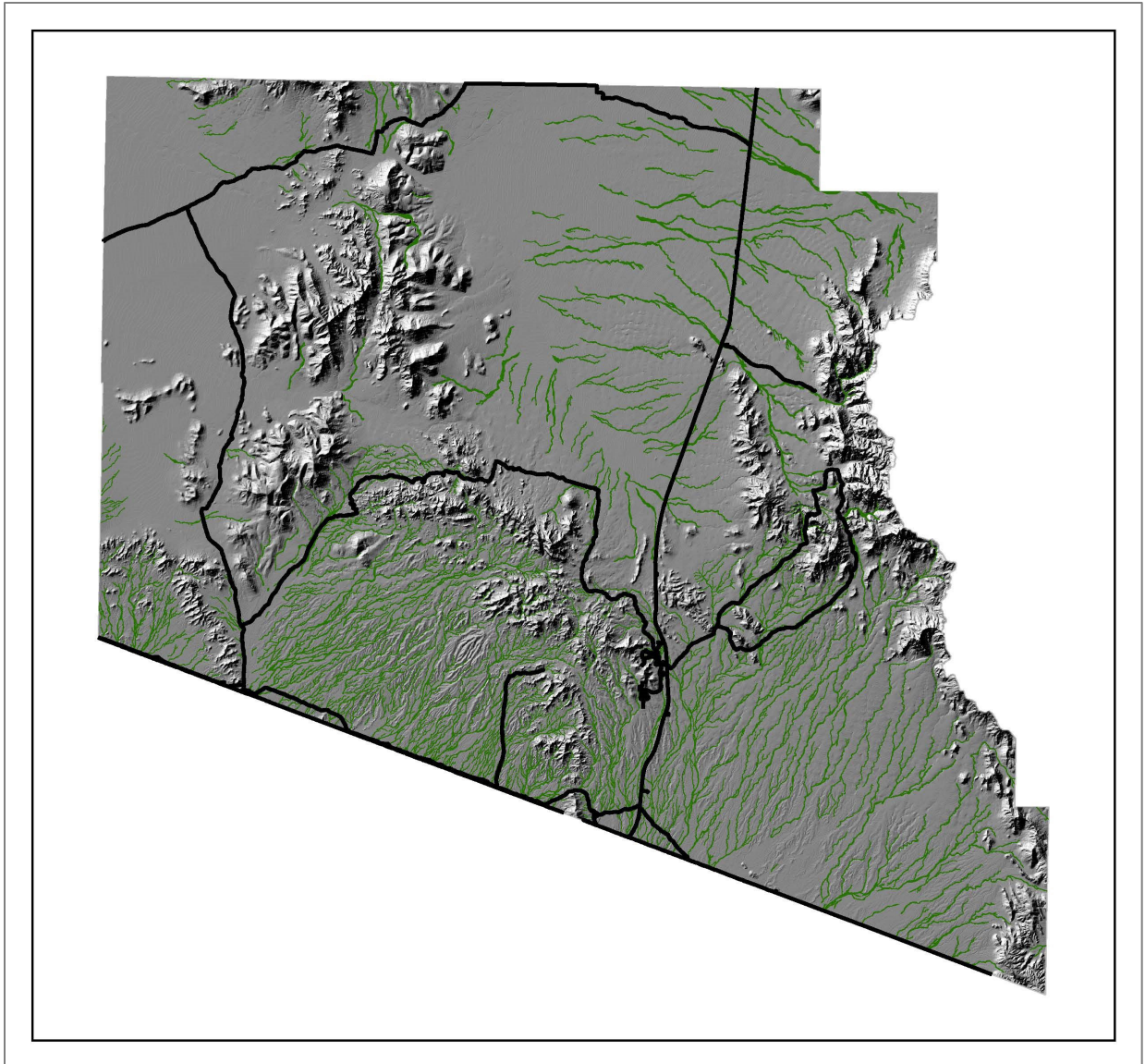


Figure 123. A distribution map, showing in green all areas mapped as Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland Association.

NPS

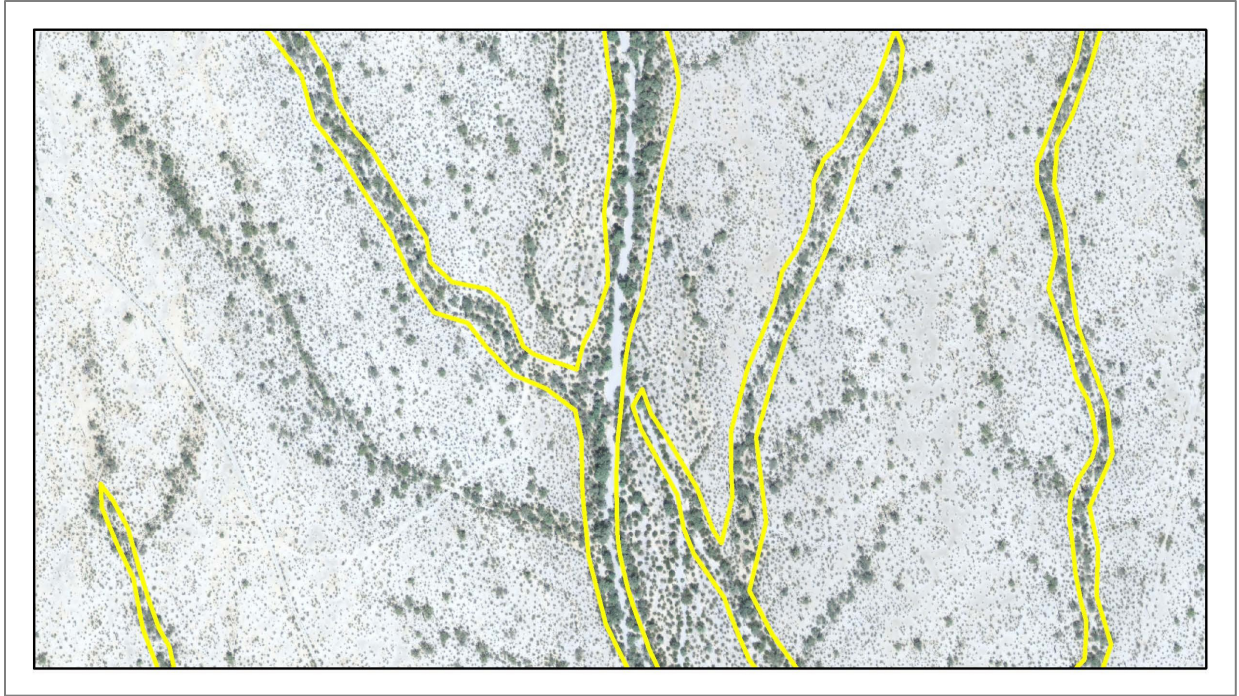


Figure 124. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Velvet Mesquite / Catclaw Acacia – Creosote Intermittently Flooded Shrubland Association.

NPS

32. *Prosopis velutina* – *Parkinsonia florida* Intermittently Flooded Woodland (P)

Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association

This intermittently flooded woodland association is characterized by a dense (30–50+%) canopy (>2 m) dominated by a mix of *Prosopis velutina* (velvet mesquite) and *Parkinsonia florida* (blue paloverde) with an understory of mixed shrubs, primarily dominated by *Senegalia greggii* (catclaw acacia) and *Larrea tridentata* (creosote). This community contains two distinct zones, a dense and linear woodland that lines the margins of washes and an open, often un-vegetated wash channel.

In the dense (40+%), linear woodlands *P. velutina* (velvet mesquite) is a consistent (1.0) canopy dominant, providing cover that ranges from 20 to 40%. *P. florida* (blue paloverde) is present as a co-dominant with *P. velutina* (velvet mesquite), providing cover that ranges from 10 to 20%. The sparse (<10%) sub-canopy (<2 m) of these woodlands is characterized by a variable mix of shrubs, most commonly dominated by *Senegalia greggii* (catclaw acacia). Cover and composition of the field stratum is dependent on the season and its associated precipitation. In years of high precipitation and moderate temperature, this community can support a robust population of annual forbs and grasses. Scattered along the wash corridor are occasional shrubby inclusions dominated by *Ambrosia monogyra* (singlewhorl burrobrush) with cover ranging from 10 to 30+%. These areas are most common where a wash becomes wider (30–50+ m) and more channelized, allowing for slightly elevated areas less prone to scouring flows.

This intermittently flooded woodland community covers about 1.1% (1,477 ha, 3,649 ac) of ORPI, exclusively in large wash systems. The most prominent examples of this community include Growler, Kuakatch, San Cristobal, and Aguajita washes. It spans low-angle (<5%) washes and adjacent floodplains from 320–520 m (1,049–1,706 ft). The soils are deep and excessively well drained torrifluvents. Within the wash channel the surface cover ranges from sand to fine gravel with occasional surface rock. Along the margins of the wash, the surface tends to be fine and silty with minimal surface rock or gravel.

Common Species: *Prosopis velutina*, *Parkinsonia florida*, *Senegalia greggii*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 125–127.



Figure 125. An example landscape photo showing the Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association.

NPS

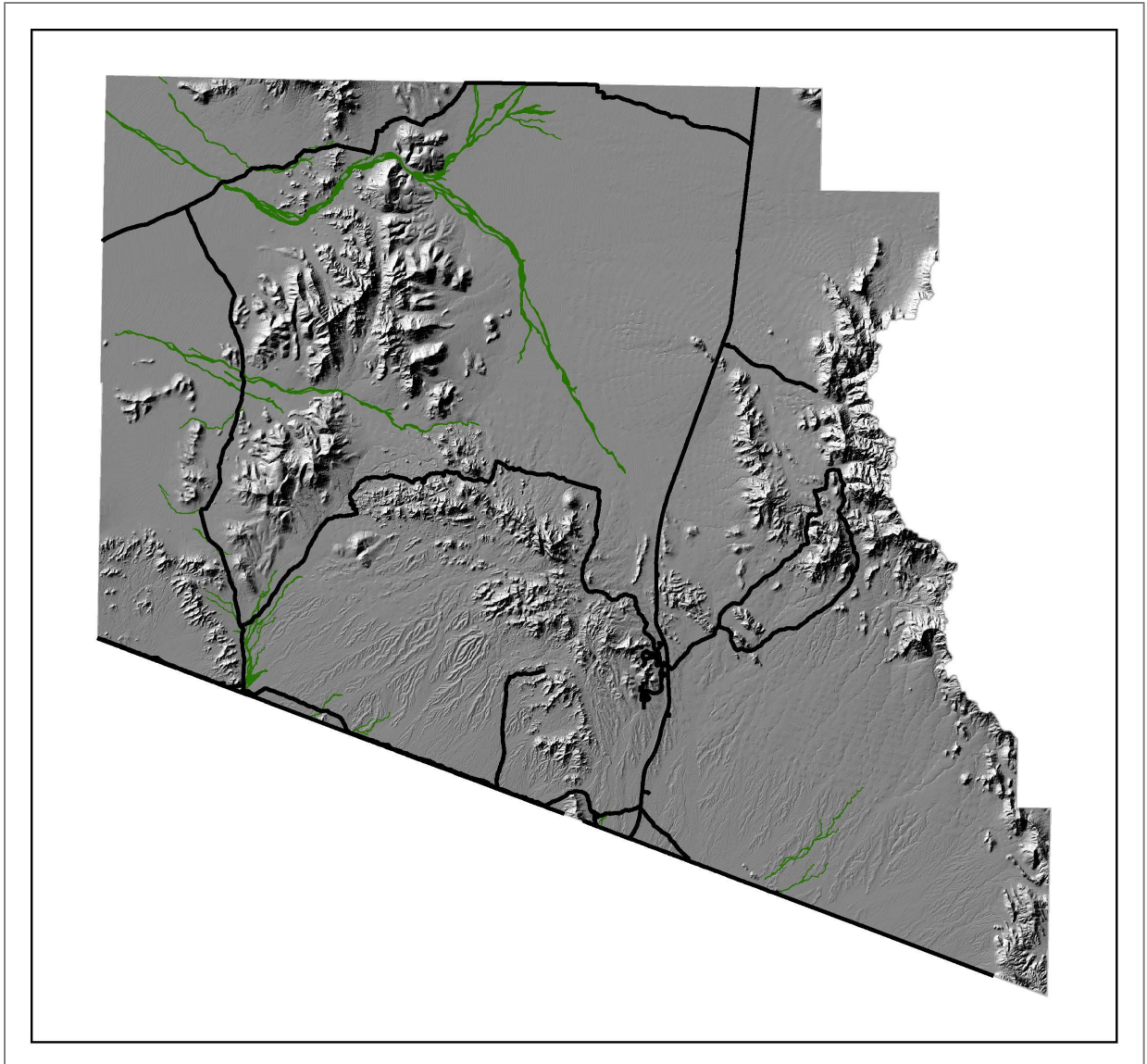


Figure 126. A distribution map, showing in green all areas mapped as Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association.

NPS

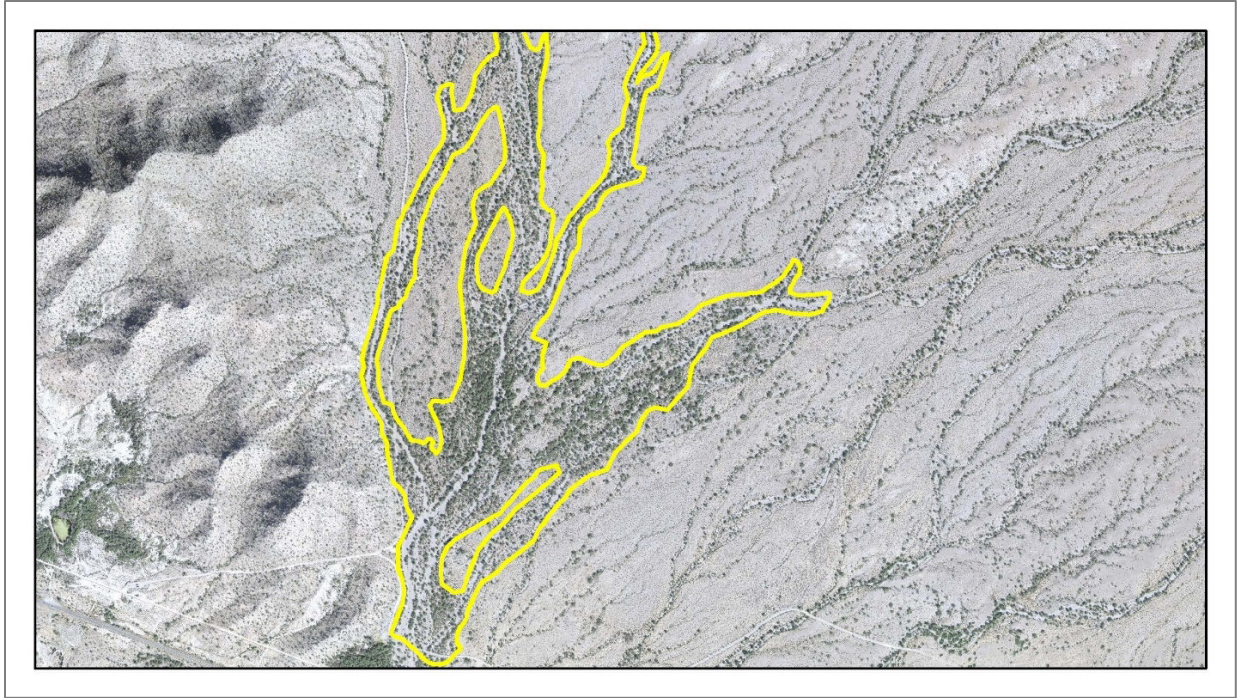


Figure 127. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Velvet Mesquite – Blue Paloverde Intermittently Flooded Woodland Association.

NPS

33. *Simmondsia chinensis* – *Senegalia greggii* – *Celtis ehrenbergiana* / *Ambrosia ambrosioides* Intermittently Flooded Shrubland Association (P)

***Joboba* – *Catclaw Acacia* – *Spiny Hackberry* / *Ambrosia Leaf Bur Ragweed* Intermittently Flooded Shrubland**

This intermittently flooded shrubland association is characterized by an open (10%) canopy of *Prosopis velutina* and a relatively dense (20–50%) mixed shrub understory dominated by *Simmondsia chinensis* (jojoba), *Senegalia greggii* (catclaw acacia), and *Celtis ehrenbergiana* (spiny hackberry) with scattered *Ambrosia ambrosioides* (ambrosia leaf ragweed).

The open canopy stratum contains a mix of patchy trees and large shrubs that predominantly occur in the understory strata. *Celtis reticulata* (netleaf hackberry) and *Prosopis velutina* (velvet mesquite) are inconsistent (0.5, 0.4) associate trees that, when present, contribute average cover of 10 and 5%, respectively. *S. chinensis* (jojoba) provides the most cover of any species in this community, with an average around 11%, including dense patches up to 20%. *C. ehrenbergiana* (spiny hackberry) and *Senegalia greggii* (catclaw acacia) are consistent (1.0) sub-dominants that each contribute an average around 5%. All three dominant shrubs can range from small (1 m) to large (3 m), occasionally tree-like individuals that reach into the canopy strata. The sparse (<5%) field stratum (<0.5 m) is characterized by the patchy (0.60) presence and occasional dominance of *Ambrosia ambrosioides* (ambrosia leaf bur ragweed) with a suite of low-cover associates. When present, this species provides 5% cover with some dense inclusions up to 10%.

This shrubland community covers about 0.02% (30 ha, 75 ac) of ORPI, exclusively in the Ajo Mountain Range. This community spans deep and narrow intermittent mountain drainages from 762–1,066 m (2,500–3,500 ft) elevation. These drainages are characterized by dominant exposed bedrock and boulders with sandy soils filling in the depressions.

Common Species: *Celtis ehrenbergiana*, *Simmondsia chinensis*, *Senegalia greggii*, *Prosopis velutina*, *Ambrosia ambrosioides*

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 128–131.



Figure 128. Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland.

NPS

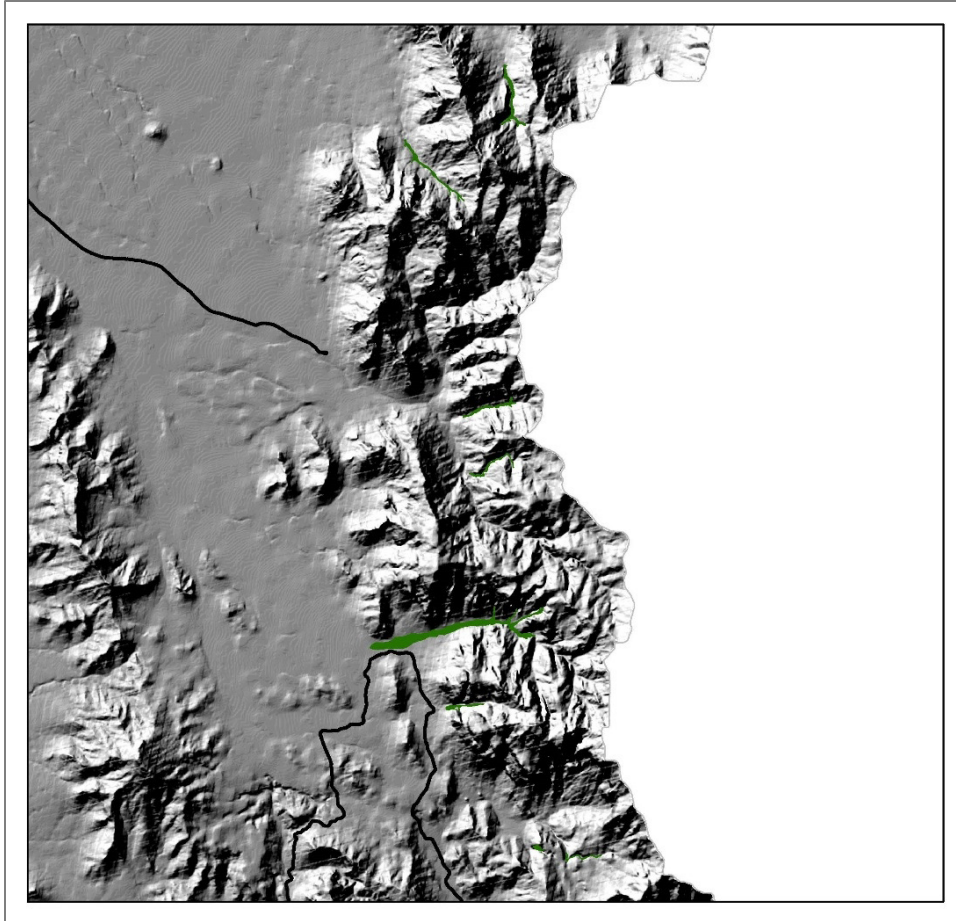


Figure 129. A distribution map, showing in green all areas mapped as Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland.

NPS



Figure 130. An example area showing the texture and appearance of aerial imagery that was classified and mapped as Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland.

NPS

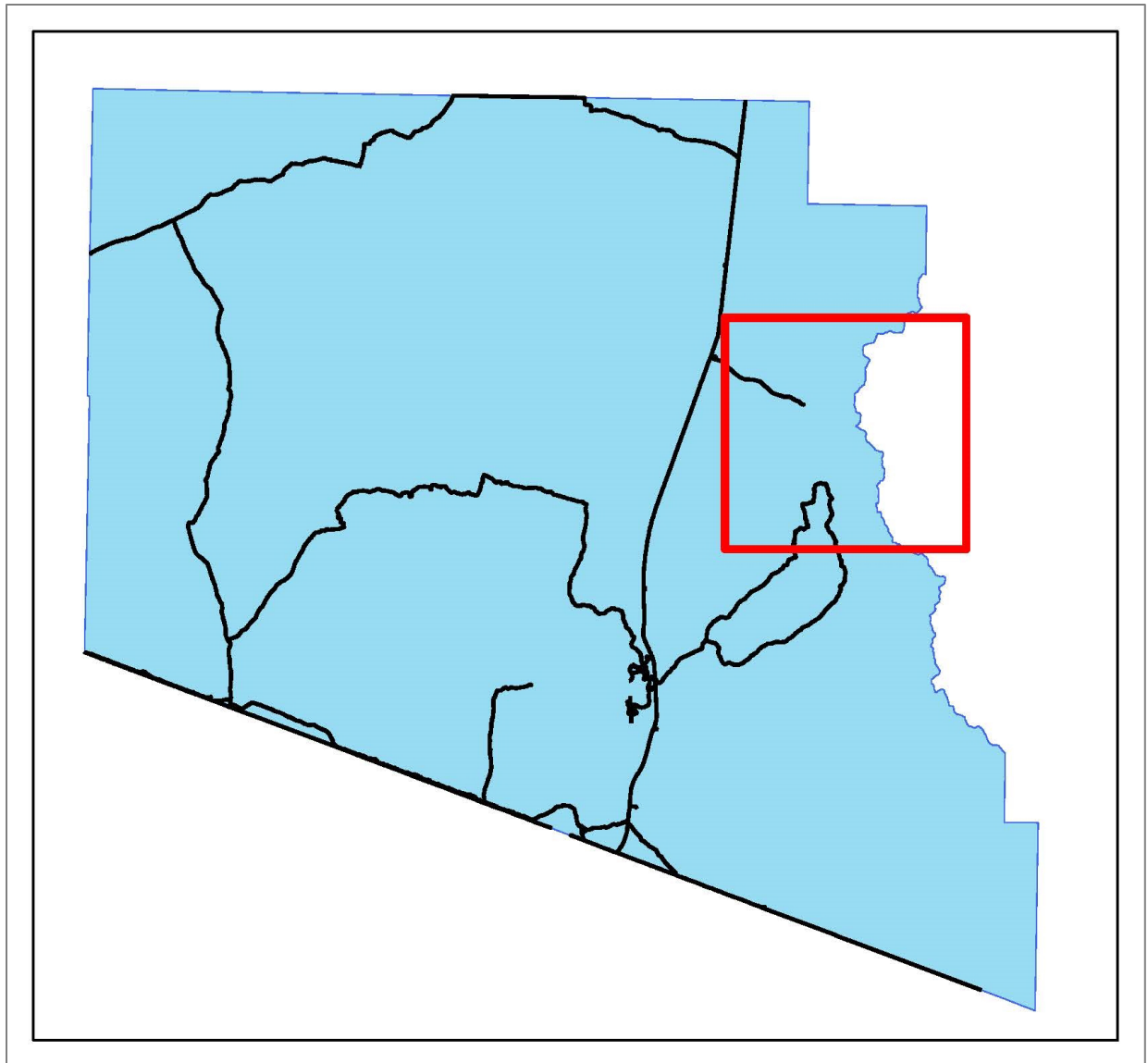


Figure 131. Map of ORPI with box around all areas Jojoba – Catclaw Acacia – Spiny Hackberry / Ambrosia Leaf Bur Ragweed Intermittently Flooded Shrubland association might occur.

NPS

34. *Schoenoplectus americanus* Herbaceous Aquatic Association (P)

Chairmaker's Bulrush Herbaceous Aquatic Association

This herbaceous community, found only at Quitobaquito spring, is characterized by a mix of aquatic macrophytes, typically dominated by *Stuckenia* spp. (pondweed), surrounded by a dense band of *Schoenoplectus americanus* (chairmaker's bulrush) along the margins of the pond.

At the margins of the pond and in the transition with the adjacent *Prosopis velutina* (velvet mesquite) bosque, a number of riparian trees may appear in the canopy strata (>2 m). Along the north end of the pond a few scattered individuals of *Salix gooddingii* (Goodding's willow) are present. The sub-canopy stratum (0.5–2 m) is characterized by the sole dominance of the wetland obligate *Schoenoplectus americanus* (chairmaker's bulrush) with a few low-cover associate shrubs. This species forms a dense, almost unbroken, band around the pond ranging from a width of 1–3 m. Where this species occurs, it provides close to 100% cover. The facultative wetland shrub *Pluchea sericea* (arrowweed) forms one dense patch along the northern shore of the pond. The field stratum (0–0.5 m) is characterized by a very sparse (<5%) mix of native and non-native grasses and forbs with a consistent dominant or common associate. The community of aquatic plants growing in the pond is characterized by the dominance of *Potamogeton* spp. (pondweed), a mix of *Potamogeton pectinatus* (sago pondweed) and *Potamogeton pusillus* (small pondweed). *Najas marina* (spiny naiad) and *Zannichellia palustris* (horned pondweed) have also been documented within the pond but were not documented during surveys for this project. These 4 species tend to grow intertwined in large masses that cover from $\frac{1}{4}$ to $\frac{3}{4}$ of the pond depending upon the season.

This herbaceous community covers about <0.01% (0.4 ha, 1 ac) of ORPI, exclusively at Quitobaquito Spring. It spans aquatic habitat, either emergent from standing water or on seasonally saturated soils.

Common Species: *Schoenoplectus americanus*, *Potamogeton pectinatus*, *Potamogeton pusillus*

It is noted that this community has undergone substantial disturbance during the reengineering and restoration projects at Quitobaquito in recent years. It is possible that the vegetation community as it is mapped and described here will change or take time to recover as a result of this work. Another major change is that the solitary mature *Populus fremontii* (Fremont's cottonwood) that characterized the pond for many years was removed during the most recent pond liner retrofitting.

Representative images of the association, its distribution across the park, and satellite imagery for a representative polygon follow in Figures 132–135.



Figure 132. An example landscape photo showing the Chairmaker's Bulrush Herbaceous Aquatic Association.

NPS

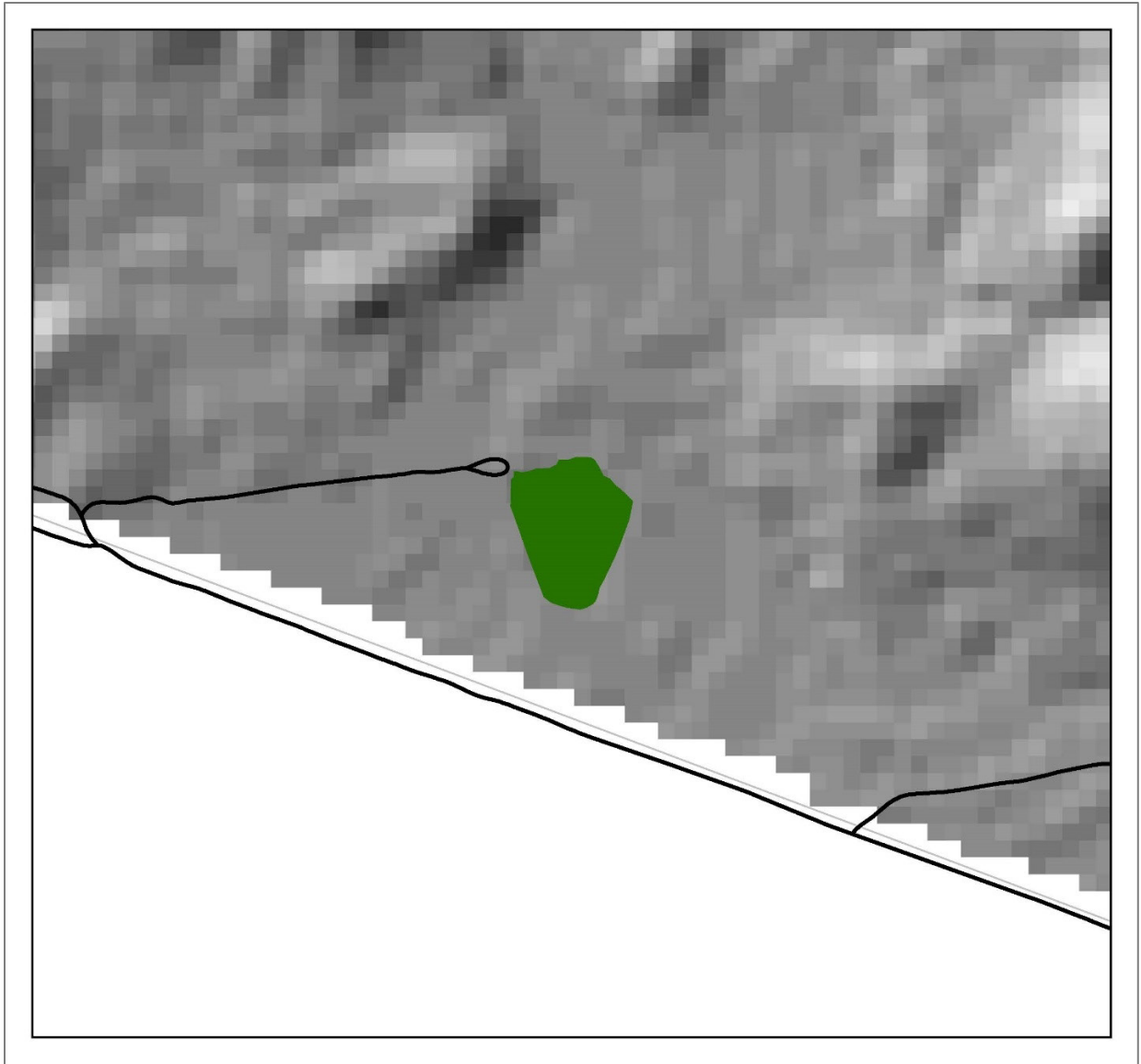


Figure 133. A distribution map, showing in green all areas mapped as Chairmaker's Bulrush Herbaceous Aquatic Association.

NPS

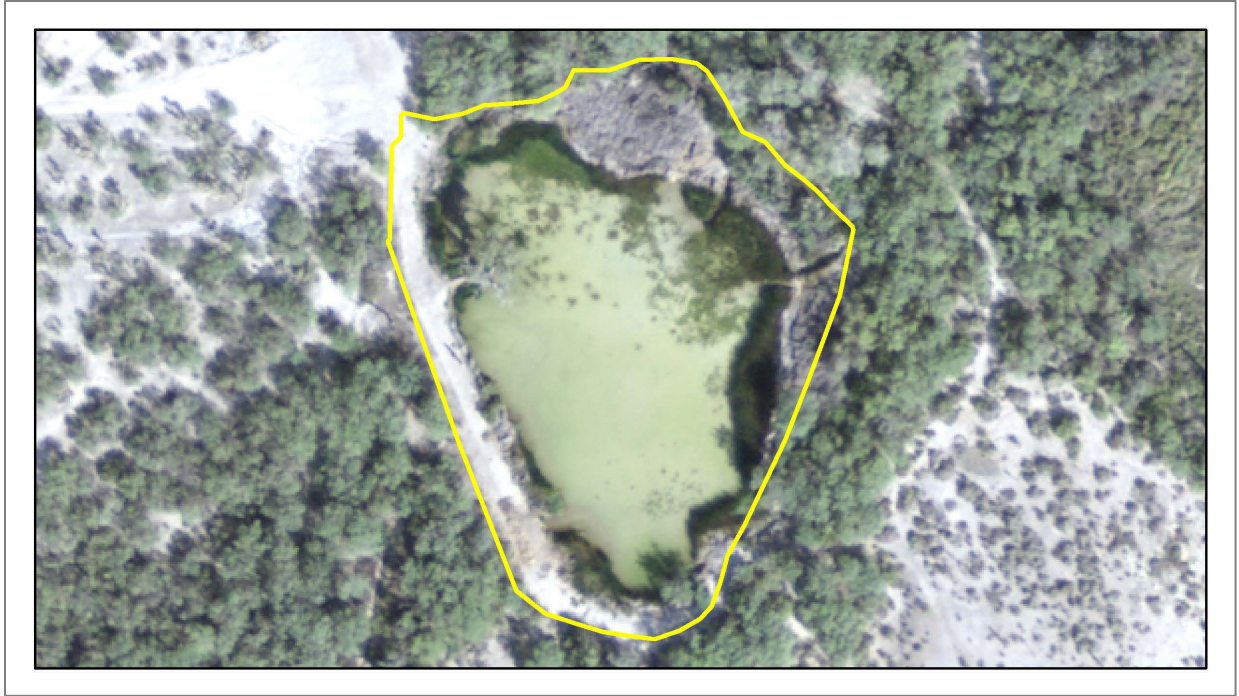


Figure 134. An example area showing the texture and appearance of aerial imagery that was classified and mapped as the Chairmaker's Bulrush Herbaceous Aquatic Association.

NPS

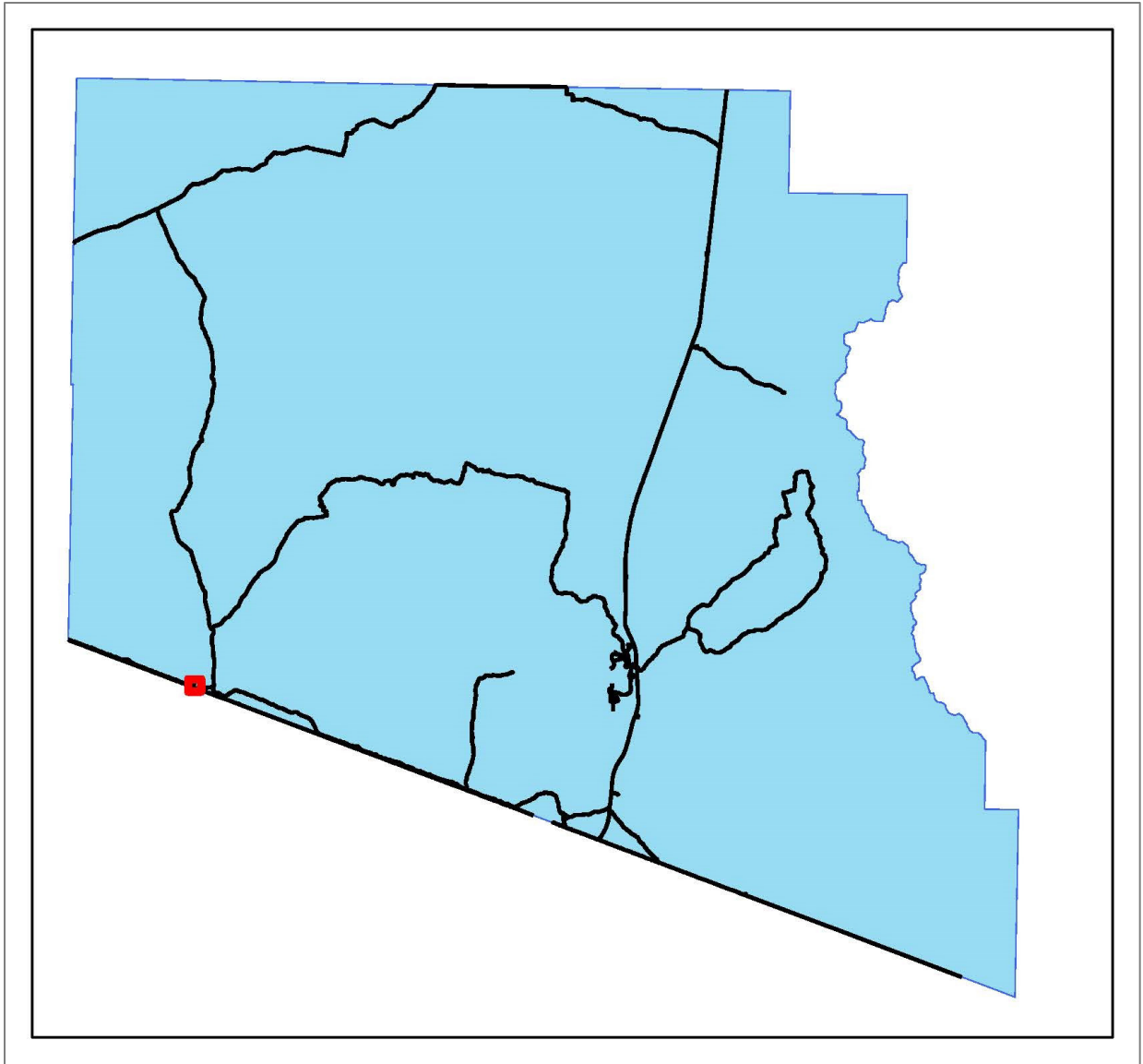


Figure 135. Map of ORPI with bounding box around the region mapped and classified as the Chairmaker's Bulrush Herbaceous Aquatic Association.

NPS

Chapter 6. Project Summary

Final Products and Geodatabase Delivery

This map and associated classification represent the most detailed descriptions of the vegetation communities and the highest resolution mapping that the monument has had to date. This map should remain of use to management for decades to come and serve as an important baseline against which large-scale disturbances or community shifts can be assessed and used to guide management actions. Vegetation community boundaries are often strongly tied to landscape-scale environmental factors such as aspect, slope, soil type, distance from water–topoedaphic factors that are very heterogeneous in certain parts of Organ Pipe Cactus National Monument (ORPI), and factors which remain relatively static over time. These landscape features will continue to influence what species thrive in particular locations within the monument.

This map and associated products can serve as the basis for future map updates and as an essential complement to long-term monitoring, research, and resource management activities. The classification will contribute to the ongoing development of the comprehensive USNVC across the Desert Southwest and permit us to place the vegetation of Organ Pipe Cactus National Monument in a regional context.

Both spatial and tabular data collected during this project were input into a file geodatabase designed to support relationships between the different data sources. This geodatabase contains all final map data, including photographs from plots and polygon photo point locations. Each spatial feature in the database (points and polygons) can be selected and will show their associated vegetation community type. Searches can be performed both forwards and backwards in this format, so the user can browse data by community and see all the locations, or by location and see all the types.

All final products³, including this report, Volume II of this report (Studd et al. 2025), keys to vegetation formations and the dichotomous key, and the geodatabase, are available for download in NPS's IRMA DataStore. Products can also be requested directly from SODN offices or accessed via [SODN's Reports & Publications, Inventory and Assessments](#).

³ Supplemental materials for this report, including Volume II of this report, are available in NPS's IRMA DataStore: [Vegetation Mapping Inventory Project for Organ Pipe Cactus National Monument](#).

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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525