Riparian Ecosystems in the Northern Appalachian /Acadian Ecoregion
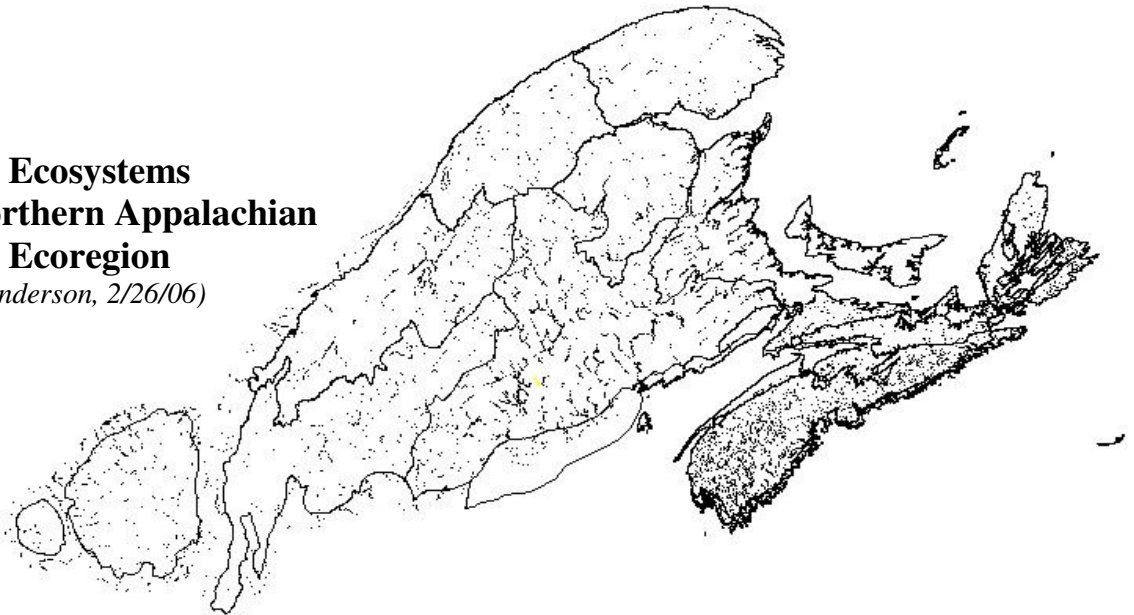
⟨*final draf Anderson, 2/26/06*)

Riversides and floodplains are some of the most dynamic areas of the landscape. During spring runoff, submerged floodplains provide critical feeding and spawning areas for fish and other aquatic species. In drier seasons, the water recedes to reveal a myriad of geomorphic features, each with its own characteristic flora and fauna. Fresh silt deposits, scoured riverbanks, sand bars, alluvial meadows, depression marshes, oxbow lakes, braided stream channels and lush floodplain forests interact to form a complex system rich in biodiversity.

In the Northern Appalachians, intact riparian corridors and floodplains are linear features, averaging about 200 acres with size varying between subregion (Figure 1). About 22, 000 intact, or semi intact, examples occur in the ecoregion, accounting for 3% (2.7 million acres) of the area. Most are found at low to mid elevations on sedimentary till, coarse sands or fine silt deposits (Figure 2)

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Figure 1. Intact riverside and floodplain
systems: mean size by ecological subregion
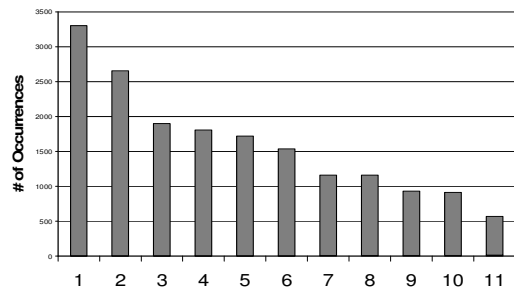
	ECOLOGICAL SECTION _NAME	Count	Acres	Ave. Size
1	Acadian 'Uplands'	3,305	1,183,111	358
2	Green & White Mountains	2,655	211,640	80
3	Nova Scotia Hills & Drumlins	1,894	958,461	506
4	Gulf of Maine, Bay of Fundy, Minas Basin	1,802	144,844	80
5	Acadian Highlands	1,717	185,802	108
6	Northumberland - Bras D'Or 'lowlands'	1,529	458,694	300
7	Temiscouata Hills - St. John Uplands - North	1,154	124,248	108
8	Adirondacks & Tug Hill	1,152	176,929	154
9	Estrie-Beauce Plateaus & Hills/St. John Uplands	921	290,304	315
10	Gaspe Peninsula	903	93,131	103
11	Atlantic Coast	555	136,046	245
	Grand Total	21,834	4,382,458	201

Figure 2. The distribution of intact riverside and floodplain systems across elevation and bedrock gradients in the Northern Appalachian / Acadian ecoregion.
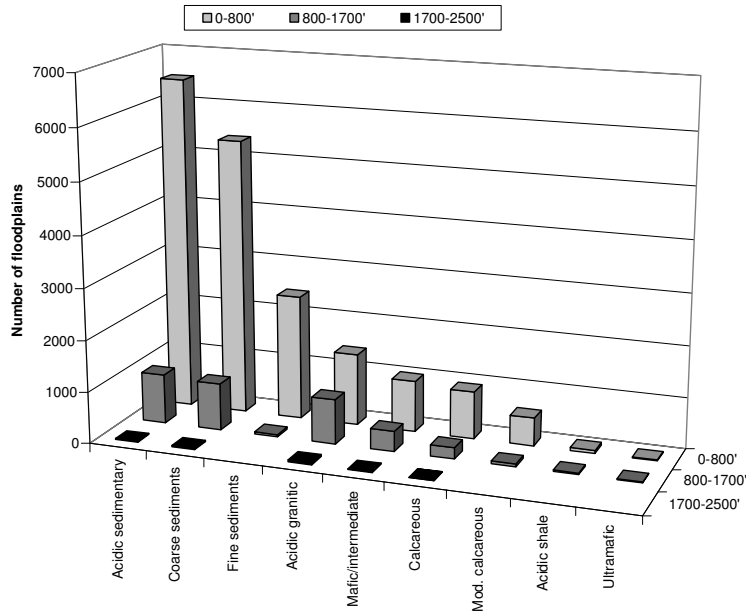
Floodplain and Riparian Biodiversity

Ecologists recognize a variety of community types associated with features created by riparian process. These are briefly described below (adapted from Basquill 2004, Anderson 1999).

Floodplain Forest: Forests dominated by flood tolerant trees such as Silver maple, Green Ash, American Elm and Box elder. These species rely on open exposed soil and silt deposition for regeneration. The constantly reworked soils create ideal conditions for many natives ferns and herbs, such as ostrich fern, sensitive fern, wood nettle, tall meadow rue, jack-in-the-pulpit, riverbank grape and poison ivy, but exotic species such as Japanese knotweed and moneywort also thrive under these conditions. Floodplain forests are strongly associated with coarse sediments and sandy outwash (40%), but may be found on almost any bedrock type: moderately calcareous (14%) acidic sedimentary (13%), Fine sediment (10%) mafic or granitic (9% each), calcareous (4%)

Riverside mud, sand and cobble barrens: Scraped river-shores may develop distinct, sparsely-vegetated communities with a floristic composition corresponding to sediment size. Spike rush, water purslane and false pimpernel are common on muddy shores of slow moving rivers. Sand and gravel bars tend to be colonized by Indian hemp and sandbar willow. Twisted sedge is very characteristic of cobble bars. These communities are associated with coarse sediment and, to a lesser extent, till derived from acidic sedimentary rocks.

Riverside Grasslands: Where shorelines are sheltered, beautiful open grasslands of reed canary grass, bluejoint grass, big bluestem and other tall grasses may develop. These are often associated with calcareous, moderately calcareous or sedimentary bedrock.

Riverside seeps: Particularly notable in calcareous limestones, these tiny communities form in permeable bedrock where cold springs and seepage forms a rare microhabitat. Pumpkin sedge, Kalm's lobelia, and grass of parnassus are diagnostic of this setting.

Alluvial marshes, sedge fens and shrub thickets: In regions of permanent saturation, such as oxbows or depression ponds, persistent scruffy marshes of reedy emergents and flood tolerant shrubs may develop. Depending on the microtopography, these may be dominated by a single species or they may form a structural complex of herbaceous emergents, shrub thickets and wet sedge meadows. Most are associated with coarse sediment settings.

Riverside outcrops & erosional river bluffs: Waterfalls, gorges and bedrock outcrops along major rivers tend to develop communities described under the steep slope section. Herbs and vines that root on the vertical outcrops, particularly those of a calcareous nature include harebell, wild red columbine, fringed loosestrife, Canada anemone, virgins bower and spreading dogbane. Commonly found in areas with resistant granitic bedrock, the types in calcareous settings are a unique rare community.

Relationships between communities, rare species and floodplain occurrences.
The fine scale community types co-occur and intertwine within an individual stretch of floodplain (Table 1). In the modeled occurrences developed for this assessment, there was a meaningful association between community composition and sediment type. Riparian reaches in calcareous soil tend to contain riverside grasslands, seeps and rare sedges. Floodplains in fine sediment had extensive freshwater, fresh tidal and saltwater marshes. Most of the tracked least bittern and sora breeding populations were found in the latter setting (Table 2).

Floodplain forests were most abundant (40% of all occurrences) in coarse sediment where they formed mosaics of seepage swamps, buttonbush swamps, alluvial thickets, cattail marshes, acidic fens and barrens of sand, gravel or mud. These examples harbored fowler's toad and several best known heron rookeries. Riparian areas in acidic sedimentary till also contained floodplain forests as well as riverside seeps, river beach and shoreline outcrop communities and species such as the declining wood turtle or rare furbish lousewort. Riversides in granitic settings had stagnant basin marshes and bogs as well as high energy riverbank communities like ice meadows and river-scour grasslands.

To ensure that the full diversity of riparian communities and species were represented in our portfolio, we set our conservation goals to represent examples of each bedrock-elevation combination.

Table 1. Communities with multiple occurrences within the floodplains and riparian models. The column titled "# Occ" is the amount of US Natural heritage program occurrences within the riparian setting.. Floodplain forest, riverside and shoreline communities and reptiles all had over 50% of their occurrences for the ecoregion in floodplain settings.

Group	Common or State name	#Occ.
Floodplain forest	Hardwood floodplain forest	21
	Silver maple floodplain forest	18
	Hardwood river terrace forest	10
	Silver maple-ostrich fern riverine floodplain forest	10
	Sugar maple-ostrich fern riverine floodplain forest	10
	NNE or SNE floodplain forest	11
	NNE Lake sediment terrace forest	4
	Silver maple-sensitive fern riverine floodplain forest	3
Riverside	Circumneutral riverside seep	20
	Calcareous riverside seep	8
	Acidic riverside seep	8
	Laurentian River Beach	8
	NNE high-energy riverbank community	7
	Rivershore outcrop	19
	Circumneutral shoreline outcrop	8
Swamp	Northern white cedar swamp	24
	Black spruce or spruce fir swamp	8
	Sweet gale shoreline swamp	5
	Red maple-northern white cedar swamp	4
	Red maple - sensitive fern swamp	3
	Shrub swamp	3
Meadow	Bluejoint meadow, graminoid swale, sedge meadow	18
Marsh	Deep emergent marsh or seepage marsh	6
Fen: circumneutral	Intermediate fen	6
Fen: acidic	Unpatterned Fens and small acidic fens	13
	Patterned fen ecosystem	4
Bog	Dwarf Shrub Bog & raised bog systems	18

Table 2. Reptiles, birds, mussels, insects and plants strongly associated with riparian systems and their adjacent waters (measured as the number of tracked occurrence points contained in the modeled occurrences).

| Standard Name	Common name		#Occ.
Clemmys insculpta	Wood turtle	Reptile	76
Pandion haliaetus	Osprey	Bird	23
Gavia immer	Common Loon	Bird	16
Circus cyaneus	Northern Harrier	Bird	9
Haliaeetus leucocephalus	Bald Eagle	Bird	6
Podilymbus podiceps	Pied-billed Grebe	Bird	5
Aythya collaris	Ring-necked Duck	Bird	4
Ardea herodias	Great Blue Heron	Bird	3
Alasmidonta varicosa	Brook floater	Mussel	75
Lampsilis cariosa	Yellow lampmussel	Mussel	41
Leptodea ochracea	Mussel	Mussel	13
Margaritifera margaritifera	Eastern Pearlshell	Mussel	8
Alasmidonta heterodon	Dwarf Wedge Mussel	Mussel	7
Ophiogomphus anomalus	Extra-striped snaketail	Insect	35
Ophiogomphus howei	Pygmy snaketail	Insect	13
Siphlonisca aerodromia	Tomah mayfly	Insect	13
Calopteryx amata	Superb jewelwing	Insect	5
Cicindela ancocisconensis	Boulder-beach Tiger Beetle	Insect	3
Cicindela marginipennis	Cobblestone Tiger Beetle	Insect	3
Trisetum melicoides	Purple False Oats	Monocots	26
Carex oronensis	Orono Sedge	Monocots	24
Carex garberi	Garber's Sedge	Monocots	22
Muhlenbergia richardsonis	Soft-leaf Muhly	Monocots	17
Carex sterilis	Dioecious Sedge	Monocots	15
Listera auriculata	Auricled Twayblade	Monocots	14
Phleum alpinum	Mountain Timothy	Monocots	12
Allium canadense	Wild Garlic	Monocots	10
Carex atratiformis	Black Sedge	Monocots	10
Primula mistassinica	Bird's-eye Primrose	Dicots	44
Parnassia glauca	Grass-of-parnassus	Dicots	37
Pedicularis furbishiae	Furbish's Lousewort	Dicots	37
Prenanthes racemosa	Glaucous Rattlesnake Root	Dicots	29
Hedysarum alpinum	Alpine Sweet-broom	Dicots	25
Castilleja septentrionalis	Northern Painted Cup	Dicots	24
Astragalus alpinus	Alpine Milk-vetch	Dicots	23
Tanacetum bipinnatum	Huron Tansy	Dicots	20
Viola novae-angliae	New England Violet	Dicots	15
Houstonia longifolia	Long-leaved Bluet	Dicots	14
Hippuris vulgaris	Common Mare's-tail	Dicots	11
Podostemum ceratophyllum	Threadfoot	Dicots	11
Erigeron hyssopifolius	Hyssop-leaved Fleabane	Dicots	10

Floodplain and Riverside Portfolio Summary

The screening criteria used to locate and identify the riparian systems most critical to maintaining biodiversity required that each qualifying example:

- Was large and contiguous: over 100 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, A or B quality ranks in US)
- Contained other confirmed biodiversity features (verification by element occurrences)

Size criteria were determined by an analysis of almost two thousand survey records for species and communities occurring on floodplain and riverside settings. Interestingly, size was not related to the likelihood of finding associated species as with other patch forming communities (e.g. summits, basin wetlands, etc.) probably because of the linear shape of riparian features. However, high quality examples, ranked A or B in the inventory data, of riparian communities were associated with modeled occurrences over 100 acres in size. None of the modeled occurrences under 100 acres had A-ranked communities in them. (Figure 3)

Figure 3. Relationship of floodplain forest quality rank (A,B,C or D) and modeled occurrence size category. "A" quality occurrences increase and "C" quality occurrences decrease with size. A similar trend is apparent for all riverside related communities. (data from US Heritage programs). Size categories: 1 = 0-100 acres, 2 = 100-1000 acres, 3 /4 = >1000 acres
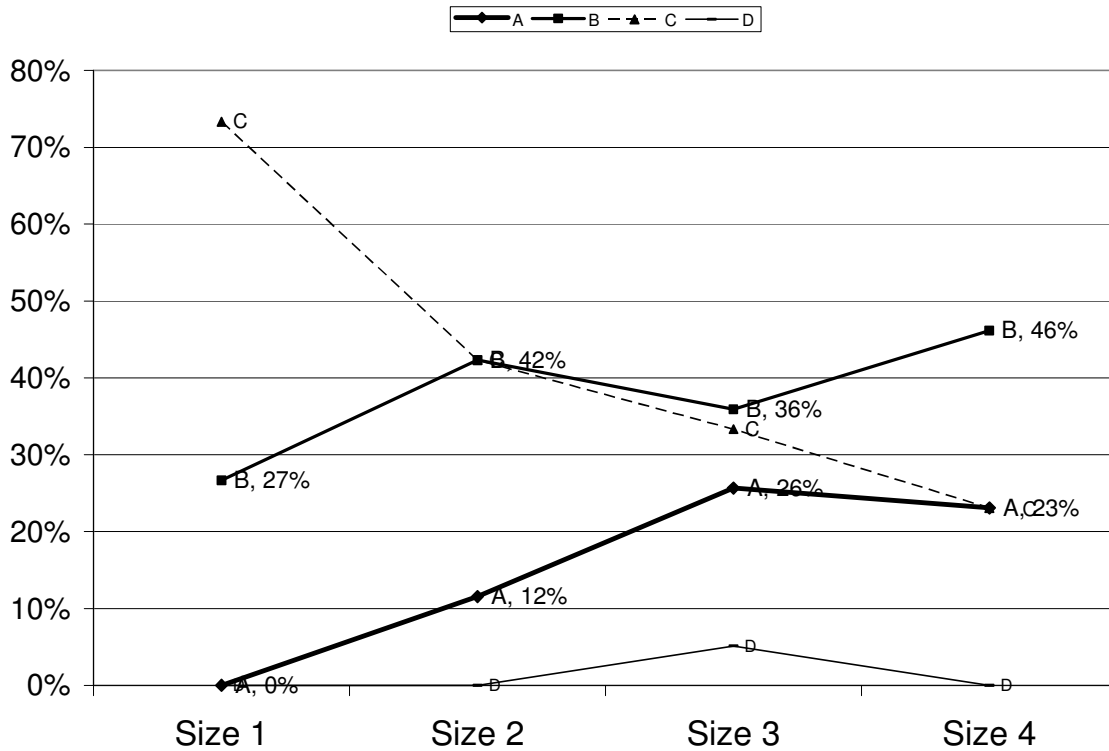
Results

Floodplains are a large patch, linear ecosystem. Our goal was to identify a **minimum of 10 exemplary examples per each of 29 bedrock/elevation combination**. This totals to 290 occurrences distributed across the ecoregion. After examining the distribution of larger (>100 acre) floodplains occurrences we redistributed the 10-per-type numeric goal across the geology/elevation gradients in proportion with the number of possible occurrences acres (Table 3).

In all we identified 240 critical occurrences, 55 less than we needed to meet our total goal. We were slightly below our goals for most bedrock/elevation combinations with the highest deficiencies being in low elevation (20-800') coarse sediment environs where most of the floodplain forests occur (Table 3). Most of the deficient environments had candidate occurrence to evaluate and new critical one may come from that pool.

Candidate and Supporting occurrences

In addition to the critical occurrences, this analysis encompassed a large number of less notable or poorly surveyed riparian ecosystems 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.*

Sites and occurrences

The boundaries for the floodplain modeled occurrences are more approximate when compared to many other ecosystem types. This fuzziness stems from the interconnected network-like nature of floodplain systems that do not typically have clear natural breaks between examples. Although adequate for the analyses done at the ecoregional scale, more precise boundaries will likely need to be delineated by conservationists as part of the protection work on these floodplain and riparian ecosystems.

Table 3: Portfolio Summary based on all intact floodplain occurrences. Legend below.

ELEVZONE	GEOLOGY	Goal	CU	CP	PC	PS	OU	T	%	D
0-20'	Sedimentary	1			1		6	7	0%	-1
	Sedimentary	4				3	47	50	1%	-4
	Calcareous	1					1	1	0%	-1
	Coarse sed.	3	3			1	32	36	1%	0
	Fine sed.	2					32	32	1%	-2
	Mafic	1					7	7	0%	-1
	Mod calcareous	1					2	2	0%	-1
20-800'	Granitic	19	13	1	21	1	228	264	7%	-5
	Sedimentary	102	70	7	79	4	1239	1399	35%	-25
	Shale	0					2	2	0%	0
	Calcareous	10	9	3	1		124	137	3%	2
	Coarse sed.	44	27		3	1	571	602	15%	-17
	Fine sed.	20	17		1		257	275	7%	-3
	Mafic	19	16		28		224	268	7%	-3
	Mod calcareous	8	10		1	1	105	117	3%	2
	Ultramafic	1					6	6	0%	-1
800-1700'	Granitic	13	8	3	41	3	123	178	4%	-2
	Sedimentary	19	14	1	23	2	216	256	6%	-4
	Shale	0					1	1	0%	0
	Calcareous	2	3		3		15	21	1%	1
	Coarse sed.	14	19	2	22		153	196	5%	7
	Fine sed.	1	5				5	10	0%	4
	Mafic	6	4		11		69	84	2%	-2
	Mod calcareous	1	1				3	4	0%	0
	Ultramafic	1					4	4	0%	-1
1700-2500'	Granitic	1		2	5		9	16	0%	1
	Sedimentary	1					6	6	0%	-1
	Coarse sed.	1		2	1		5	8	0%	1
	Mafic	1			3		3	6	0%	-1
Grand Total		295	219	21	244	16	3495	3995	100%	-55

%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,

TC = total critical occurrences (unprotected + protected)

D = the difference between the amount identified for the portfolio and the goal,

Current Protection Levels of Critical Features.

Critical floodplain and riparian occurrences amount to 3% by count and 18% by acreage of all the floodplain features in the ecoregion – thus amounting to roughly one half percent of the entire region by acreage (Table 4). Currently 27,000 acres are on lands protected for biodiversity leaving 776,951 acres remaining for active protection efforts.

Table 4. Overall floodplain & riparian portfolio protection levels by acreage and by count.

	CU	CP	PC	PS	OU	T
Acres	776,951	26,502	211,605	24,347	3,343,053	4,382,458
%acres	18%	1%	5%	1%	76%	100%
Count	502	152	244	1,573	19,363	21,834
%count	2%	1%	1%	7%	89%	100%

*Figure 5.Protection levels of critical and defacto floodplain occurrences. Chart shows **total acreage** by state or province. Legend as for Table 3(with modification PC = DC and PS = DS).*

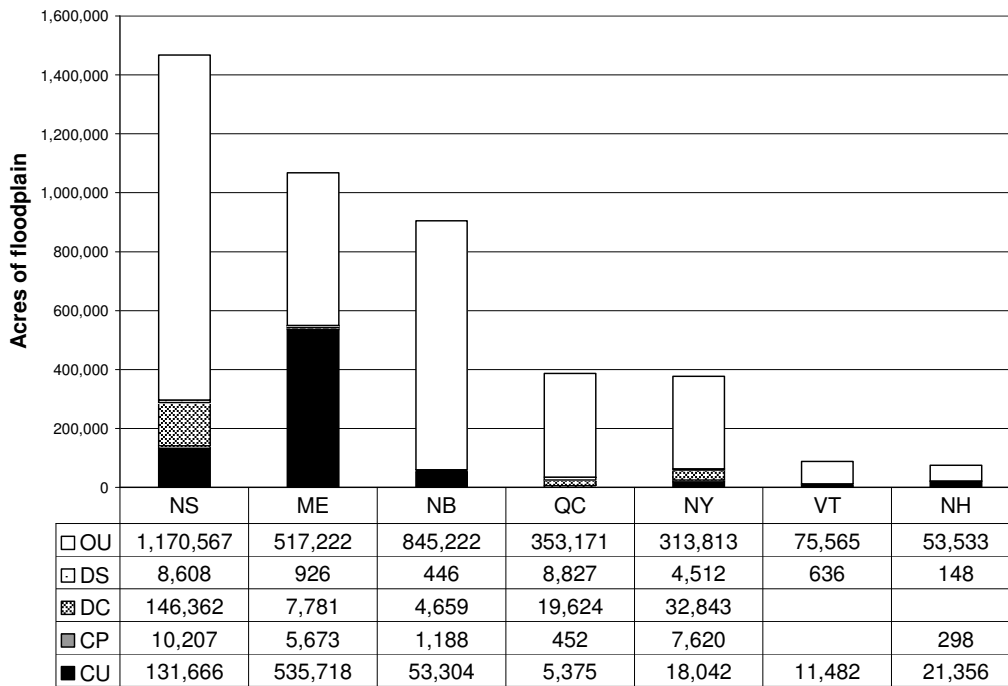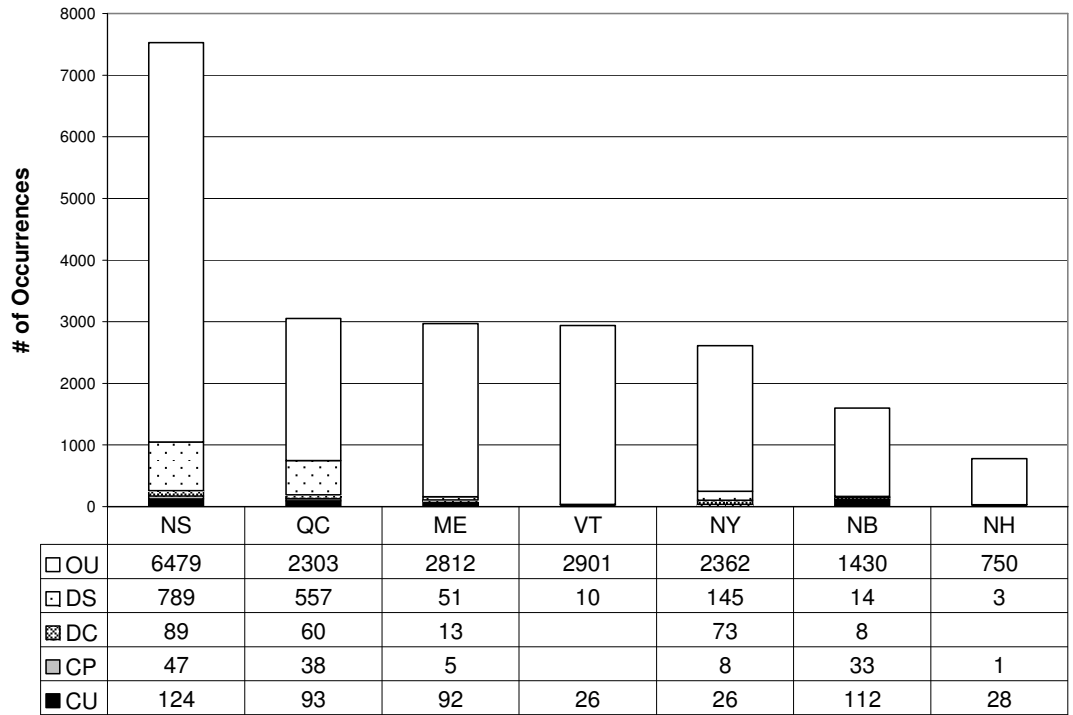|	NS	ME	NB	QC	NY	VT	NH
□ OU	1,170,567	517,222	845,222	353,171	313,813	75,565	53,533
□ DS	8,608	926	446	8,827	4,512	636	148
▨ DC	146,362	7,781	4,659	19,624	32,843		
▨ CP	10,207	5,673	1,188	452	7,620		298
■ CU	131,666	535,718	53,304	5,375	18,042	11,482	21,356

*Figure 6.Protection levels of critical and defacto floodplain occurrences. Chart shows **total number** by state or province. Legend as for Table 3(with modification PC = DC and PS = DS).*

	NS	QC	ME	VT	NY	NB	NH
☐ OU	6479	2303	2812	2901	2362	1430	750
☐ DS	789	557	51	10	145	14	3
▨ DC	89	60	13		73	8	
▨ CP	47	38	5		8	33	1
■ CU	124	93	92	26	26	112	28

Sites: Site lists are found in Appendix A