Vegetation of the Costilla Massif, Taos County

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New Mexico has about 11,000 hectares (28,000 acres) above timberline in nine areas. All are in the Sangre de Cristo Mountains except Sierra Blanca, which is marginally alpine. The largest, with 3000 hectares, is the Truchas Peaks alpine, a network of narrow ridges and peaks. Next in size but at the other topographic extreme is the Costilla Massif in Taos County on the Colorado border: within New Mexico 2700 hectares of rolling sedge meadow, broken here and there by the rock and cushion communities characteristic of the Truchas Peaks. In 1979 and 1982 I studied vegetation of the Massif and here summarize highlights from that unfinished and unpublished work.

The Costilla Massif is about 13 km. (8 miles) north-south and 2.5-4 km. (1.6-2.5 miles) east-west but narrower just south of State Line Peak. This tableland ends abruptly on the east but is cut by more gradual stream-heads to the west. Its top is not flat; about 10 summits are spaced along it, but at 3900 m. (12800 ft.) they do not rise much above the general height-of-land at 3700 to 3800 m. (12200 to 12500 ft.). To east and west from that divide elevation decreases to 3600 m. (11800 ft.) at the edge of the tableland (and of tundra).

The geology is PreCambrian, mostly granitic rocks but with quartzites and other metamorphics where the massif is narrow south of State Line Peak (McKinlay 1956).

The meadows were grazed heavily by elk, lightly by cattle, and mule deer were seen just twice. Sheep sign was seen just east of the tableland. Elk hunting is the prime economic product of this private land.

Methods

I visited 3 times (15 days) and collected 266 specimens from State Line Peak south to Big Costilla Peak. Many collections were discarded after checking identifications. Specimens of species new to New Mexico are at New Mexico State University; others are in the herbarium of the New Mexico Natural History Institute at the Randall Davey Audubon Center in Santa Fe, and some are at both. Plant names are those of Allred 2008 except (as discussed) for a *Carex* species.

August 13-18 1982 were devoted to sampling vegetation on the alpine plain, avoiding rough topography. On Big Costilla Peak 7.5-min. quadrangle we selected 65 sampling points, and from each of these we randomly selected bearings and distances (1 to 40 meters) to 3 meter-square plots. If a plot turned out to be on a slope exceeding 5^0 or within 10 m of a tree, a substitute random bearing and distance was chosen. At each plot we measured topsoil soil depth and texture. Using a wire grid within each plot we sampled 100 points for vascular plants (by species), mosses, lichens, rock, or soil, and we listed species in the plot but not sampled. Due to lightning and hail storms and other impediments we finished only 32 of the sampling points (96 1-m plots) in the time available, and these were in the northern half of the Massif, 1.5 to 7 km north of Big Costilla Peak. Most sampled plots clustered near the north-south height-of-land and to its east. Westward-draining washes (in which the definition of “alpine” was often difficult) were scarcely sampled, so shrub habitat is under-represented. Not

all data points were reliably recorded in relation to vouchers so data are lumped for some species in Apiaceae, Asteraceae, Caryophyllaceae, Liliaceae, and Rosaceae.

Sampling Results and Vegetation Description

Of 96 plots and 9600 sample points, soil occurred at 1998 points in 95 plots, rock (> 2 cm. diam.) at 450 points in 59 plots, and water at 90 points in 4 plots. Lichens were at 723 points in 81 plots, bryophytes at 192 points in 42 plots, and vascular plants at 6140 points in all plots. Cow manure was at only 7 points and, surprisingly, elk droppings were missed in the samples although present in plots.

Five plant community types, obvious to the eye, were confirmed and analyzed by the samples.

(1) Broad sedge meadows dominated by *Kobresia myosuroides* cover flat or rolling uplands. Dense mats formed by *Kobresia* and by the vegetatively similar *Carex elynoides* become several centimeters thick. *Carex rupestris*, *Geum rossii*, moss, and lichens occur on soil between the large *Kobresia* mats and there are large patches—often circles--of *Trisetum spicatum* and patches of *Helictotrichon mortonianum*, *Danthonia intermedia*, and smaller grasses. In the 35 plots where *Kobresia* hits exceeded 19, topsoil depths ranged from 8 to >30 cm., average >20 cm. The number of soil hits ranged from 4 to 29, average 14, and of rock from 0 to 7, average 1. Lichens—mostly fruticose, on soil—were common in this community, averaging 10 points, and mosses averaged 2 points per plot. In 34 additional plots *Kobresia* or *Carex elynoides* occurred at 1 to 19 points, reflecting the fact that this tableland is mostly covered by dense sedge meadow.

(2) Gently convex hills and ridges are dominated by *Carex rupestris* with much soil (often gravelly) and rock showing. Crustose and foliose lichens are common on rock and soil. Accompanying plants include cushions of *Paronychia* and *Minuartia*, usually with *Thalictrum alpestre*, *Geum rossii*, *Trifolium nana*, *T. dasyphyllum*, or *Bistorta vivipara*. In 12 plots where *Carex rupestris* hits exceeded 10 and *Kobresia* was absent, topsoil depths ranged from 6 to 21 cm., average 12; soil hits ranged from 5 to 55, average 28, and rock hits from 1 to 27, average 9. Crustose, foliose, and fruticose lichens averaged 3, 6, and 2 points per plot in this community; mosses 1.

(3) On more sharply convex surfaces and rocky surfaces and those most exposed to wind, *Paronychia pulvinata*, *Minuartia obtusiloba*, and other cushion plants dominate, with *Carex rupestris* and forbs such as *Sibbaldia procumbens* filling in. Soil (particles <2 cm. diam.) and rock dominate. These “crest” communities were largely avoided by our <5%-slope rule for plot selection, but 3 plots that might qualify had topsoil depths of 11-13 cm. (av. 12), soil 27-57 hits (av. 38), rock 12-29 (av. 22), and *Paronychia* 13-19 (av. 16). Lichens averaged 8 hits per plot, on large rocks more on east than west sides. At an average of 5 hits mosses were also abundant.

(4) Bogs and moist lowlands are on concave surfaces with open water in 4 plots. Dominant are wetland sedges (for species see discussion below) and mesophytic grasses and forbs including *Deschampsia cespitosa*, *Podistera eastwoodiae*, *Cymopteris lemmonii*, and *Geum rossii.* Water in plots (standing or occasionally running) was temporary, some of it related to nearby snowbanks (in mid-August). In 17 lowland plots topsoil depths averaged >23 cm. (in 8

plots >30 cm., the maximum depth measured), soil hits 12, rock 2, water 5. Wetland *Carex* species averaged 9 points, *Deschampsia* 13, and *Podistera eastwoodiae* (with some *Cymopterus lemmonii*?) 8. Lichens and mosses were least abundant in this community, averaging 3 and 1.5 points per plot.

(5) Small sites disturbed by pocket gophers (Geomyidae), elk, and cattle and erosion-caused bare spots (including wind blow-outs and semi-permanent snowbanks) are occupied by pioneer grass and forb species: *Elymus bakeri*, *E. scribneri*, *Poa fendleriana*, *Eremogone fendleri*, *Minuartia rubella*, *Trifolium dasyphyllum*, *T. nanum*, *Bistorta vivipara*, *Geum rossii,* and *Artemisia scopulorum.* In 10 disturbed plots soil points averaged 28, rock 2, and the just-named species 34 points per plot. One luxuriant plot on an old gopher mound had 44 points of *Geum rossii*, 31 of *Poa fendleriana*, and only 4 of soil + rock. Another had 17 of moss, 11 of *Geum rossii*, and 12 of *Salix arctica*, with 18 of soil + rock. *Carex rupestris* takes over as disturbances heal. *Deschampsia* dominated some moist eroded sites. *Kobresia* mats often closely surrounded gopher mounds during the rodents' early build-up; these are not counted as disturbed sites.

A few plots fit none of the 5 community types as defined. Most of these, lacking 10 points of *Carex rupestris* or having a point or two of Kobresia*,* belong to a more broadly defined Community 2*.* One shallow-soil plot was 33% *Selaginella*, 33% bare soil, with only traces of *Carex rupestris* and *C. elynoides*.

Kobresia myosuroides is the most abundant plant:1628 points in 62 plots. Its look-alike associate *Carex elynoides* seemed more abundant than was caught by samples (21 points in 6 plots). Both species form solid mats that exclude competitors.

Carex rupestris is common in all five communities. Rhizomatous-spreading *C. rupestris* plants leave room for other plants and lichens and many rock and soil "hits" in their interstices. In 80 plots with 850 data points it is the second most abundant plant of the study and would have seemed more so had plot selection not favored "flats."

Geum rossii, the third most common plant with 525 points in 70 plots, is also in all 5 communites. It often occurs in rocky, rough sites and would also have appeared more abundant had plots been allowed there.

Of the 9600 sample points 723 fell on lichens: 209 crustose in 55 plots, 246 foliose in 64 plots, and 268 fruticose in 54 plots. In very rocky areas (topographically rough so not included in samples) lichen communities are extensive but in the study plots lichens are in small patches mixed with vascular plants—crustose lichens especially in Communities #2 and 3, 50% on soil and 50% on rock; fruticose lichens on soil (100%) mostly in #1; and foliose lichens on both soil (82%) and rock (18%) in all communities.

Bryophytes comprise 191 (mosses) plus 1 (liverwort) of the 9600 samples in 42 plots, mostly associated with *Kobresia* or *Geum*.

As in New Mexico's other alpine areas, there is encroachment by trees, mainly *Picea engelmannii*, but in 1982 it was very limited. Invaded areas were avoided by site-selection rules.

Floristics

Above-timberline vascular plants of the Massif (not merely of the sampled plain) are listed below, with occurrences by plot and sampling point. Several species are omitted that occurred with alpine plants only near krummholz or trees, including *Erigeron ursinus*, *Festuca ~idahoensis*, and *Castilleja rhexifolia*. *Erigeron vetensis* and *Vaccinium scoparium* also seemed "accidentally alpine" but, occuring up to 100 m. from trees, are included.

In the list of plants are some unknowns no longer recoverable. "*Cerastiium beeringianum*" was mostly that, but some plants seemed closer to *C. arvense*. *Minuartia rubella* was present but also *Sagina saginoides*—not reliably distinguished during sampling—and mayhap other *Arenaria* and *Minuartia* species not separated. Not all *Erigeron*, *Hymenoxys/Tetraneuris*, and "*Haplopappus*" species were reliably distinguished, nor *Allium geyeri* from *Lloydia serotina*.

One species, *Taraxacum officinalis* (occasional), is non-native. The more common *Achillea millefolium*, or some of it, may also be non-native. Non-native "*Poa compressa*" was assigned to 1 of 36 *Poa* collections but the specimen was discarded, the identication was questioned, and that species is not included. *Poa pratensis*, common in the subalpine, was not seen in the alpine zone at Costilla.

Difficulties with *Carex* listings are of two sorts. "*Carex nova"* is used for that species including *C. nelsonii* and *C. pelocarpa* but it is possible that *C. albonigra*, *C. atrata*, and *C. chalciolepis* are included with it in plot data. *C. chalciolepis* is documented by a non-plot collection.

The second problem is taxonomic. I use *"Carex macloviana"* not only for *C. ebenea*, known in alpine New Mexico, but also for plants that key to *C. haydeniana*, known in alpine Colorado. Differences are not clear-cut and when specimens of *C. microptera* from lower elevations are included in comparisons, these three "species" (as treated in *Flora North America* and Allred 2008) intergrade in ways that lead me to treat them as one. Scott (1995) includes *C. macloviana*—the oldest name—in the complex, and I follow him in using that name..

Carex lachenalii and *Eriophorum altaicum* are here first reported from New Mexico. Both were found only in standing water at the foot of large snowbanks, the latter only one plant. Both species were identified for me by W. A. Weber. *C. lachenalii* is close to *C. stevenii*, also known as *C. norvegica* and in New Mexico as *C. media*, and there could be confusion between them.

Chionophila jamesii is also newly recorded for New Mexico. It is occasional in meadows and wet lowlands. "*Poa pattersonii*" was recorded from many plots in *Kobresia* meadows and occurs also in communities #2 and 5 and into the edge of spruce stands. Most of nine specimens were discarded and Peterson 82-371 cannot be found so this species is not yet proposed for listing in New Mexico.

Of 4 or more *Potentilla* species, *P. concinna* was much the most common. Peterson's (2000) discussion of difficulties in alpine *Potentilla* was based partly on this Costilla study. Eighteen of 100 "hits" on *Potentilla* were recorded as *P. nivea* but no voucher for the identification survived and this confusing species is still reported only unreliably for New Mexico, so it is omitted from the species list.

That leaves 116 alpine species recognized. *Eriophorum altaicum* was the only real surprise, distant from its station in the Mosquito Range of central Colorado. The tableland has no sites inaccessible to elk and few or none inaccessible to cattle, so these are plants that can survive under grazing pressure. The ~2000 hectares of dense *Carex* mat seemed healthy in spite of heavy impact by elk..

Acknowledgments

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Plant list with data from sampling study

plant	plots	"hits"
Apiaceae		
Cymopterus bakeri	81	182
Cymopterus lemmonii + Podistera eastwoodiae	25	176
Asteraceae		
Achillea millefolium	3	19
Agoseris aurantiaca	0	0
Agoseris glauca	1	0
Antennaria media (+ A. spp. ?)	2	0
Artemisia scopulorum (+ A. sp.?)	40	107
Erigeron glacialis + grandiflorum	10	43
Erigeron melanocephala	2	0
Erigeron vetensis	0	0
Helianthella parryi + similar	14	33
Hymenoxys brandegeei	26	15
Packera werneriifolius	0	0
Senecio taraxacoides	0	0
Solidago spathulata	1	1
Taraxacum officinale	2	8
Tetraneuris acaulis	13	14
Tonestus pygmaeus	43	49
Boraginaceae		
Eritrichum nanum	20	17
Brassicaceae		
Draba aurea		
Draba crassifolia		
Draba streptocarpa		
Draba spp. together	39	12
Erysimum capitatum	0	0
Noccaea fendleri	3	4
Campanulaceae		
Campanula rotundifolia	5	7
Campanula uniflora	1	0
Caryophyllaceae		

Cerastium beeringianum + C. arvense	6	14
Eremogone fendleri	36	57
Minuartia obtusiloba	70	259
Minuartia rubella, M. spp. Sagina saginoides		
Minuartia spp., Sagina sp.	25	35
Paronychia pulvinata	34	183
Silene acaulis	31	54
Stellaria longipes	0	0
Crassulaceae		
Sedum integrifolium	0	0
Sedum lanceolatum	1	0
Sedum rhodanthum	1	0
Cyperaceae		
Carex chalciolepis	0	0
Carex elynoides	7	21
Carex lachenalii (bipartita)	1	7
Carex macloviana (see discussion)	0	0
Carex nova (see discussion)	13	141
Carex phaeocephala	0	0
Carex rupestris	84	849
Carex siccata	0	0
Carex scopulorum	4	10
Carex stevenii (norvegica)	0	0
Eriophorum altaicum	0	0
Kobresia myosuroides	62	1628
Ericaceae		
Vaccinium scoparium	0	0
Fabaceae		
Trifolium dasyphyllum	15	106
Trifolium nanum	42	279
Trifolium parryi	1	3
Gentianaceae		
Gentiana algida	8	9
Gentiana prostrata	1	0
Gentianella amarella	0	0
Gentianella tenella	1	0
Juncaceae		
Juncus castaneus	3	2
Juncus drummondii	0	0
Juncus triglumis	0	0
Luzula spicata	6	4
Liliaceae		
Allium geyeri + Allium sp. Lloydia serotina Allium + Lloydia together	10	7
Orobanchaceae		
Castilleja haydenii	0	0
Castilleja occidentalis	1	0
Plantaginaceae		
Chionophila jamesii	1	0
Penstemon whippleanus	0	0
Synthyris (Besseya) alpina	2	0
Veronica wormskoldii	1	0
Poaceae		
Agrostis variablis	13	16
Calamagrostis purpurascens	1	0
Danthonia intermedia	2	16
Deschampsia cespitosa	22	292
Elymus bakeri	0	0
Elymus scribneri	0	0
Elymus trachycaulus	0	0
Festuca brachyphylla	13	17
Festuca saximontana	15	26
Helictotrichum montanum	16	13
Phleum alpinum	2	11
Poa alpina	3	19
Poa arctica	0	0
Poa fendleriana	2	39
Poa glauca (both varieties)	34	74
Poa pattersonii (undocumented)	23	25
Poa secunda	0	0
Trisetum spicatum	24	43
Polemoniaceae		
Phlox condensata	0	0
Polemonium viscosum	3	5
Polygonaceae		
Bistorta bistortoides	17	23
Bistorta vivipara	51	201
Portulacaceae		
Claytoniana megarhiza	0	0
Primulaceae		
Androsace chamaejasme	39	52
Androsace septentrionalis	5	1
Primula angustifolia	14	9
Ranunculaceae		
Caltha leptosepala	5	23
Delphinium alpestre	0	0
Ranunculus inamoenus	0	0
Ranunculus macauleyi	0	0
Ranunuculus sp.	2	0
Thalictrum alpestre	34	103
Rosaceae		
Geum rossii	70	525
Pentaphylloides fruticosa Potentilla concinna	1	3

Potentilla diversifolia		
Potentilla gracilis		
Potentilla subjuga		
Potentilla spp. together	20	100
Sibbaldia procumbens	4	27
Salicaceae		
Salix arctica	3	15
Salix reticulata	4	8
Saxifragaceae		
Saxifraga bronchialis	1	6
Saxifraga flagellaris	0	0
Saxifraga rhomboidea	7	3
Selaginellaceae		
Selaginella densa (& S. spp?)	17	82
Violaceae		
Viola adunca		