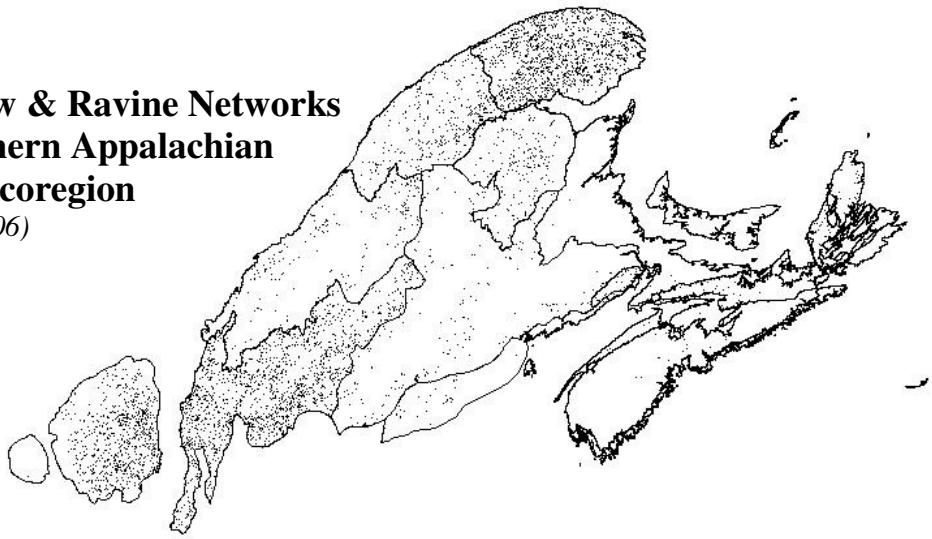
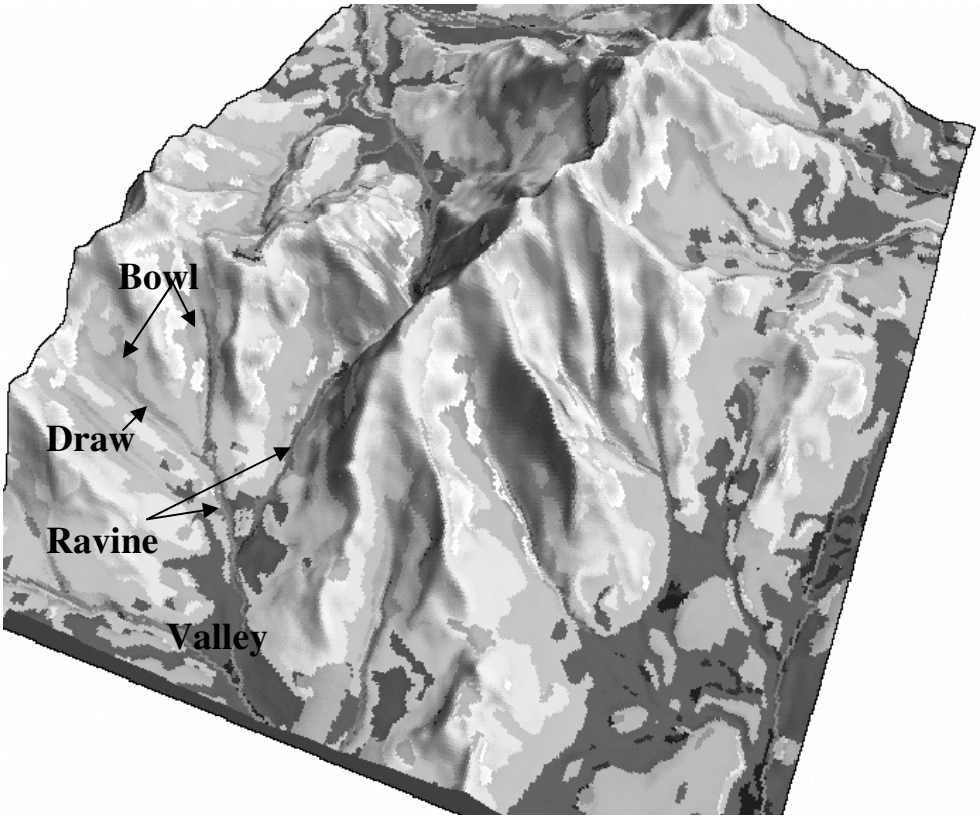
Bowl, Hollow & Ravine Networks in the Northern Appalachian / Acadian Ecoregion

(final draft 1/2006)



Bowls are shallow hillslope concavities linked by moist drainageways ("draws") that deepen into ravines. This setting provides some of the most fertile settings in the Northern Appalachian / Acadian region. These concave areas on moderate slopes (technically "head slopes" or locally "coves"or "hollows") are places were rain water converges and slopewash sediments collect. Like streams, they form multifaceted networks connected by toe-slopes. With over 200,000 in the ecoregion, it can be hard to determine where one occurrence ends and another begins.. Most are small, averaging 18 acres in size, with 88% of them being less than 25 acres. In landscapes conducive to their development, extensive intertwined networks occur. These "large examples" reflect the extent and complexity of the system more than an increase in the size of the individual components (Figure 1). Although widespread in the region, they are concentrated on harder bedrock at moderate elevation (Figure 2).

Figure 1. Enriched settings tend to form networks with small cirque-like bowls at their head (a bowl, cove or hollow) that narrow into a shallow drainageway or "draw" and often into a deeply cut ravine. The pattern forms a spoon-like feature.

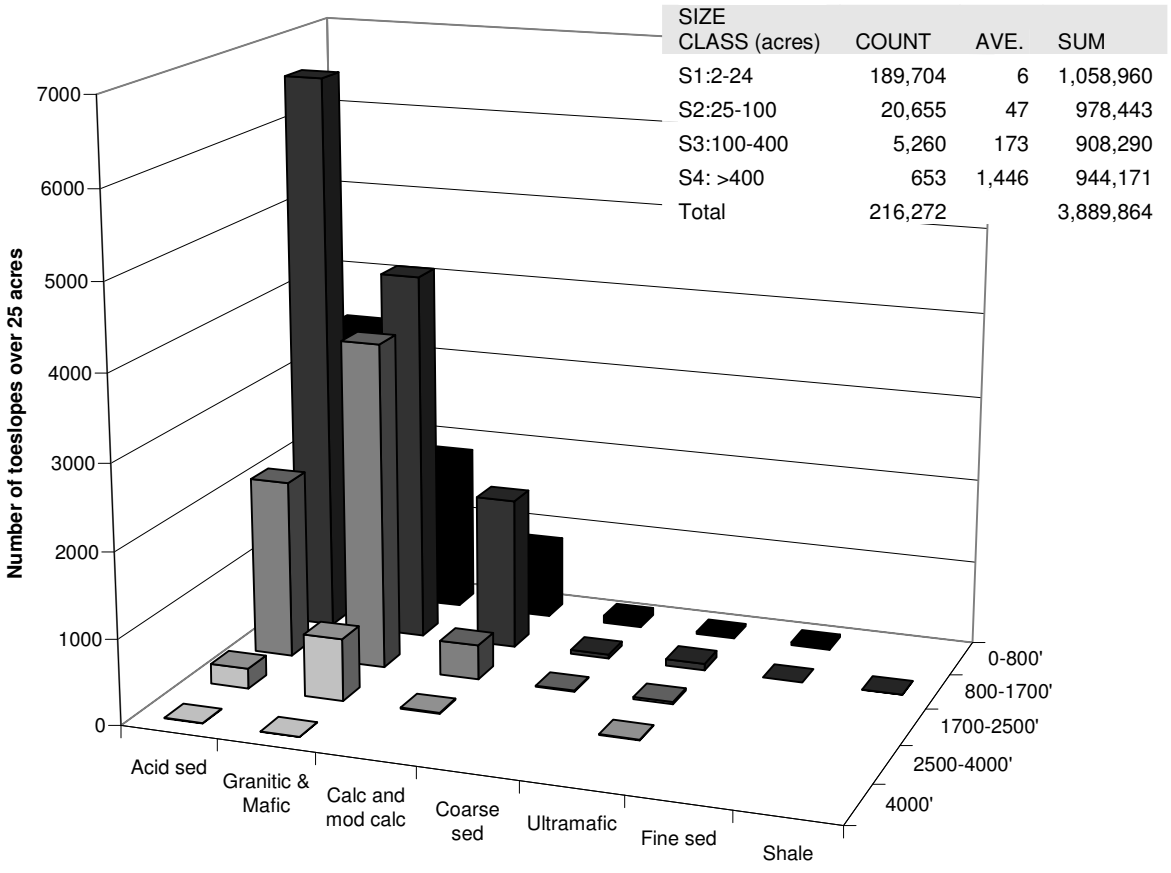


The distribution of bowl/ravine features varies among the subregions. Mountainous areas contain the most occurrences and the most extensive networks. In flatter regions these features are more discrete, fewer in number and tend to co-occur with steep slopes and summits (Table 1). Because they form just upslope of valleys, these features are most common on mid-elevation bedrock settings (Figure 2).

Table 1. The distribution of bowl and ravine features by subregions

ELC_NAME	# of Occurrences	Total Acres	Average size	Maximum size
Green & White Mountains	60,607	1,250,521	21	1,757
Gaspe Peninsula	10,521	970,067	92	53,016
Adirondacks & Tug Hill	31,283	580,246	19	1,823
Temiscouata Hills - St. John Uplands - North	17,772	303,328	17	30,151
Acadian 'Uplands'	35,057	247,155	7	264
Acadian Highlands	25,517	230,257	9	366
Estrie-Beauce Hills/St. John Uplands	16,239	178,227	11	1,185
Gulf of Maine, Bay of Fundy, Minas Basin	7,000	57,778	8	647
Nova Scotia Hills & Drumlins	5,422	25,809	5	152
Northumberland - Bras D'Or 'lowlands'	4,011	21,238	5	168
Atlantic Coast	1,176	5,420	5	220
Total	216,272	3,889,864	18	

Figure 2. Bowl and ravine networks larger than 25 acres across elevation and bedrock gradients in the Northern Appalachian / Acadian ecoregion.

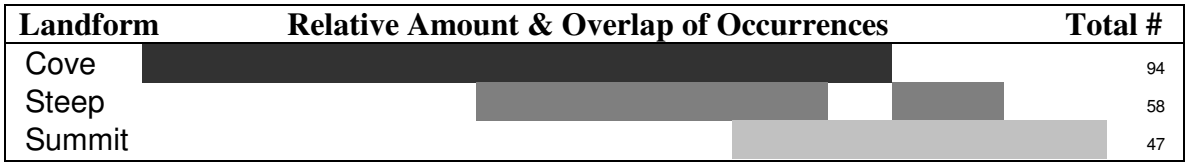


Bowl and Ravine Biodiversity

Bowls and hollows are local repositories of nutrients and moisture (Figure 1). Rich damp soils develop in the shallow concavities and support a variety of nutrient-loving plants such as ginseng or Goldie's fern, and trees like basswood, white ash and sugar maple. The lush patches of forest that develop in these settings are known variously as "rich northern hardwood forests", "rich mesic forest", "maple-ash-basswood forest" or "cove hardwoods" and they are often sought out by botanists for their unique flora. Most commonly they occur on sedimentary till, but they can occur on any bedrock. Soils derived from calcium rich bedrock further accentuate the fertility of rich hardwood forests and remarkable understories of maidenhair fern, trilliums and pale jewelweed may result.

In this ecoregion, 78 percent of the inventoried rich hardwood forests occurred in this setting, although the local extent of those occurrences often overlapped with steep slopes and summits (Figure 3).

Figure 3. Occurrences of rich hardwood forests summarized by landform. Based on 121 occurrences provided by US NHP and CANADA CDC



Rich hardwood forests are not the only community associated with this setting. Talus slope woodlands, moist seepage forests and hemlock ravines are all characteristically found on bowl/ravine settings, particularly in steeper and more deeply cut portions (Table 3). Rare or uncommon plants are abundant (Table 4).

Table 3. Communities and species strongly associated with bowls features in NAP. Based on 1564 occurrences. Columns show the occurrence distribution across size classes.

Name	2—25 acres	26-100 acres	100-400 acres	400-1800 acres	Total EOs	Habitat preference
Rich Northern Hardwoods	17	36	36	5	94	
Talus slope woodland	8	11	28	8	55	
Forest: seepage	4	5	1	1	11	
Forest: hemlock	7	3	6	1	17	moist soil on hillsides
Panax quinquefolius	7	13	11	3	34	rich woods
Dryopteris fragrans	7	4	10	2	23	cliff crevices/limestone
Epilobium hornemannii	5	4	9	3	21	Stream banks & wet places
Geum peckii	5	4	6	5	20	damp slopes
Galium kamtschaticum		9	7	1	17	mossy woods
Forest: hemlock	7	3	6	1	17	moist soil on hillsides
Dryopteris goldiana	6	5	4	1	16	moist woods in rich soil

Table 4: Bedrock relationships for typical bowl/ravine species. These species were subsequently used to confirm portfolio examples. Data based on 1564 USHP and Canadian CDC occurrences.

STANDARD NAME	HABITAT	Sedimentary	Calcareous	Moderately Calcareous	Granitic	Mafic	Ultramafic	Coarse sediment	Total
Amerorchis rotundifolia	wet woods	100%							5
Carex bromoides	wet woods, swamps	100%							6
Carex tenera	moist or wet soil	100%							3
Dryopteris filix-mas	wooded hillsides, oft calc	100%							10
Viola selkirkii	shady ravines	100%							3
Adiantum pedatum	rich woods	67%	33%						3
Impatiens pallida	rich woods	67%	33%						3
Dryopteris clintoniana	wet woods	60%	20%				20%		5
Carex eburnea	calc soil	43%	29%	29%					7
Cystopteris tenuis	rocky forests/shaded cliffs	56%	11%		33%				9
Milium effusum	rich woods	83%			17%				6
Botrychium lanceolatum	mountain slopes	60%			40%				5
Epilobium hornemannii	stream banks	25%			75%				4
Geum peckii	damp slopes	46%			54%				13
Trillium erectum	moist woods					67%			3
Panax quinquefolius	rich woods	45%				55%			11
Tiarella cordifolia	rich woods	67%				33%			3
Allium tricoccum	rich woods	72%				21%	7%		29
Carex garberi	moist calc soil	60%	20%	10%				10%	10
Cystopteris fragilis	wooded slopes, neut. soil	72%	11%	11%	6%				18
Anemone multifida	rocky banks, calc	25%	25%		25%	25%			4
Listera auriculata	wet woods	50%	10%		20%	20%			10
Dryopteris fragrans	cliffs. shady hillsides, calc	36%			57%			7%	14
Arabis drummondii	various	21%		14%	29%	29%			14
Polystichum braunii	upland woods, calc soils	60%		13%	13%	13%			15
Polystichum lonchitis	shaded hillsides, calc.	80%		4%	8%	4%			25
Woodsia glabella	calc rocks	50%		8%	38%	4%			24
Arabis hirsute	woods & hillsides, calc.	50%	6%	13%	19%	6%			16
Listera convallarioides	wet shady woods	42%	8%	17%	25%			8%	12
Woodsia alpina	rock crevices cool sites	50%	10%	20%	15%	5%			20
Asplenium trichomanes	shaded calc. rocks	44%	4%	19%	11%	15%		4%	27
Arnica lanceolata	moist shady places, banks	75%		2%	2%	14%	5%	2%	44

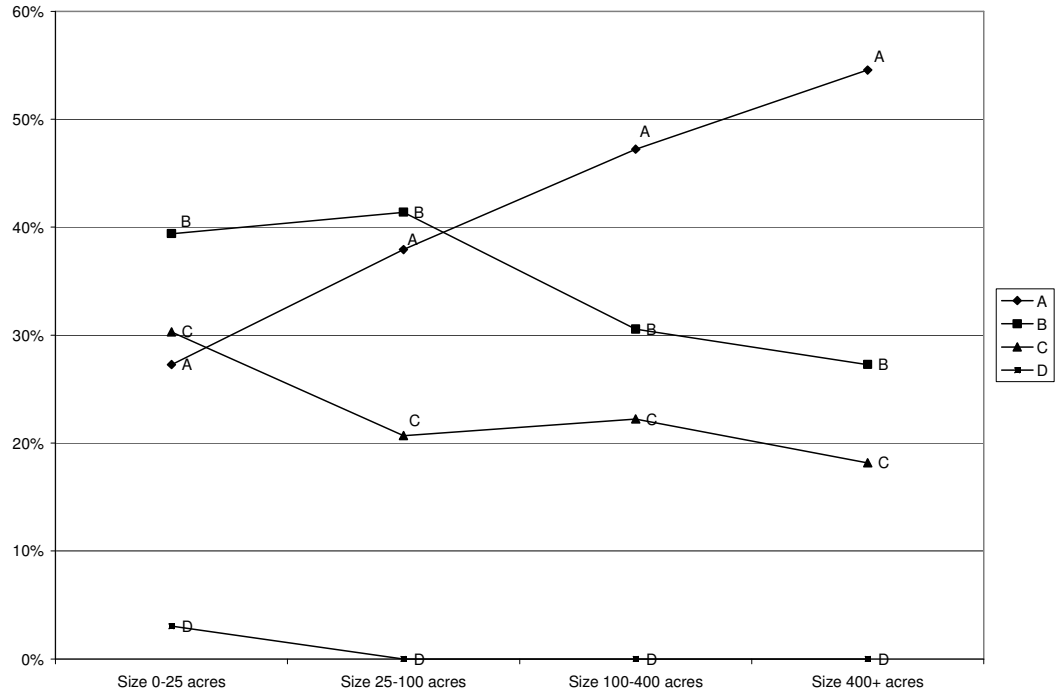
Bowl, Hollow and Ravine Portfolio Summary

The portfolio identifies the set of critical sites most important to the conservation of enriched bowl/ravine ecosystems. The screening criteria used to identify crucial portfolio occurrences required that each example:

- Was large and contiguous: over 25 acres
- Was in good landscape settings (Land Cover Index < 20)
- Was in good condition based on ground surveys and expert opinion (corroboration by at least one source)
- Contained other confirmed biodiversity features (element occurrences) appropriate to the system type.

Size criteria were determined by an analysis of over a thousand survey records for species and communities occurring on bowl/ravine settings. As with other network forming features, the size of an occurrence did not appear to directly effect its function as a coarse filter for associated species. Although larger occurrences typically had more species represented, we did not find any species restricted only to small examples. A direct relationship was apparent in the ground inventoried information between the **condition** of the inventoried example and the size of the occurrence to which it corresponded (Figure 4). The 25 acre size criterion, slightly above the feature's mean size in the region, increases the likelihood of selecting high condition examples with complete biodiversity.

Figure 4. Relationship between the condition rank (A,B, C or D) of rich hardwoods, talus slopes, outcrops and other Bowl/draw related communities and the size of the modeled bowl/ravine occurrence. As the size of the feature increases the percentage of A (best) ranked examples increases.



Candidate and Supporting occurrences:

In addition to the critical occurrences, this analysis encompassed a large number of less notable or poorly surveyed bowls/ravines that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence:* A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. These may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.
- *Supporting occurrence:* A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *defacto* conservation picture for the region. Because conserved examples of these occurrences may serve to bolster biodiversity protection we included them for context in some of our analyses. However, c*andidate and supporting occurrences were not counted as contributing to the portfolio goals.*

Results

Insuring that the portfolio would make a lasting impact on the conservation of biodiversity requires having adequate replication and redundancy of bowl/ravine features across all important environmental gradients. Thus, we set an initial minimum number of critical occurrences to protect as **20 examples per 24 bedrock/elevation combinations**. This goal of at least 480 individual occurrences totals to less than 1 percent of all the bowl/ravine features in the ecoregion or an estimated 1% of all bowls/ravines by area (using the mean size of features over 25 acres -e.g. 107 acres). After examining the distribution of the occurrences across gradients, we redistributed the minimum goal of 480 across the bedrock/elevation classes in proportion with the number of possible occurrences, adding a minimum of two for rarer environments. This totaled to a goal of 499 (Table 5).

Our results identified 1269 critical occurrences, 770 more than the number needed to meet our minimum goals. We met or surpassed the specific minimum goals for each bedrock/elevation setting except in a few uncommon settings. Measured by area, the critical sites account for 13% percent of all bowl/ravine features, more than the expected estimate of 1% because the critical sites were consistently larger than the average size.

Occurrences, Sites and Goals

In our analysis a "site" could consist of either an exemplary individual bowl/ravine feature or a natural complex comprised of many bowls/ravines and other features in close proximity. In some of the latter cases, not all the individual examples met our selection criteria, but as an aggregate the area did. The surplus of occurrences, a rarity in the overall portfolio, reflects the tangled and intertwined nature of these networks in regions of high bowl/ravine densities. From a practical stand point they will need to be conserved as a complex in order to conserve the processes that form and maintain these fertile drainageways. Thus, although we are able to count them as individual features they are not independent at a landscape scale.

Table 5. Goals and Distribution for critical occurrences of bowls and draws. This table gives detail on the goals set for critical sites and the adequacy of the portfolio in meeting those goals.

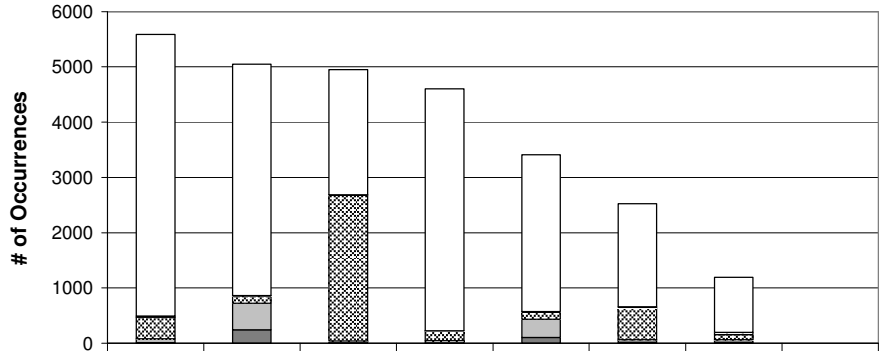
ELEV.	GEOLOGY	Goal	CU	CP	DC	OU	T	%	PA	N
	Acidic sedimentary	62	248	73	123	2966	3410	13%	Y	0
0-800'	Calc/mod calc	15	68	17	25	738	848	3%	Y	0
	Coarse sed	2	7	1	2	78	88	0%	Y	1
	Fine sed	2				35	35	0%	-2	2
	Granitic/mafic	33	77	67	169	1540	1853	7%	Y	0
	Ultramafic	2	6			20	26	0%	Y	2
800-	Acidic sedimentary	120	223	33	199	6162	6617	25%	Y	87
1700'	Acidic shale	2				4	4	0%	-2	2
	Calc/mod calc	32	30	7	28	1725	1790	7%	Y	25
	Coarse sed	2			7	42	49	0%	-2	2
	Fine sed	2			1	1	2	0%	-2	2
	Granitic/mafic	79	69	34	951	3316	4370	16%	Y	45
	Ultramafic	2	18		1	59	78	0%	Y	2
1700-	Acidic sedimentary	38	64	34	233	1769	2100	8%	Y	4
2500'	Calc/mod calc	7	5	2	12	390	409	2%	Y	5
	Coarse sed	2			9	4	13	0%	-2	2
	Granitic/mafic	70	67	56	1807	1918	3848	14%	Y	14
	Ultramafic	2	1	4		22	27	0%	Y	0
2500-	Acidic sedimentary	4	7	13	74	145	239	1%	Y	0
4000'	Calc/mod calc	2			2	11	13	0%	-2	2
	Granitic/mafic	13	12	35	498	187	732	3%	Y	0
	Ultramafic	2	1	3		5	9	0%	Y	0
	Acidic sedimentary	2			5	1	6	0%	-2	2
>4000'	Granitic/mafic	2			2		2	0%	-2	2
								100		
Grand Total		499	890	379	4148	21138	26568	%	770	200
Total acres			99,583	295,799	398,130	2,043,274	2,837,663			
Average size			361 ac	330 ac	96 ac	96 ac	107 ac			

%Goal = the portfolio goal
CU = Critical occurrences that occur on lands managed for extraction or are unprotected.
CP = Critical occurrences that occur on lands explicitly protected for biodiversity.
PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.
PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.
OU = Other occurrences that occur on lands managed for extraction or are unprotected.
T = total # of occurrences larger than 25 acres,
% = percent of the total occurrences in this bedrock/elevation combination,
S = portfolio sufficiency in finding occurrences. Y = adequate or surplus
N = protection needs for portfolio occurrences

Current Protection Status of Bowl/Ravine Features.

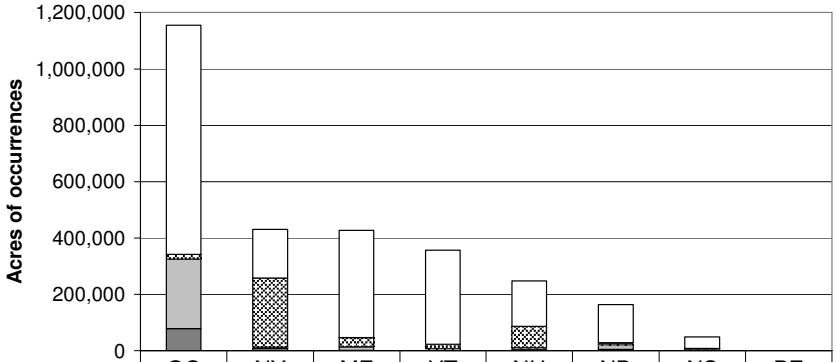
Of the almost 4 million acres of bowl/draw features we identified 13% as critical for protection, accounting for less than 1% of the whole ecoregion. Currently, 76 % of the critical occurrences lie within lands of Gap 1 or 2 protection status although that percentage reduces to 40% when examined across gradients (e.g. some types are overrepresented others underrepresented on present protected lands). Highest protection needs are for features in the 800-1700 ft. elevation zone (Table 5)..

Figure 5. The Number of bowl/ravine features and their portfolio status across all size classes. Legend as for table 5 except DC = PC and DS = PS.



	ME	QC	NY	VT	NB	NH	NS	PE
OU	5094	4181	2261	4376	2839	1864	998	1
DS	22	5	5	4	9	12	37	
DC	385	133	2641	178	130	583	96	
CU	71	480	13	42	328	46	44	
CP	14	246	29	5	107	18	20	

Figure 6. The acres of bowl/ravine features and their portfolio status across all size classes. Legend as for table 5 except DC = PC and DS = PS.



	QC	NY	ME	VT	NH	NB	NS	PE
OU	813,381	172,249	380,722	334,364	160,861	136,138	41,009	30
DS	38	54	148	34	94	116	394	
DC	16,577	245,134	32,301	16,186	75,910	7,209	4,684	
CU	246,320	4,187	13,192	6,677	7,137	15,669	2,560	
CP	79,018	8,772	1,425	92	3,691	5,210	806	