Capitol Reef National Park
Survey Design and Site Selection Report

Defining the Upland Resources for Monitoring

Discussions with CARE resource management staff identified grasslands as the major resource of concern for long-term monitoring. Grasslands in the park occur within active and retired grazing allotments. It was decided that the general goal for NCPN monitoring was to document the variability and trends in natural and grazed grassland systems. For the latter, monitoring will provide a basis for determining possible remediation action in active allotments. Additionally, monitoring will provide a baseline for evaluating the long-term recovery after allotments are retired. There is no defined time-line for retirement of the currently active grazing allotments.

Five grazing allotments were of interest – Cathedral (retired over a number of years between 1988 and 1999) and the adjacent Rock Springs Bench (retired in 1989), Hartnet (active), Sandy III (active), and Waterpocket (retired in 1988). Grasslands occur across the relatively flat areas across the allotments. Additionally, grasslands occur in combination with mixed shrubs and PJ (Pinyon-Juniper) on hillsides. These areas can include sufficient grasslands to support grazing and were of interest for long-term monitoring purposes.

Allotments were prioritized due to the large spatial extent of the four allotments and sample-size needs for effective monitoring. The prioritization was the combined Cathedral/Rock Springs Bench allotments and the Hartnet allotment, followed by Sandy III and Waterpocket allotments. The Cathedral/Rock Springs Bench and Hartnet areas provide a potentially useful comparison of a relatively native grassland (Cathedral/ Rock Springs Bench) with a grazed grassland (Hartnet). For the initial monitoring effort in CARE, only the Cathedral/Rock Springs Bench and the Hartnet allotments were considered.

Accessibility

Steep slopes ($\geq$ 50%) and areas isolated due to steep slopes (e.g., mesa tops) have been deemed to be inaccessible for NCPN upland monitoring. Accessibility in CARE was derived using the NCPN Landscape Accessibility Model. The resulting accessibility data layer was clipped to the respective allotments in further processing (described below).

Delineating the Target Population

Initial 'Data' Filtering

The NRCS-UT685 soil map (USDA NRCS 2004) and corresponding Ecological Site Descriptions were used to identify map units with soil components and ecological sites that potentially supported herbaceous vegetation (i.e., grasslands, grass-shrublands, grass-woodlands). Additionally, the NCPN CARE vegetation map (Clark et al. 2009) was overlaid on the soil map layers to generate maps and lists of soil-vegetation combinations. Office assessments and field visits were employed to filter-out the soil map units and vegetation types that were not of interest given the monitoring goals.

The soil map units eliminated from further consideration in the combined Cathedral/Rock Springs Bench allotments and the Hartnet allotment are listed in Tables 1 and 2, respectively. The soil map units retained for further consideration are listed in Tables 3 and 4.

The vegetation types eliminated from further consideration consisted of all vegetation map units with a prefix label of $\leq$5 and $\geq$15. For reference, these vegetation types are included in Tables 5 and 6 which list all vegetation map units occurring in the two sets of allotments. An exception to this exclusion was the inclusion of vegetation map unit 63 in the Hartnet allotment, based on the occurrence of 'grassy' conditions observed during initial field visitations.

After the initial filtering of inaccessible areas, and of unsuitable soil and vegetation map units, the remaining area (shown in Fig. 1 as target area) was included in field-based investigations of ecological sites.

Table 1. NRCS soil map units eliminated from consideration in the Cathedral/Rock Springs Bench allotments.

NRCS Map Unit	Reason for Elimination
280	Rock outcrop and shallow soils with PJ
320	Low spatial extent and mostly PJ

Table 2. NRCS soil map units eliminated from consideration in the Hartnet allotment.

NRCS Map Unit	Reason for Elimination
0	Low spatial extent; non-target ecological sites (based on vegetation)
100	Low spatial extent; riparian ecological sites
125	Mostly rock outcrop
140	Low spatial extent clay/mat saltbush ecological sites
175	Rock outcrop and steep shallow soils with PJ
275	Shallow soils with PJ and some rock outcrop
280	Rock outcrop and shallow soils with PJ
285	Low spatial extent and mostly PJ, although very limited area of ecological site 215
315	Rock outcrop and shallow soils with PJ
320	Low spatial extent and mostly PJ
325	PJ ecological sites

Table 3. NRCS soil map units included in the assessment of Cathedral/Rock Springs Bench allotments.

NRCS MapUnit	Description	Comments
110	Shallow gypsum hills and steep, deep hillslopes with volcanic stones	Some evidence that target ecological sites occur within this map unit
115	Rock outcrop, badlands, and rubbleland	Contains veg13 – verify occurrence/absence of target ecological sites
200	Deep alluvial valleys	Contains mostly target ecological sites (201, 212, 215)
210	Structural benches with deep alluvial soils	Contains mostly target ecological sites (201, 212, 215)
300	Structural benches with deep old alluvium	Lots of Veg8; known that veg8 in this soil map unit can be target, but not always. Delineation of patches of this map unit with target ecological site potentially of greatest interest.

Table 4. NRCS soil map units included in the assessment of the Hartnet allotment.

NRCS MapUnit	Description	Comments
110	Shallow gypsum hills and steep, deep hillslopes with volcanic stones	Some evidence that target ecological sites occur within this map unit
115	Rock outcrop, badlands, and rubbleland	Contains veg13 – verify occurrence/absence of target ecological sites
120	Colluvial hillslopes with shallow clayey soil or deeper soil with volcanic boulders	Veg8 (30-ha), veg11a (18-ha), veg13 (170+ha)
130	Shallow gypsum hills and rock outcrop	Contains Veg8,13,13a – verify occurrence/absence of target ecological sites
160	Gypsum hills	Contains 30-ha of veg13 (desert gypsum loam)
170	Shallow gravelly hillsides with sparse PJ and rock outcrops	Veg13 (301 ha)
200	Deep alluvial valleys	Contains mostly target ecological sites (201, 212, 215)
210	Structural benches with deep alluvial soils and eolian sand	Contains mostly target ecological sites (215, 242)
225	Deep alluvial valleys and eolian dunes	Contains mostly target ecological sites (201, 212, 215)
230	Shallow conglomerate residuum and rock outcrop	Veg13 (1,186 ha)
235	Rock outcrop with shallow to deep sand dunes	Veg8 & 14 (<50-ha). Mostly rock, but does contain ecological site 212. Probably waste of time!
245	Deep alluvial valleys with alkali soils	Veg6 (ca. 60-ha); ecological site 201
258	Deep alluvial valleys and shallow gypsum hills	Veg8, 11, 13, 13a, some 11a
260	Structural benches and hillslopes with deep old alluvium	Clapper/Happle – Likely ecological sites 242 and 260, but grass condition of interest
265	Deep gravelly alluvium on valley sides	Veg6; most likely is ecological site 242
300	Structural benches with deep old alluvium	Lots of veg8; Veg8 in this map unit can be target, but not always. Delineation of these areas is a priority.

Table 5. Vegetation map units in Cathedral/Rock Springs Bench allotments. Map units with a prefix ≤5 or ≥15 were excluded from consideration.

Veg map unit	Veg Association	General assessments relative to target ecological sites
4	Atriplex spp. badlands complex	very little grass expected
6	Atriplex confertifolia shrubland complex	may have some grass; ecological sites 242 & 260?
8	Mixed grassland complex	most likely areas for target ecological sites
11	Desert wash shrubland mosaic	may have some grass; ecological sites 201 & 215?
11a	Sarcobatus vermiculatus shrubland complex	may have some grass; ecological site 201?
11c	Artemisia tridentata shrubland complex	may have some grass; ecological site 201?
12b	Mesic canyon bottom shrubland complex	ecological site 201? Or use to screen out wash bottoms
13	Mixed desert shrubland complex	may have some grass
13a	Ephedra torreyana shrubland complex	may have some grass
13d	Artemisia tridentata ssp. wyomingensis/ Bouteloua gracilis shrubland	supposed to have significant grass component
13z	Ericameria nauseosa/ Bouteloua gracilis shrub herbaceous vegetation	ecological site 215?
14	PJ/mixed grass woodland complex	grass understory
15	PJ/xeric shrub woodland complex	very little grass expected
15d	PJ/sparse understory woodland complex	very little grass expected
15e	PJ/Artemisia tridentata woodland complex	very little grass expected
15f	PJ/Artemisia nova woodland complex	very little grass expected
16	PJ/mesic shrub woodland complex	very little grass expected
16a	PJ/Cercocarpus montanus woodland	very little grass expected
24	Populus fremontii woodland complex	riparian area
25	Springs and seeps mosaic	riparian area
40	Tall mixed mesic shrubland complex	very little grass expected
64	Tamarix spp. temporarily flooded shrubland	riparian area
71	Mudstone cliffs	nontarget area
72	Bare talus/slides	nontarget area
75	Mines, quarries, mine tailings	nontarget area
76	Stock ponds	nontarget area
77	Barren wash bottom	nontarget area
78b	Gravel roads	nontarget area

Table 6. Vegetation map units in the Hartnet allotment. Map units with a prefix ≤5 or ≥15 were excluded from consideration, with the exception of map unit 63.

Veg map unit	Veg Association	General assessments relative to target ecological sites
1	Atriplex spp. extremely sparse shrubland	badlands with little grass
4	Atriplex spp. badlands complex	badlands with little grass
5	Eriogonum corymbosum badlands sparse vegetation	badlands with little grass
6	Atriplex confertifolia shrubland complex	may have some grass; ecological sites 242 & 260?
8	Mixed grassland complex	most likely areas for target ecological sites
9	Artemisia filifolia shrubland complex	ecological site 212?
11	Desert wash shrubland mosaic	may have some grass; ecological sites 201 & 215?
11a	Sarcobatus vermiculatus shrubland complex	may have some grass; ecological site 201?
11c	Artemisia tridentata shrubland complex	may have some grass; ecological site 201?
12b	Mesic canyon bottom shrubland complex	ecological site 201/215? Or use to screen out wash bottoms
13	Mixed desert shrubland complex	may have some grass
13a	Ephedra torreyana shrubland complex	may have some grass
14	PJ/mixed grass woodland complex	grass understory
15	PJ/xeric shrub woodland complex	PJ with little grass
15b	PJ/Opuntia fragilis woodland	PJ with little grass
15d	PJ/sparse understory woodland complex	PJ with little grass
15e	PJ/Artemisia tridentata woodland complex	PJ with little grass
16	PJ/Artemisia nova woodland complex	PJ with little grass
16e	PJ/Quercus havardii var. tuckeri woodland	PJ with little grass
19	Cercocarpus intricatus slickrock sparse vegetation	very little grass expected
21	Pinus ponderosa/Arctostaphylos patula woodland	very little grass expected
23a	Pseudotsuga menziesii mesic montane woodland complex	very little grass expected
24	Populus fremontii woodland complex	riparian area
25	Springs and seeps mosaic	riparian area
32	Salix spp, shrubland complex	riparian area
33	Pinus ponderosa woodland complex	very little grass expected
40	Tall mixed mesic shrubland complex	very little grass expected
43	Sparse cushion plant herbaceous vegetation	very little grass expected
63	Abandoned fields	most likely includes target ecological sites
64	Tamarix spp. temporarily flooded shrubland	riparian area
67	Non-residential developed areas	nontarget area
71	Mudstone cliffs	nontarget area
72	Bare talus/slides	nontarget area
74	Exposed bedrock/sandstone cliffs	nontarget area
76	Stock ponds	nontarget area
77	Barren wash bottom	nontarget area
77a	Barren wash bottom with water	nontarget area
78a	Paved roads	nontarget area
78b	Gravel roads	nontarget area

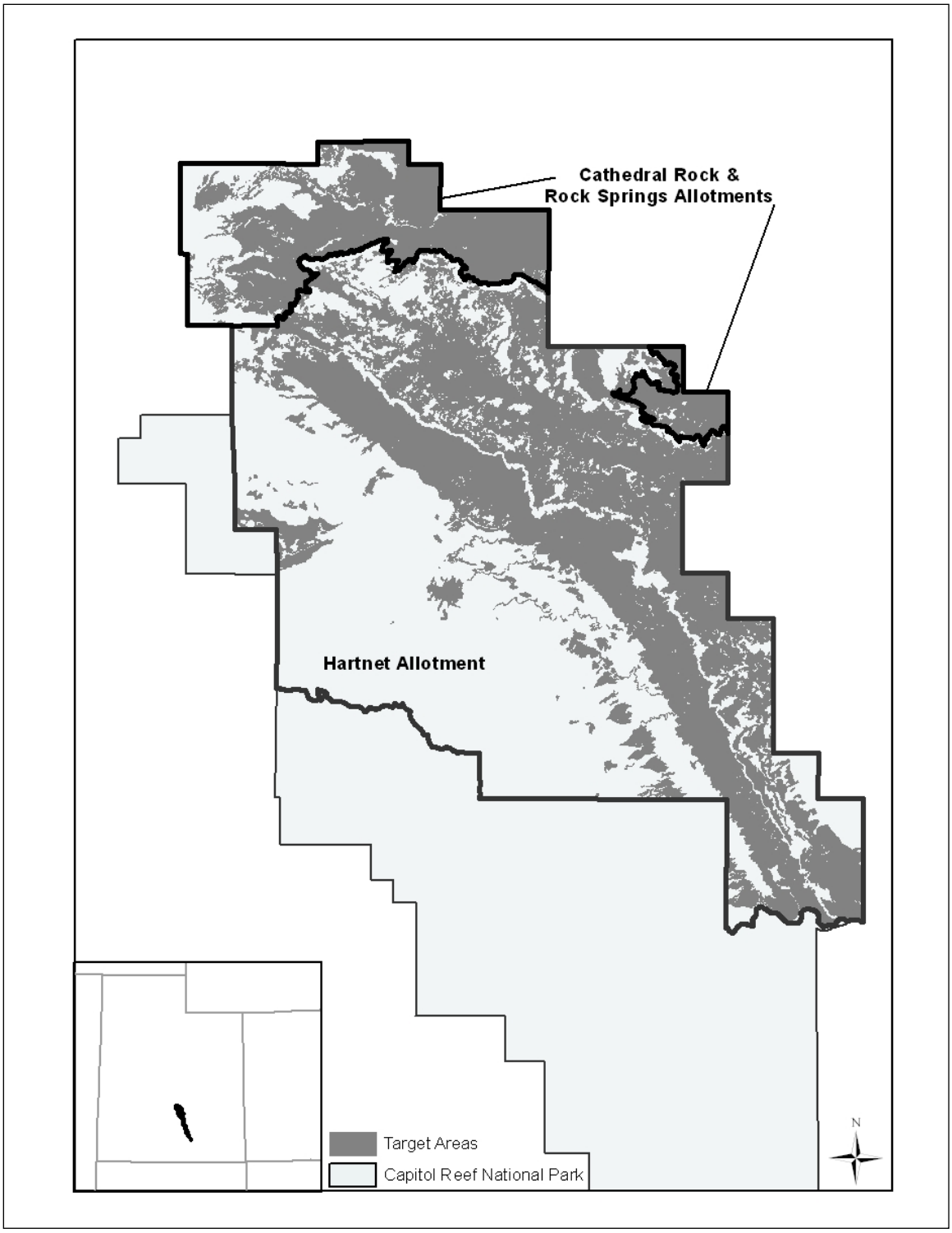

Figure 1. Location of the allotments selected for initial Upland Vegetation and Soils monitoring in CARE, and the resulting portion (target areas) of these allotments considered in field investigations of ecological sites (after filtering out inaccessible area, and unsuitable soil and vegetation map units).

Target Ecological Sites

During the initial assessment, four primary ecological sites were identified as potential targets (Fig. 2), with the potential to include a fifth site type (Table 7). Ecological sites #201 and 215 are deep sandy loams and support a mixture of grass and grass-shrublands. No. 201 is primarily the Begay Alkali soil component (Semidesert Alkali Sandy Loam ecological site). No. 215 is primarily Begay or Mivida (Semidesert Sandy Loam ecological site). Additionally, ecological site #212 (Semidesert Sand) supports sparse grasslands, but occurs in small patches scattered among ecological sites 201 and 215. Given its adjacency to otherwise target ecological sites and its relatively patchy distribution, this ecological site will not be excluded when encountered during plot establishment, but it will not be explicitly targeted. The other two primary ecological sites are #242 (Clapper soil component – Semidesert Stony Loam ecological site) and #260 (Happle soil component – Semidesert Very Steep Stony Loam ecological site). Grass and shrub density and cover are generally sparse but prevalent on these two ecological sites, at least in certain soil map units.

Training Samples for Predictive Mapping

Mapping of ecological sites was required since the soil components which define ecological sites are not explicitly mapped in soil surveys. Predictive mapping requires the use of training sites.

A total of 577 points were visited in the field, and an area ca. 1-ha in size centered on the point was assigned to one of 15 possible ecological sites (based on NRCS soil descriptions of ecological sites for the three allotments). Additionally, 228 vegetation-mapping accuracy assessment locations were reviewed by assessing the plant-species information, physical location and context via GIS, and visual assessment of digital photographs, and assigned to an ecological site type where possible.

Semidesert Sandy Loam (Four-wing Saltbush)

Semidesert Alkali Sandy Loam (Alkali Sacaton)

Semidesert Stony Loam (Shadscale)

Semidesert Very Steep Stony Loam (Salina Wildrye)

Figure 2. Examples of the four primary target ecological sites for Upland Vegetation and Soils monitoring in CARE (see Table 7 for description of site types).

Table 7. Description of target ecological sites selected for upland monitoring in Capitol Reef National Park.

Ecological Site Name/ **notation/No.**	Physiognomic type	Soil properties	Geological properties	Vegetative properties	Disturbance-mediated alternative states
Semidesert Alkali Sandy Loam (alkali sacaton) / **SDASL201/ 201**	herbaceous	deep alkali sandy loams on dissected alluvial fans	alluvium and eolian deposits from mixed sedimentary rocks	dominated by alkali sacaton, greasewood, Indian ricegrass, and shadscale	Decreased bunchgrass and increased snakeweed, yellow rabbitbrush, and prickly pear. Cheatgrass and Russian thistle may invade.
Semidesert Sand (4-wing saltbush) / **SDS212/ 212**	herbaceous	deep sands on dunes and sand sheets	eolian deposits derived from sandstone	dominated by Indian ricegrass, four-wing saltbush, and Mormon tea	Decreased bunchgrass and saltbush and increased snakeweed, prickly pear, juniper, and sand sage. Russian thistle may invade.
Semidesert Sandy Loam (4-wing saltbush) / **SDSL215/ 215**	herbaceous	deep sandy loams on mesas and valleys	alluvium and eolian deposits derived mainly from sandstone	dominated by Indian ricegrass, needle and thread, four-wing saltbush, and Mormon tea	Decreased bunchgrass and increased snakeweed, Mormon tea, and prickly pear. Cheatgrass and Russian thistle may invade.
Semidesert Stony Loam (shadscale) / **SDStL242/ 242**	shrubland	deep stony loams on tops of structural benches and valley sides	alluvium and colluvium derived from sandstone and shale	dominated by galleta, shadscale, Torrey Mormon tea, Bigelow sagebrush, winterfat, and Indian ricegrass	Decreased Indian ricegrass, Torrey Mormon tea, and Bigelow sagebrush and increased galleta, shadscale, and snakeweed. Cheatgrass and juniper may invade.
Semidesert Very Steep Stony Loam (Salina wildrye) / **SDVSStL260/ 260**	shrubland	deep stony loams on steep remnant hillsides	basalt glacial outwash over sandstone and shale residuum	dominated by Indian ricegrass, shadscale, Torrey Mormon tea, Bigelow sagebrush, and Salina wildrye	Decreased Indian ricegrass, Torrey Mormon tea, and Bigelow sagebrush and increased galleta, snakeweed, and juniper. Cheatgrass and halogeton may invade.

Predictive Modeling of Ecological Sites on the Landscape

The ecological site and biophysical attributes of each location (gleaned from GIS layers) were used in a Classification and Regression Tree Model (CART) to develop 'rules' for classifying the landscape to ecological site. CART models afford a means to describe relationships of continuous and categorical independent variables with multiple responses (Garman et al. 2010, De'Ath amd Fabricius 2000, Breiman et al. 1984). Biophysical attributes consisted of soil-map unit, vegetation-map unit, bedrock geology, elevation, percent slope, and slope position. The geology data layer is stored under geology, and the bedrock attribute is GLG_Sym. The topographic features were extracted from the NCPN corporate 10-m DEM layer. Slope position provides a relative measure, where 1=valley floor, 100 = mesa or mountain top, and is derived using a water-accumulation algorithm (USDA Forest Service ArcMap AM). Each of these attributes was derived for the 1-ha area around each acceptable field sample. A majority rule was used to derive categorical attributes and an arithmetic mean was derived for continuous variables. The CART modeling was conducted separately for Cathedral-Rock Springs Bench and Hartnet allotments, using STATISTICA (StatSoft, Inc 2004).

CART (Classification and Regression Tree) Model

Screen-dumps of the resulting CART tree and classification table are provided in Appendix B for the Cathedral/Rock Springs Bench allotment, and Appendix C for the Hartnet allotment. A generalization of the CART decision rules is provided for the two sets of allotments in Tables 8 and 9 showing the ecological sites of soil-vegetation combinations.

CART results indicated soil-vegetation combinations that were non-target ecological sites and target site types. Physical variables had only a minor influence on separating target from non-target sites. Differentiation among the individual target sites, however, was not very clean. The CART results generally provided soil-vegetation combinations which were mixtures of similar target ecological sites (nos. 201-215 in Cathedral-Rock Springs, nos. 201-215 and 242-260 in Hartnet). Nevertheless, CART results provided evidence to drop soil map unit 170 from Hartnet. This map unit was nearly all shallow gravelly soils with sparse PJ and shrubs. Additionally, vegetation map units 13d and 14 were excluded from both Cathedral/Rock Springs and Hartnet allotments. Map unit 13d had dense *Artemisia tridentata* and very little grass. Map unit 14 was generally associated with ecological site 321-Upland Stony Loam (PJ).

Table 8. Summary of the decision rules generated by the CART model for the Cathedral and Rock Springs Bench allotments. Potential Ecological Sites is the 'predicted' response.

Soil map unit	Veg Map units	Potential Ecological Sites
110	6, 8, 11, 11c, 14	201, 215
115	6, 8, 11, 11c, 14	201, 215
200	all vegetation types	201, 215
210	all vegetation types	215
300	8, 13	215, 242

Table 9. Summary of the decision rules generated by the CART model for the Hartnet allotment. Potential Ecological Sites is the 'predicted' response.

Soil Map Unit	Veg Map Units	Potential Ecological Sites
110	8, 9, 11, 12b	201, 215, 242, 260
115	8	201, 215
120	all (but <3% slope)	201, 215
130	8, 9, 11, 12b	201, 215
160	all (but <3% slope)	201, 215, 242
200	all except 13a	201, 215
210	6, 8	215, 242
225	all except 13a	201, 215
230	8	201, 215
235	8, 11a	201, 215
245	6,13	201, 215
258	all except 13a	201, 215
260	all	242, 260
265	all	242
300	6, 8, 13	215, 242

Predictive Modeling

CART-generated rules were applied to the different allotments to produce a map of ecological site combinations. Rules were applied using a customized program. This program applied the rules described in Tables 8-9 to the area of the park that was accessible and that contained the soil and vegetation map units otherwise not excluded (see above). Grid-based data layers are the input to the program, and were generated using a spatial grain of 10 m (the spatial grain of the DEM). The customized program derives an average (or a majority) of the biophysical properties of an approximate 1-ha area centered on a landscape cell and applies the CART rules to determine the predicted ecological site of the cell. This procedure is repeated for every cell of the landscape that is designated for mapping (which is designated by input data layers).

To reduce locating monitoring locations in high-visibility areas (as requested by CARE resource management staff), roads, washes, and high-use areas were buffered and eliminated from consideration.

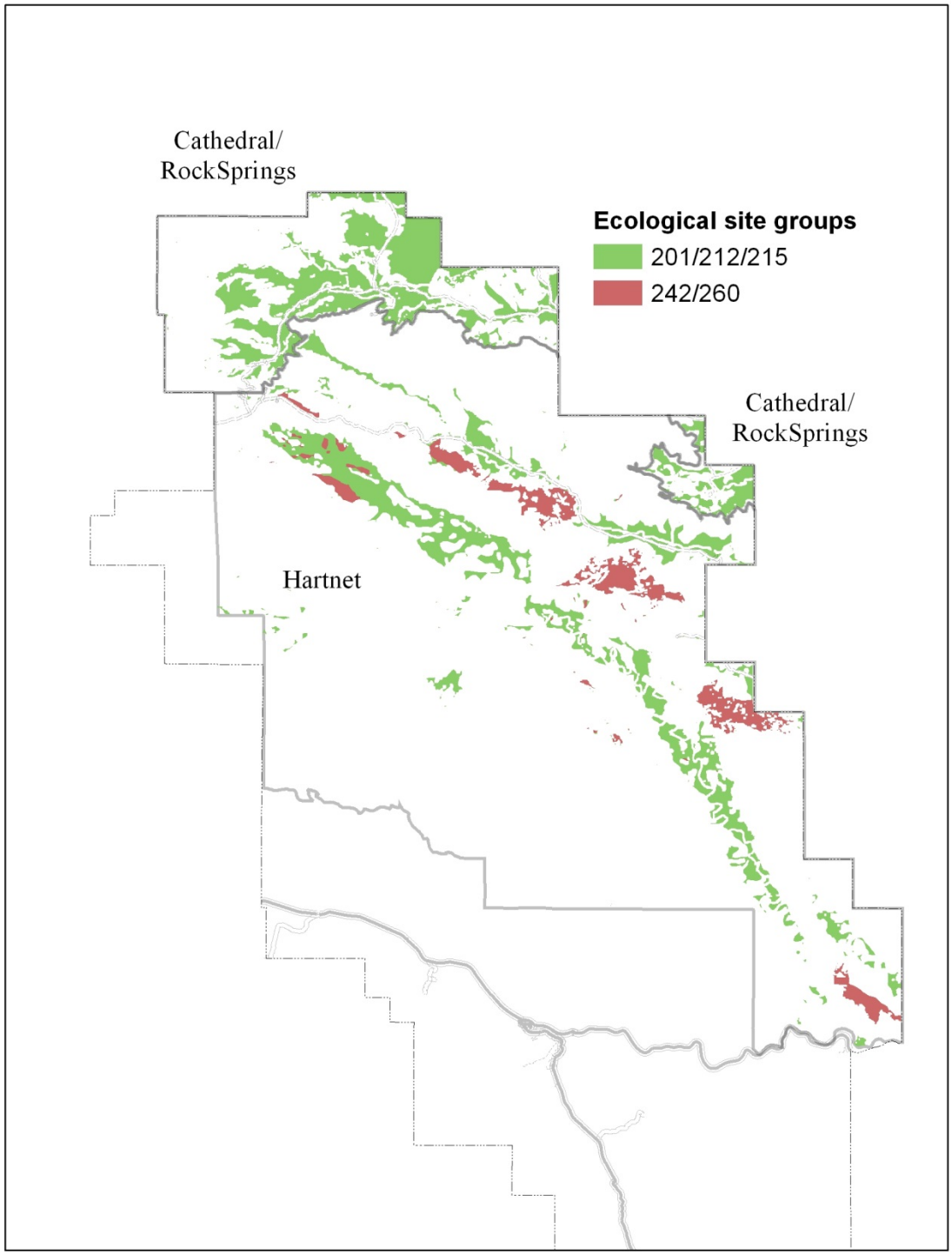

Figure 3. Predicted ecological site map for all of the CARE allotments considered in the initial phase of Upland Vegetation and Soils monitoring. Predictions are the final output from the customized program for Cathedral/Rock Springs Bench and Hartnet Allotments.

Preparation of a Predictive Map for Monitoring Site Selection

The resulting maps of predicted, target ecological sites were stored as shape files and can serve as the input to the site-selection process. However, to avoid selection of sites too close to boundaries, polygons of predicted site types were buffered 'inward' by 20 meters. These versions can also serve as the basis of site selection. In an attempt to provide a consistent sampling frame for possible future expansion of monitoring, the buffered layer was enhanced by adding the non-target area of the entire allotment. The non-target area was codified as 0, for background, and was assigned a selection probability of 0. This final design of the sampling frame may or may not be useful in future applications. However, this design is still valid and credible for the selection of the target ecological sites included in the initial phase of CARE upland monitoring.

Monitoring Site Selection

Monitoring sites were selected using the RRQRR (Reversed Randomized Quadrant Recursive Raster - Theobold et al. 2007) system and a 5-m grain size. Sites were selected separately for Cathedral/Rock Springs Bench and Hartnet. Input GIS layers consisted of the entire extent of the allotment, with background set to 0 and a code for predicted ecological site complexes. For Cathedral/Rock Springs Bench, a code of 1 was used to identify the ecological site #201/215 complex. For Hartnet, a code of 1 was used for this same complex, and a code of 2 was used for the ecological sites #242/260 complex. For both allotments, sites were selected with equal probability of selection. The use of a 5-m grid was to ensure complete coverage of the landscape while balancing the amount of time necessary for RRQRR to select points. We found that at a 1-m grid, RRQRR took most of a day to select points that had no better spatial balance than at a 5-m grid.

Monitoring Site Selection Shape Files

Output from the RRQRR process includes the following shape files:

CRsample_pts – the first 150 sequential locations for the Cathedral/Rock Springs Bench allotment,corresponding to predicted ecological site complex of #201/215.

CRsmpts – all target ecological site locations in sequential order for the Cathedral/Rock Springs Bench allotment, corresponding to predicted ecological site complex of #201/215.

Hart_sample_pts – the first 300 sequential locations for the Hartnet allotment, corresponding to one of the two predicted ecological site complexes (#201/215 and #242/260). The points must be overlaid on the predicted ecological site map of this allotment to separate locations for the two different site-type complexes.

Hart_smpts – all target ecological site locations in sequential order for the Hartnet allotment, corresponding to one of the two predicted ecological site complexes (#201/215 or #242/260). The points must be overlaid on the predicted ecological site map of this allotment to separate locations for the two different site-type complexes.

Tracking Monitoring Sites

We used the order provided by RRQRR to create simple PlotID numbers for each stratum. PlotIDs for the Cathedral/Rock Springs Bench allotment range from 1 to 150. For the Hartnet locations, the first 225 locations corresponding to the #201/215 complex were renumbered with PlotIDs from 151-375. The first 75 locations corresponding to the #242/260 complex were renumbered with PlotIDs from 376-450.

CARE_upland_master.shp, derived from CRsample_pts.shp and Hart_sample_pts.shp, contains the first 450 potential monitoring plots and any relevant tracking information (Table 10). In this file, the GRID_CODE (or order) attribute was renamed “RQorder” for consistency among parks.

Table 10. Attributes of CARE_upland_master.shp for tracking Capitol Reef National Park monitoring locations.

Field	Description
Veg_Type	Vegetation type for upland sampling methods (grassland/shrubland)
EcoType	Predicted vegetation type based on sampling frame (deep grasslands=201, 212, or 215; rocky grasslands=242 or 260).
Allotment	Grazing allotment (Cathrock or Hartnet)
Grazing	Indicates whether grazed or ungrazed
MasterStrt	Indicates groups for analyzing data (CR deep, Hartnet deep, Hartnet rocky)
PlotID	The plot number, based on ascending order of the RQorder field, renumbered to give unique plot numbers for each point on the list.
panel	Panel that plot is associated with in the revisit design
PanelYear	Year(s) that panel is sampled
EvalStatus	Ultimate status of a plot (estab = established; NotEval = not visited; accept = visited and deemed to be acceptable as a monitoring site; reject = rejected)
S_Action	Status of plot determined in the field and recorded on GPS (accept or reject)
EvalReason	Describes why a site was accepted or rejected
Estab_Date	Month, day, and year of plot establishment
Soil_MU	Soil map unit from UT685 associated with the monitoring plot
X	UTM E (NAD83, Zone 12)
Y	UTM N (NAD83, Zone 12)
Hike_km	Hiking distance to plot in kilometers
AreaDescr	General area of the park where the plot is located
Comments	Miscellaneous
ActualEco	Actual ecological site number (201, 212, 215, 242, or 260)
RQorder	Sequence number produced by RRQRR that doesn't start at 1 or increment by 1 (=order in sample_pts shape files and =GRID_CODE in smpts shape files)
inc_prob	inclusion probability; 1 indicates equal probability of selection for all points from the sample_pts shape files
CartNode	Predicted node number corresponding to the CART model

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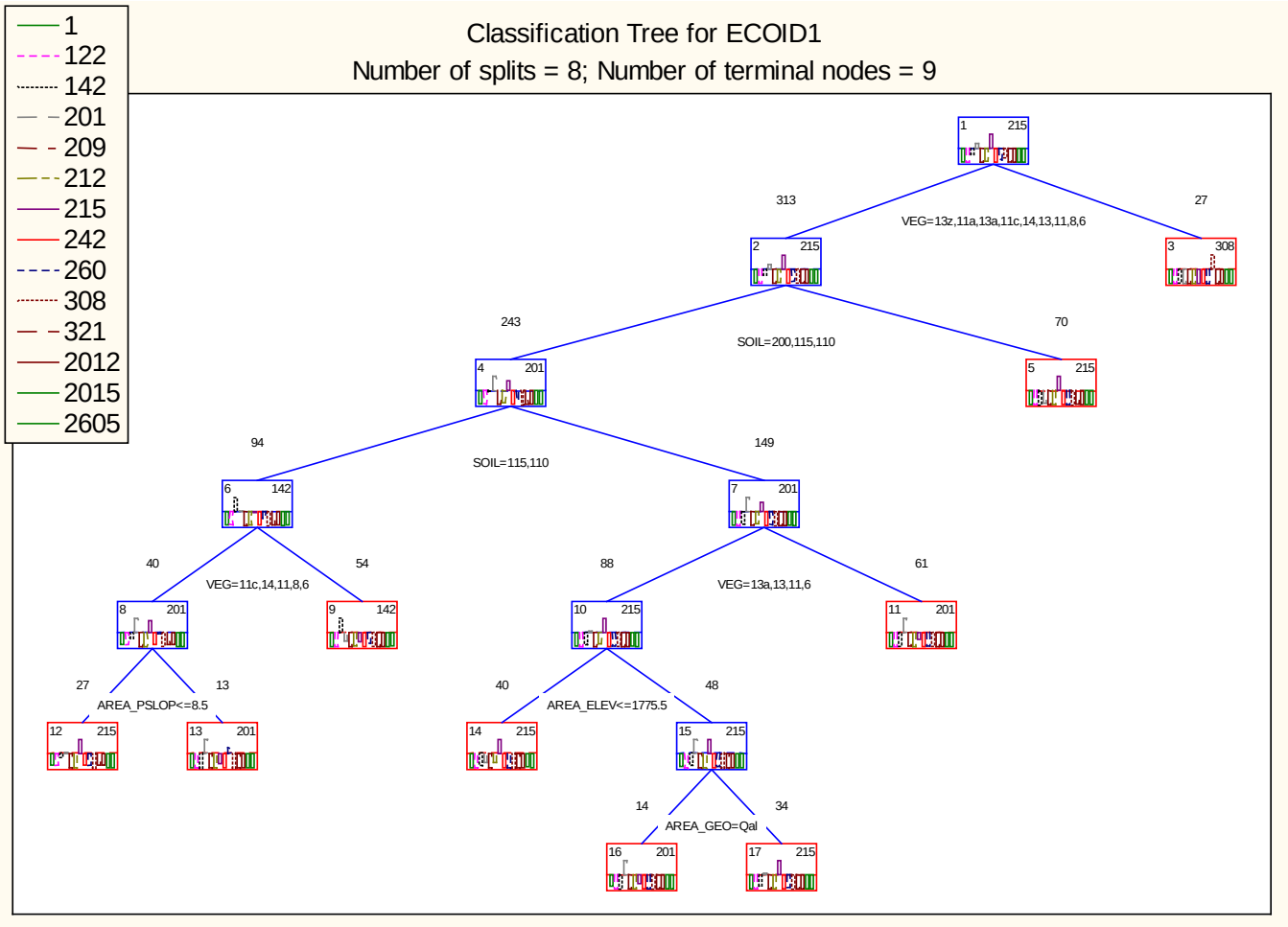
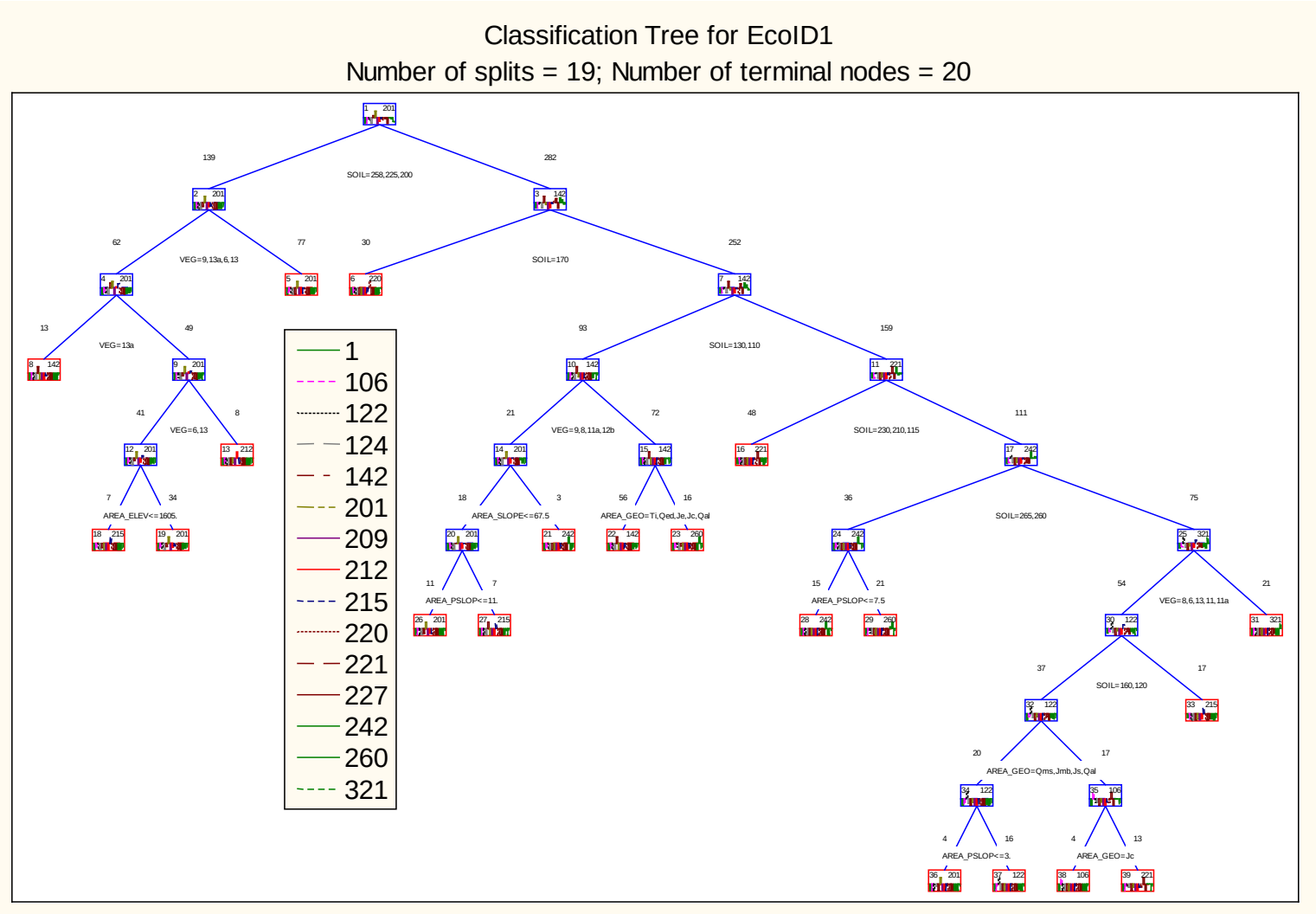
Appendix A. CART-model results for the Cathedral/Rock Springs Bench allotments. ECOID1 is the ecological site number assigned to a field-visited training site. Codes 2012, 2015, and 2605 are combinations of site types 201/212, 201/215, and 260/215, respectively.



Class compositions (CathRock1(no 9898).sta)
Child nodes and observed class n's
for each node

Node	**Left branch**	Right branch	n in cls 1	n in cls 122	n in cls 142	n in cls 201	n in cls 209	n in cls 212	n in cls 215	n in cls 242	n in cls 260	n in cls 308	n in cls 321	n in cls 2012	n in cls 2015	n in cls 2605
1	2	3	2	1	43	97	1	6	145	1	12	27	2	1	1	1
2	4	5	2	1	43	97	1	6	145	1	12	0	2	1	1	1
3			0	0	0	0	0	0	0	0	0	27	0	0	0	0
4	6	7	2	1	43	94	1	6	79	1	12	0	1	1	1	1
5			0	0	0	3	0	0	66	0	0	0	1	0	0	0
6	8	9	1	1	39	20	0	1	18	1	10	0	1	1	0	1
7	10	11	1	0	4	74	1	5	61	0	2	0	0	0	1	0
8	12	13	1	1	4	13	0	0	12	1	6	0	1	1	0	0
9			0	0	35	7	0	1	6	0	4	0	0	0	0	1
10	14	15	1	0	4	27	0	5	49	0	1	0	0	0	1	0
11			0	0	0	47	1	0	12	0	1	0	0	0	0	0
12			1	1	4	6	0	0	11	1	1	0	1	1	0	0
13			0	0	0	7	0	0	1	0	5	0	0	0	0	0
14			0	0	2	5	0	5	27	0	0	0	0	0	1	0
15	16	17	1	0	2	22	0	0	22	0	1	0	0	0	0	0
16			1	0	0	11	0	0	2	0	0	0	0	0	0	0
17			0	0	2	11	0	0	20	0	1	0	0	0	0	0

Appendix B. CART-model results for the Harnet allotment. ECOID1 is the ecological site number assigned to a field-visited training site.



for each node

Node	**Left branch**	Right branch	n in cls 1	n in cls 106	n in cls 122	n in cls 124	n in cls 142	n in cls 201	n in cls 209	n in cls 212	n in cls 215	n in cls 220	n in cls 221	n in cls 227	n in cls 242	n in cls 260	n in cls 321
1	2	3	4	5	22	5	61	94	1	19	39	31	38	3	44	37	18
2	4	5	0	0	2	0	16	78	1	14	19	0	1	0	4	4	0
3	6	7	4	5	20	5	45	16	0	5	20	31	37	3	40	33	18
4	8	9	0	0	2	0	15	17	0	10	14	0	1	0	1	2	0
5			0	0	0	0	1	61	1	4	5	0	0	0	3	2	0
6			0	0	0	0	0	0	0	0	0	28	0	0	0	0	2
7	10	11	4	5	20	5	45	16	0	5	20	3	37	3	40	33	16
8			0	0	0	0	10	0	0	0	3	0	0	0	0	0	0
9	12	13	0	0	2	0	5	17	0	10	11	0	1	0	1	2	0
10	14	15	0	1	2	1	44	9	0	2	6	1	1	0	6	20	0
11	16	17	4	4	18	4	1	7	0	3	14	2	36	3	34	13	16
12	18	19	0	0	2	0	5	16	0	3	11	0	1	0	1	2	0
13			0	0	0	0	0	1	0	7	0	0	0	0	0	0	0
14	20	21	0	0	0	0	4	8	0	1	4	0	0	0	3	1	0
15	22	23	0	1	2	1	40	1	0	1	2	1	1	0	3	19	0
16			2	0	1	0	1	2	0	0	2	0	32	0	8	0	0
17	24	25	2	4	17	4	0	5	0	3	12	2	4	3	26	13	16
18			0	0	0	0	1	0	0	0	6	0	0	0	0	0	0
19			0	0	2	0	4	16	0	3	5	0	1	0	1	2	0
20	26	27	0	0	0	0	4	8	0	1	4	0	0	0	0	1	0
21			0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
22			0	1	0	1	37	1	0	1	2	1	0	0	3	9	0
23			0	0	2	0	3	0	0	0	0	0	1	0	0	10	0
24	28	29	0	0	2	1	0	0	0	0	0	0	0	0	22	11	0
25	30	31	2	4	15	3	0	5	0	3	12	2	4	3	4	2	16
26			0	0	0	0	1	8	0	1	1	0	0	0	0	0	0
27			0	0	0	0	3	0	0	0	3	0	0	0	0	1	0
28			0	0	0	0	0	0	0	0	0	0	0	0	15	0	0
29			0	0	2	1	0	0	0	0	0	0	0	0	7	11	0
30	32	33	2	4	15	3	0	5	0	1	12	1	4	1	4	2	0
31			0	0	0	0	0	0	0	2	0	1	0	2	0	0	16
32	34	35	0	4	15	3	0	4	0	0	1	1	4	0	3	2	0
33			2	0	0	0	0	1	0	1	11	0	0	1	1	0	0
34	36	37	0	0	14	2	0	3	0	0	0	0	0	0	1	0	0
35	38	39	0	4	1	1	0	1	0	0	1	1	4	0	2	2	0
36			0	0	0	1	0	3	0	0	0	0	0	0	0	0	0
37			0	0	14	1	0	0	0	0	0	0	0	0	1	0	0
38			0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
39			0	0	1	1	0	1	0	0	1	1	4	0	2	2	0