Conservation of Nine Ponds through Three Decades: Consequences for Marsh Vegetation

Marjorie M. Holland[1], C. John Burk[2], and David McLain[3]
[1] University of Mississippi, University, MS, USA
[2] Smith College, Northampton, MA, USA
[3] Massachusetts Audubon Society, Easthampton, MA, USA

Abstract

Ned's Ditch, now a part of Arcadia Wildlife Sanctuary in Northampton and Easthampton, Massachusetts, is part of an oxbow that was cut off from the main stem of the Connecticut River about 800 yr BP. Vegetation of the site, which now includes one of the largest stands (Figures 1 and 2) of floodplain forest in New England, dense stands of buttonbush (*Cephalanthus occidentalis*) swamp and nine scattered ponds, has been studied from spring 1973 through 2007. Fully developed zonation of the ponds includes concentric bands of high marsh which is transitional to the lower strata of adjacent floodplain forest vegetation; mid marsh, a zone of emergent plant species; and low marsh, which supports a variety of aquatic hydrophytes. However, in 1973, before the area was acquired by the Massachusetts Audubon Society, five of the nine ponds lacked zones of high marsh, two lacked zones of mid marsh, and one lacked a low marsh zone. The four high marsh zones were dominated by either royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), wild grape (*Vitis* spp.) or seedlings of floodplain forest trees. Six of the seven mid marsh zones in 1973 were dominated by emergent buttonbush, the seventh by buttonbush and seedlings of ash (*Fraxinus pennsylvanica*). Seven of the eight low marsh zones were dominated by spatterdock (*Nuphar variegatum*), and one by seedlings of willow (*Salix* spp.). Human activities in 1973 at the site included occasional logging for firewood, disposal of wastes including sediments from road construction, hunting, and trapping of resident muskrats.

When Ned's Ditch was acquired by the Massachusetts Audubon Society in 1974, most of these disturbances were halted. Over the next three decades, despite annual fluctuations resulting from periods of flooding (Figure 3 and 4) or drought, overall plant species richness increased and zones of high, mid, and low marsh developed where previously lacking. In 2004, six zones of high marsh were dominated by royal fern, two by sensitive fern and ash seedlings, and one by seedlings of silver maple (*Acer saccharinum*). Silver maple seedlings had become well established in high marsh at most ponds. Buttonbush continued to dominate seven zones of mid marsh while common duckweed (*Lemna minor*) had greatest coverage in two. Over the study period, spatterdock in the low marsh had largely been replaced by a variety of floating or submerged aquatics, including common duckweed, *Polygonum* spp., watermeal (*Wolffia columbiana*), and elodea *(Elodea nuttallii*). Observed changes in wildlife populations since 1973 include an increase in muskrat populations, the invasion of beavers, (Figure 6) which had built a lodge in high marsh in one pond, (Figure 7) and the establishment of a breeding colony of great blue herons (Figure 8) in the floodplain forest. These changes in wildlife populations may have contributed to changes within the pond vegetation through trampling, herbivory, and nutrient enrichment from the droppings of the herons and beavers.

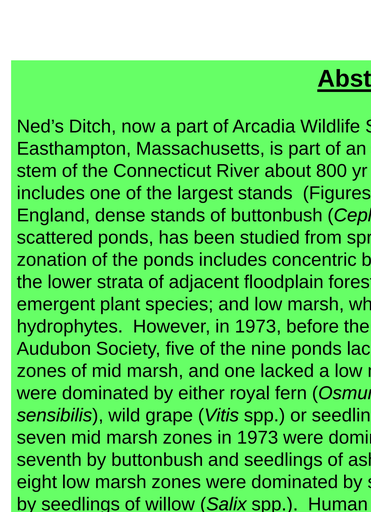

Figure 1. Map of New England indicating Connecticut River study area in western Massachusetts, USA.

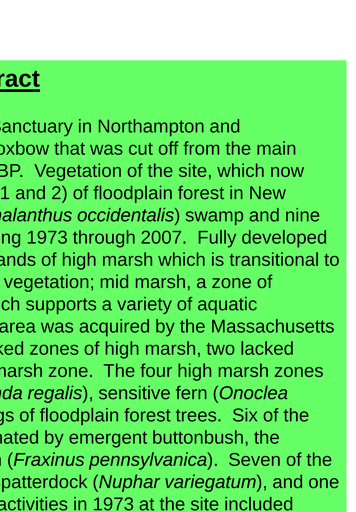

Figure 2. Map showing the location of old oxbows in western Massachusetts, USA.

Methods

The vegetation analysis of Ned's Ditch was conducted in the old Connecticut River channel (Figures 4 and 5). At Ned's Ditch in 1973, five belt transects approximately 300m long and 1m wide were established across the oxbow at regular intervals, as part of a general survey of vegetation type. Marsh vegetation occurred on all transects and was accessible on each. Three distinct zones of vegetation were sampled in nine ponds: high marsh was highest in elevation; mid marsh supported emergent vegetation; and low marsh supported floating or submerged vegetation. On each transect sampled, ten 0.5m x 0.5m quadrats were evenly spaced in each zone at intervals of 1m on a baseline perpendicular to the transect (Figure 5). Presence and coverage as determined by visual estimate were noted for all vascular plants including herbs, vines, and woody seedlings under 60 cm height in each of the quadrats. For purposes of consistency, nomenclature follows the US Department of Agriculture Plant Database (2009).

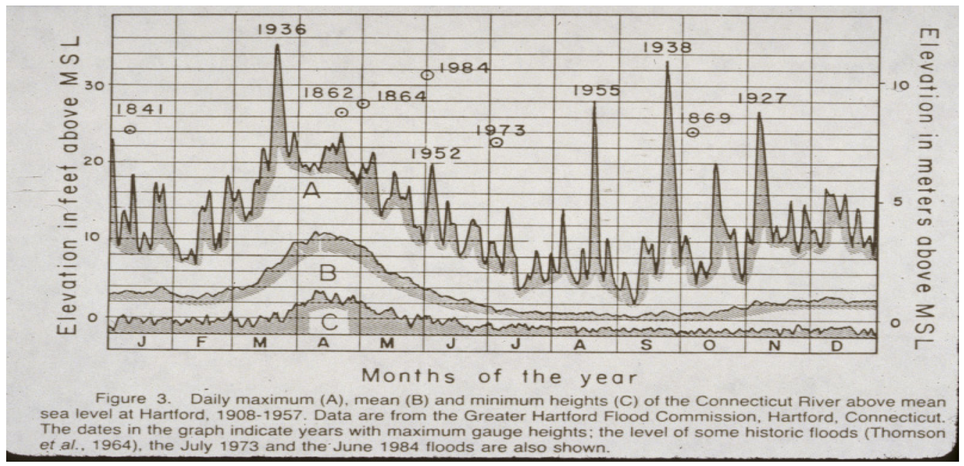

Figure 3. Daily maximum (A), mean (B) and minimum heights (C) of the Connecticut River above mean sea level at Hartford, 1908-1957. Data are from the Greater Hartford Flood Commission, Hartford, Connecticut. The dates in the graph indicate years with maximum gauge heights; the level of some historic floods (Thomson *et al.*, 1964), the July 1973 and the June 1984 floods are also shown.

(from Metzler and Damman 1985)

Results and Discussion

Comparisons of two ponds [Ponds 3 and 6] are presented with data from 1973 and from sampling in 2004-2006 in Tables 1 and 2. In both ponds in 1973, *Cephalanthus* was dominant in mid marsh. However, no species were present in either the high or low marsh zones of Pond 6 in 1973. By the 2004-2006 samplings, Pond 6 had 20 species present in high marsh, while 3 species were sampled in low marsh (Table 2). *Onoclea sensibilis* was a dominant species in Pond 3 in 1973, and continues its dominance in the 2004-2006 sampling (Table 1). Table 3 shows that high marsh was dominated by different species in 1973, but by the 2004-6 sampling, high marsh for 7 ponds was dominated by *Osmunda regalis*. Mid marsh was dominated by *Cephalanthus occidentalis* throughout all samplings, while low marsh was dominated by *Nuphar variegatum* in 1973, with the genera *Elodea, Lemna*, and *Wolffia* the dominants in the 2004-2006 samplings. With an increase in muskrat populations and an invasion of beavers throughout Ned's Ditch, *Nuphar* rhizomes were uprooted and eaten resulting in a decrease in the abundance of *Nuphar variegatum* plants. During the 30 year sampling period, species richness has increased in all three marsh zones. Fixed location photos show that much of the Ned's Ditch ponds continue to remain open.

Figure 4. The May 1984 flood is the most recent major flood in the Connecticut River Valley.

Figure 5. Aerial view of Ned's Ditch showing Ponds 3, 4, 6, and 7.

Figure 6. Beaver swimming through swamp.

Figure 7. Nests of Great Blue Herons.

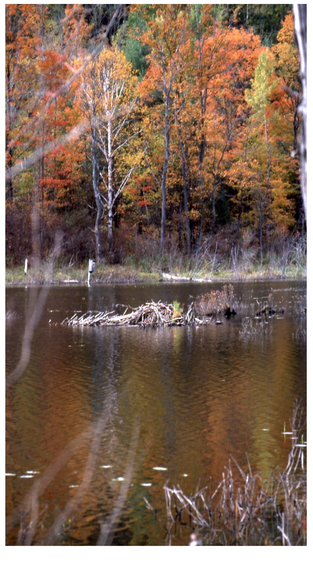

Figure 8. Beaver lodge in western Massachusetts.

Table 1. Number of vascular species and zone dominant
Pond 3, Ned's Ditch, 1973 and 2004-7

Zone	Year			
	1973		2004-7	
	# Species	Dominant	# Species	Dominant
High	9	Onoclea/Fraxinus	12	Onoclea
Mid	9	Fraxinus/Cephalanthus	8	Cephalanthus
Low	5	Nuphar	7	Elodea*
*Nuphar present				

Table 2. Number of vascular plant species and zone dominant
Pond 6, Ned's Ditch, 1973 and 2004-7

Zone	Year			
	1973		2004-7	
	# Species	Dominant	# Species	Dominant
High	_____	_____	20	Osmunda
Mid	1	Cephalanthus	6	Cephalanthus
Low	_____	_____	3	Wolffia

Table 3. Number of marsh zones, principal zone dominant and total vascular plant species for each of 9 Ned's Ditch ponds, 1973 and 2004-7

Zone	Year			
	1973		2004-7	
	# Species	Dominant	# Species	Dominant
High	4 -	each different	9 -	78% Osmunda regalis
Mid	7 -	86% Cephalanthus	9 -	78% Cephalanthus
Low	8 -	88% Nuphar	9 -	45% Lemna
Total species all zones	35		42	

Conclusion

The integrity of the oxbows' marsh community is largely dependent on dynamic hydrological conditions resulting from periodic flooding on the Connecticut River. Since the initial sampling of vegetation in the 1970s, the concept of a vegetation type that may persist indefinitely through "pulse stability" (Odum 1969) has been explored with reference to floodplain forests in particular. Our studies, along with other investigations of floodplain forest vegetation, suggest that preserving and successfully managing these communities will require the maintenance of species of diverse ecological requirements adapted to a range of habitat conditions. In these dynamic systems, individual species tend to fluctuate in abundance and may sometimes disappear completely from a given floodplain marsh site, only to reappear in subsequent years.

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Acknowledgements

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