Composition of Riparian Herb Communities on Streams with Regulated and Unregulated Streamflow, Eldorado National Forest, California

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Introduction

This study was carried out at the request of the USDA-Forest Service, Eldorado National Forest. The objective was to collect data about riparian herb communities associated with regulated and unregulated streams. The intended use of these data was to establish a baseline for analyzing effects of flow regulation.

There is a relatively extensive literature that describes the responses of meadow vegetation to changes in groundwater (Ponce and Lindquist 1990). Reduced groundwater levels can occur when streams incise to levels below their floodplains. When this occurs, vegetation composition may change from species adapted to high soil moisture to more drought tolerant species. These effects are thought to be common in the Sierra Nevada (Kattelmann 1996). Raising a water table through geomorphic restoration or use of instream structures can reverse these vegetation changes.

There have been few studies that have looked specifically at the effects of stream flow regulation on herb communities. When streams have been completely diverted in and regions there have been changes in species composition from mesic to xeric herb species (Ham's et. al. 1987). In cases such as Project No. 184 where hydrologic changes are relatively complex, responses of herb communities have not been studied. Soils, light and other environmental variability plus land use history confound attempts at such studies.

The information presented below does not provide a comprehensive assessment of the many regulated and unregulated streams in the Eldorado National Forest. It does provide a benchmark for considering whether or not herb monitoring might be warranted to determine future operational effects of Project No. 184.

Methods

We defined suitable study sites as having distinctive, relatively extensive (at least several hundred square feet) riparian meadows free from excessive forest or shrub cover. Study sites were selected on three stream reaches affected by Project No. 184: Caples Creek downstream from Caples Lake, South Fork American River downstream from the Echo Lake conduit, and South Fork American River in the vicinity of Phillips (Figure 1). Other regulated stream reaches on the South Fork, Caples Creek, and Silver Fork were evaluated for sampling but eliminated due to the absence of significant riparian herb communities. Study sites on unregulated streams were selected in consultation with Forest Service staff. These included Foster Meadow, Bryan Meadow, Benwood Meadow, Round Meadow and Kirkwood Meadow (Figure 1). All sites, including those affected by Project No. 184, are located at altitudes greater than 6000 feet. None are within active grazing allotments although they may receive limited grazing from horses passing through.

Sampling occurred in July-August, 2000 corresponding to the time when most species would be identifiable. At each site, experienced ecologists selected sampling locations. The objective was to select locations that typified the vegetation community. In some cases, more than one location was required.

The study design consisted of establishing transects that were generally 200 feet long, but that varied somewhat based on the diversity of vegetation and topography, width of meadow dominated sites, and accessibility. The transects were placed perpendicular to the channel, with a roll tape that was stretched across the creek where possible and secured with metal pegs at each end to hold it in place. The toe-point method was used to collect vegetation composition data (Anon. 1996). A pointed wooden dowel was used at one foot intervals along the transect to identify plant "hits" providing frequency data. Hits were recorded to the species level when possible, but grouped by the following categories: sedge, rush, graminoids, forbs, willow, barren, litter or water. Sedges and rushes are typical wet meadow plants. They have especially high value for streambank stabilization. Graminoids include all annual and perennial grasses. Forbs include all broad-leaved herbaceous plants, some of which are associated with wet or dry sites. Typical forbs include clovers, Indian paintbrush and lilies. Willows include any willow species. Data were recorded on a field data form along with relevant field notes and each site was photographed and described to facilitate finding the same location at a later date. Species that could not be identified in the field were later identified by a local botanist. Phenology prohibited developing complete lists of all species but the dominant species at each site were identified. Only inconspicuous or sparsely distributed species would have been missed.

Analysis included compiling tabulations of vegetation category frequency and percent frequency data for each site and for regulated and unregulated streams, combined. A species list was compiled for each site as well. Statistical analysis was performed to determine if there were significant differences between frequency of vegetation categories on regulated versus unregulated streams.

Results and Discussion

In all, data were collected on 14 transects at the eight study sites. This included five transects at Caples Creek, two at Kirkwood and Bryan Meadows and one each at the other sites. Appendix A contains lists of the plant species encountered at each site. Appendix B and C contain frequency distributions for vegetation units at regulated and unregulated sites, respectively. Appendix D is a chart of pooled data for regulated versus unregulated streams.

Species composition at regulated versus unregulated sites was not indicative of any specific effects of streamflow regulation. Because these sites have not been heavily grazed for many years, it was more indicative of natural meadow succession. All sites had essentially complete cover. Bare ground, litter and rock ranged from four to 16 percent cover on the transects.

Table I summarizes percentage frequency data for regulated and unregulated streams. Overall, the proportional distribution of vegetation categories on regulated versus unregulated streams was similar except for the sedge and water categories. Three transects on Caples Creek had relatively low proportions of sedge and relatively high proportions of graminoids. There was also more surface water present at Caples Creek than at other sites. This is an artifact of the flow regime which is augmented during normally low flow periods. When water was excluded from the transects i.e., only vegetation or bare ground hits were included, and proportions were recalculated, the difference in sedge cover between regulated and unregulated transects was reduced (average 35 percent on regulated versus average 42 percent on unregulated).

Table 1: Proportions of Vegetation Units by Study Transect (values in percentages)

Site	Sedge	Grass	Shrub	Forb	Willow	Bare	Litter	Water	Rush
South Fork	34	7	1	37.5	0	1.5	11.5	0	7.5
South Fork	44.5	3.5	0	31.5	0	0	3.5	9	8
Caples	12	23	0	31	5.5	8.5	4	12.5	3.5
Caples	28	40.5	0	7.5	3.5	0	3	17.5	0
Caples	16	22.5	0	34	1.5	1.5	2	17.5	5
Caples	18	13	0	29.5	11.5	2.5	2	17.5	6
Caples	30.5	11.5	0	21.5	5	3.5	9.5	12.5	6
Average	26.1	17.3	0.1	27.5	3.9	2.5	5.1	12.4	5.1
Benwood	65	12	0	7	0	12	4	0	0
Bryan	31.5	17	0	25	7.5	7.5	1	2.5	8.5
Bryan	40	18	0	17	8	8	1	3	6
Foster	29	6	0	50	0	8	0	0	7
Kirkwood	36	17	0	32	5	1	9	0	0
Kirkwood	21	19	0	50	6	1	3	0	0
Round	48	14	0	24	5	3	1	2	0
Average	39	15	0	29	4.5	5.8	2.7	1.1	3.1

A chi-square analysis was performed to determine if samples from regulated versus unregulated streams differed in frequency distributions of vegetation categories, excluding water. Regulated streams had higher frequencies of barren, forb, and graminoid hits than unregulated streams, and lower frequencies of sedge and willow hits. Overall, the differences were highly significant ($p<0.001$). Riparian herb communities characterized by high proportions of sedges and rushes occurred on all sites to at least some degree. The somewhat higher proportions of grarninoids on some Caples Creek transects may be indicative of a locally lowered groundwater table. Additional data on hydrology and channel morphology would be required to confirm this condition. Theoretically, reduced groundwater at Caples Creek could result from reduced frequency and magnitude of overbank flooding or it could be due to incision caused by the 1997 flood.

Conclusions

Because of the limited scope of this study it is not appropriate to draw any general conclusions. The conditions on the South Fork American River, where peak flows are not reduced and only low summertime flows are affected by Project No. 184, are suggestive of relatively rich riparian herb communities, comparable to those found on unregulated streams. Conditions at Caples Creek, where many factors have affected the stream, including recreational and livestock traffic, beaver dams and Project No. 184, suggest that monitoring meadow composition, in conjunction with additional hydrologic and geomorphic monitoring, might be useful for providing guidance on future management.

Literature Cited

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Kattelmann, R. 1996. Riparian areas and wetlands. Sierra Nevada Ecosystem Project: Final Report to Congress, vol. 111, Assessments, Commissioned Reports, and Background information. Davis: University of California, Centers for Water and Wildland Resources Report No. 38.

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Appendix A: Species Lists for Study Sites (note that grasses are in Italics)

Project Affected Sites

Caples Creek: sampled July 17, 2000.

Achillea millefolium
Aconitum columbianum
Agrostis sp.
Aster occidentalis
Bromus inerinus
Calamagrostis canadensis
Carex utriculata (Old name C. rostrata)
Carex sp.
Castilleja sp.
Deschampsia cespitosa
Elvmus glaucus
Epilobium sp.
Heracleum lanatum
Hordeum brachvantherum
Ligusticum grayi
Pascopyrum smithii
Pen'den'dia sp.
Phleum pratense
Potentilla glandulos
Potentilla gracilis
Rumex sp.
Senecio triangularis
Sisyrichium bellum
Lupinus polyphyllus
Mimulus sp.
Polygonum bistortoldes
Potentilla gracilis
Salix lemmomi
.Salix lucida ssp. lasiandra

South Fork American River: sampled July 18, 2000.

Site #1
Sierra at Tahoe, Phillips Station meadow

Agrostis sp.
Aster apiginus var. andersonii

Carex nebrascensis
Carex sp.
Hordeum brachyantherum
Juncus balticus Juncus xipbioides Periden'dia sp.

Site #2
Above Sierra at Tahoe and Audrain Way

Aster alpinginus var. andersomi
Carex nebrasensis
Carex sp.
Lilium parvum
Muhlenbergia filiformis
Penstemon rydbergii
Phleum alpinum
Salix eastwoodiae
Trifolium longipes

Control Sites

Round Meadow: sampled July 25, 2000.

Agrostis idahoensis
Allium validum
Carex echinata ssp. echmata
Carex luzulma
Carex utriculata
Deschampsia caespitos
Muhlenbergi filifon-nis
Pamassia sp.
Periden'dia parisbii
Platanthera leucostacbys
Salix castwoodiae
Scirpus sp.
Senecio hydrophiloides

Foster Meadow: sampled July 25-26, 2000.

Achnatherum nelsonii ssp. dore
Agrostis capillaris
Agrostis stolonifera
Aster alpiginus var. andersonil
Aster integrifolius
Carex lemmomi
Carex sp.
Castilleja miniata ssp. miniata
Danthonia californica
Delphinium glaucum
Homalotheclum aeneum (moss)
Juncus xiphioides

Ligusticum grayi
Luzula comosa
Mimulus pnimuloides
Muhlenbergia richardsonis
Peridefidia so.
Poa pratensis
Polygonum bistortoldes
Senecio triangularis
Scirpus congdonii

Kirkwood Creek: sampled July 25, 2000.

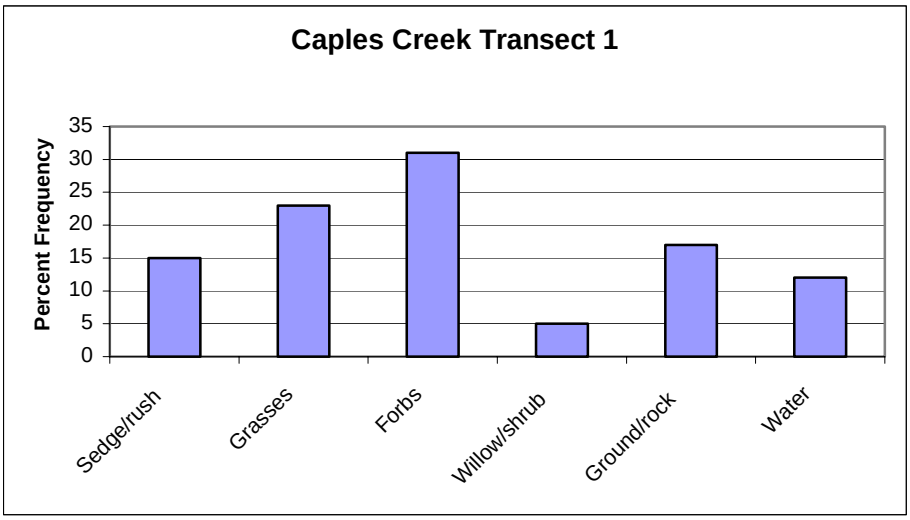
Achillea millefolium
Artemisia douglasian
Carex lemmomi
Carex nebrascensis
Castilleja miniata ssp. miniata
Deschampsia cespitosa
Hordeum brachyantherum
Poa pratensis
Trifolium longipes

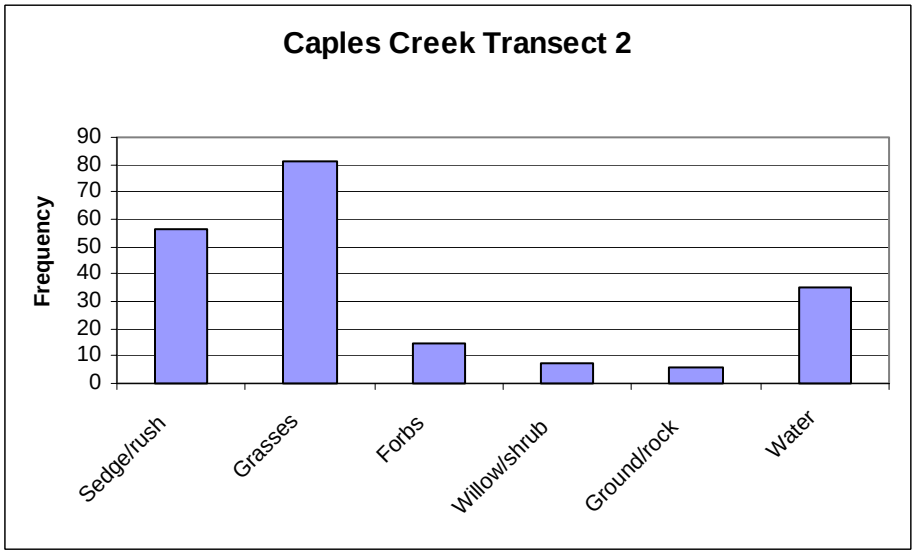
Bryan's Meadow: sampled July 26, 2000.

Agrostis sp.
Aster alpinginus var. andersonii
Carex angustata
Carex echinata ssp. echinata
Carex illota
Carex sp. (2)
Deschampsia cespitosa
Dodecatheon alpinum
Epilobium sp.
Muhlenbergia filiformis
Pamassia sp.
Polygonum bistortoides
Ranunculus sp.
Salix eastwoodiae
Salix orestera
Sambucus raccmosa var. microbotrys
Senecio triangulari
Trifolium longipes
Benwood Meadow: sampled July 27, 2000.

Atlium validum
Aster alpiginus var. andersonii
Carex nebrascensis
Deschampsia cespitosa
Deschampsia elongata

Penstemon rydbergii
Peridcn*dia sp.
Polygonum bistortoides
Sphenosciadium capitellatum


Caples Creek Transect 1
Percent Frequency
35
30
25
20
15
10
5
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Caples Creek Transect 2
Frequency
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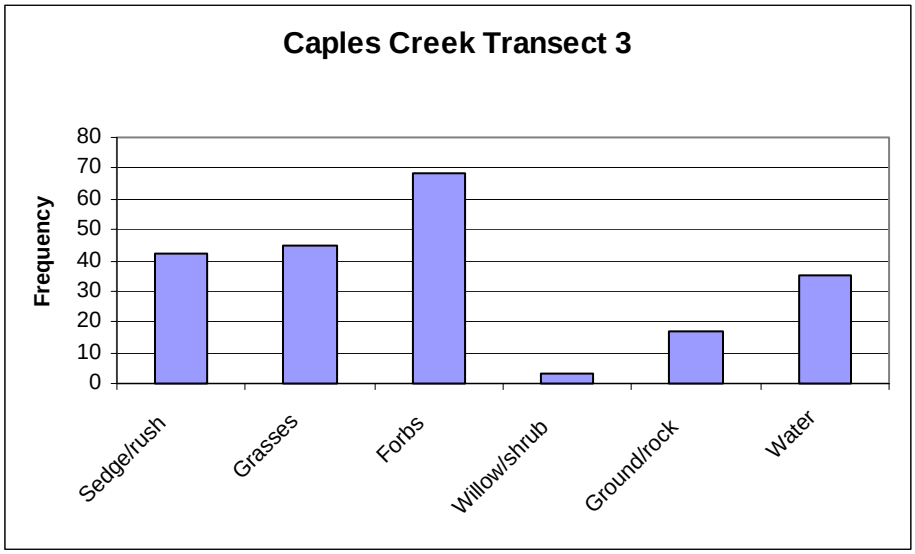
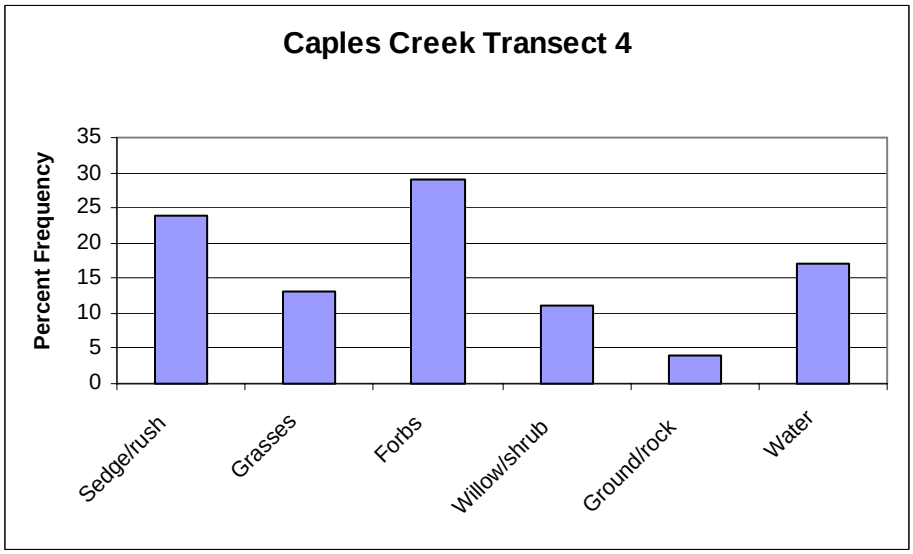
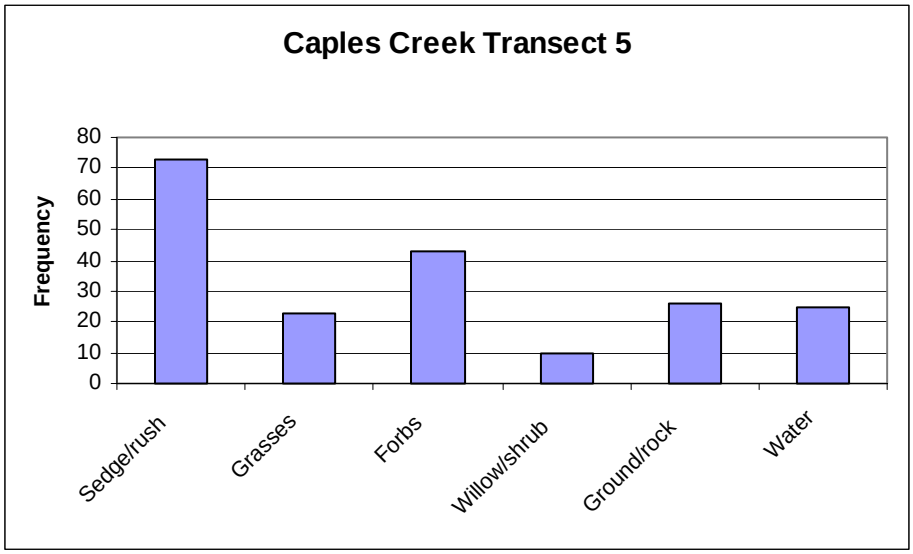
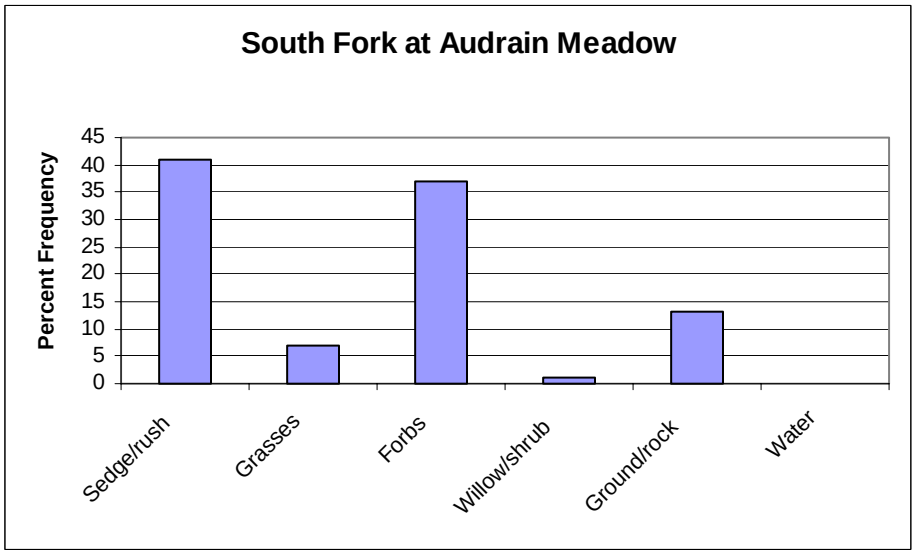
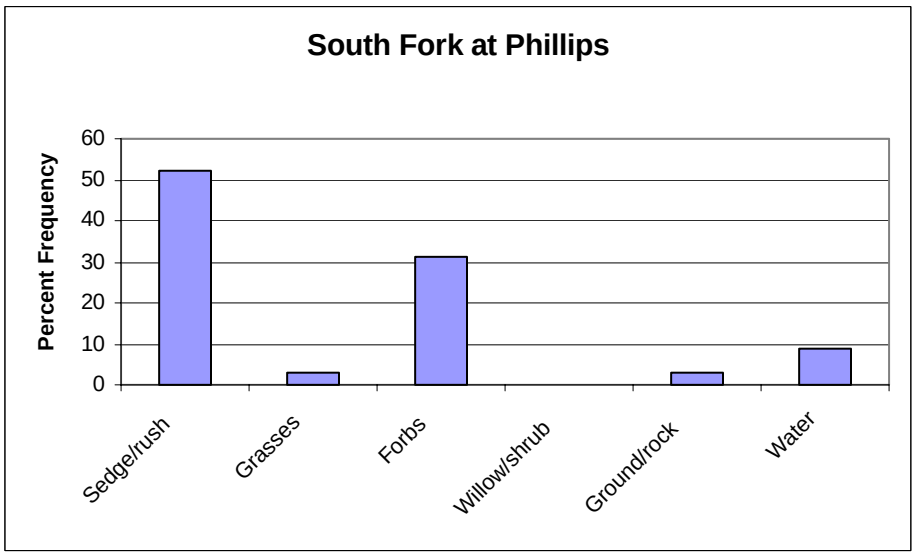
80
70
60
50
40
30
20
10
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Caples Creek Transect 3
Frequency
80
70
60
50
40
30
20
10
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Caples Creek Transect 4
Percent Frequency
35
30
25
20
15
10
5
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Caples Creek Transect 5
Frequency
80
70
60
50
40
30
20
10
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


South Fork at Audrain Meadow
Percent Frequency
45
40
35
30
25
20
15
10
5
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


South Fork at Phillips
Percent Frequency
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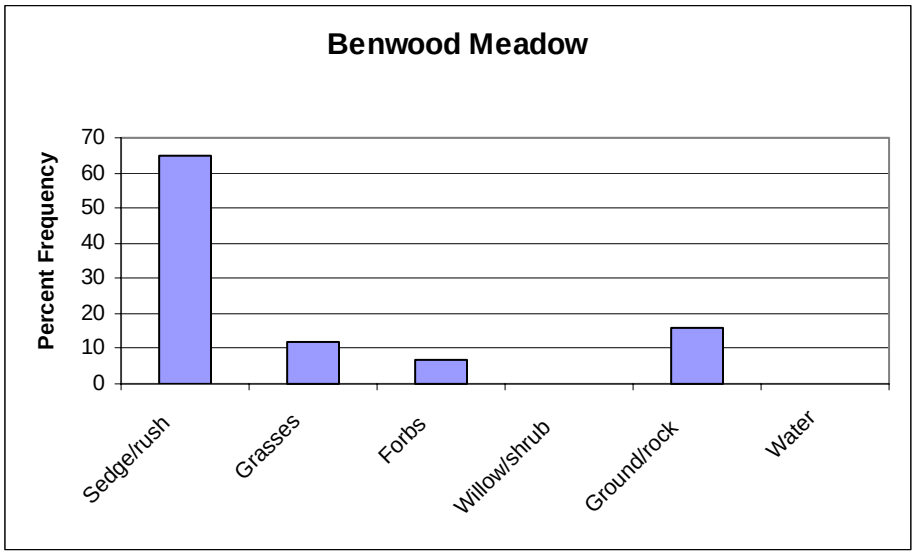
50
40
30
20
10
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Benwood Meadow
Percent Frequency
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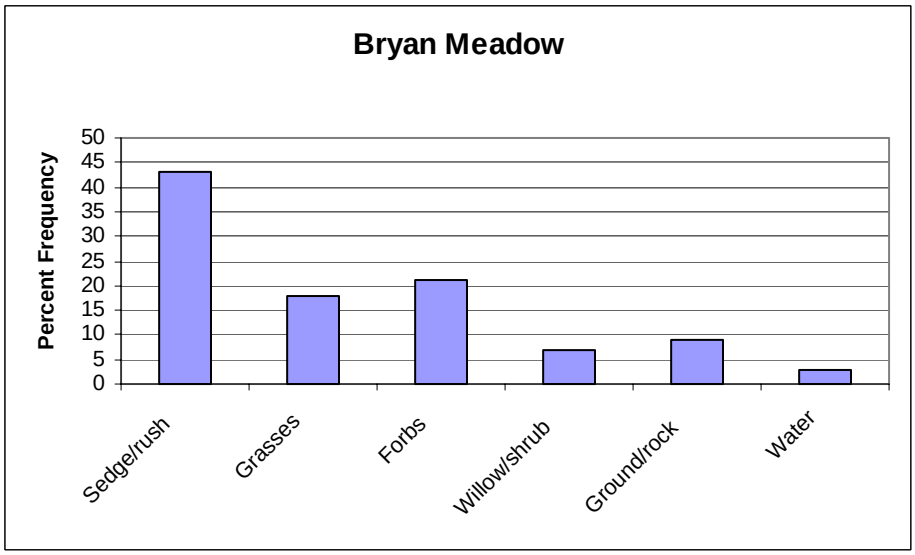
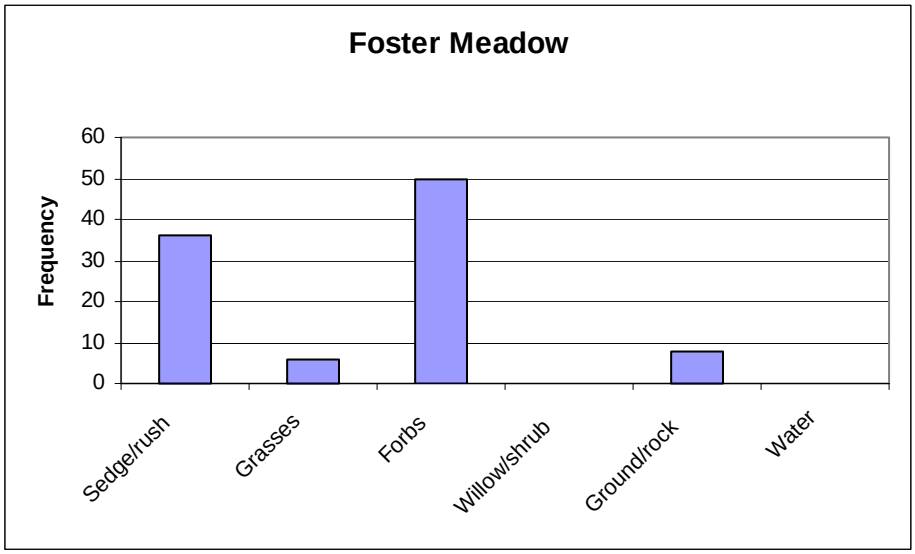
60
50
40
30
20
10
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Bryan Meadow
Percent Frequency
50
45
40
35
30
25
20
15
10
5
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Foster Meadow
Frequency
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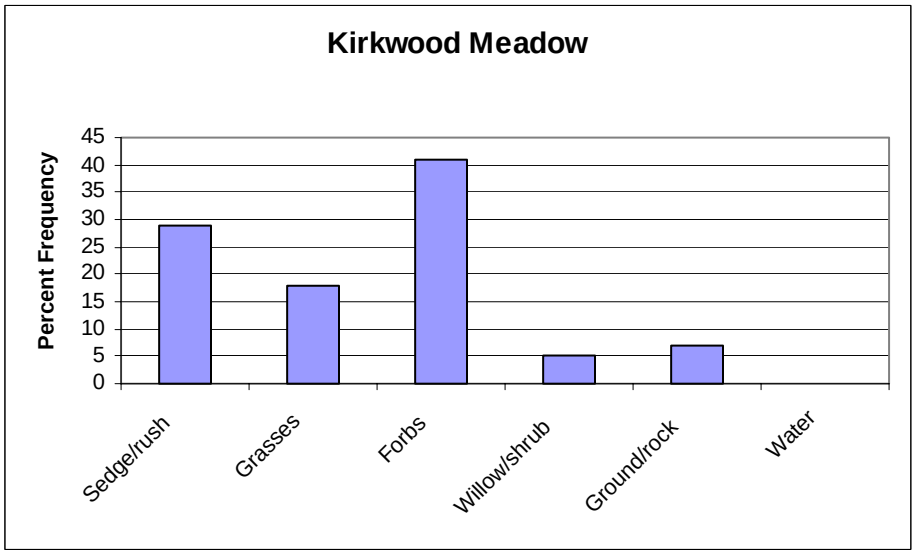
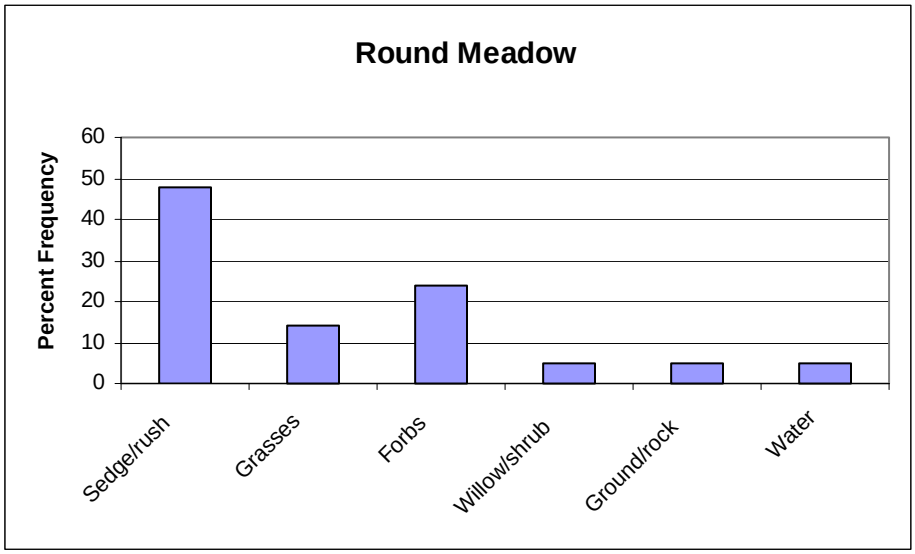
50
40
30
20
10
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Kirkwood Meadow
Percent Frequency
45
40
35
30
25
20
15
10
5
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Round Meadow
Percent Frequency
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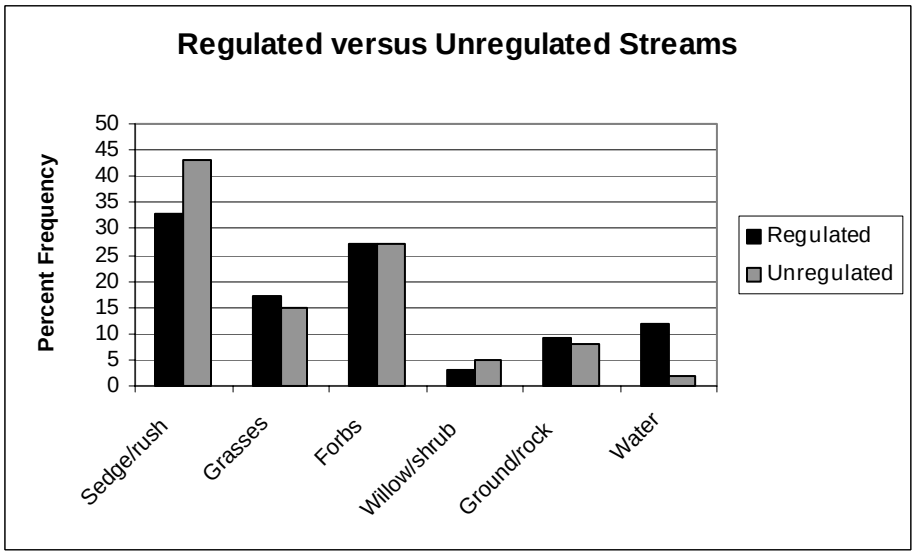
50
40
30
20
10
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water


Regulated versus Unregulated Streams
Percent Frequency
50
45
40
35
30
25
20
15
10
5
0
Sedge/rush
Grasses
Forbs
Willow/shrub
Ground/rock
Water
Regulated
Unregulated