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The Conservation and Management of a Threatened Coastal Plain Plant Community in Eastern North America (Nova Scotia, Canada)

Irene C. Wisheu & Paul A. Keddy

Department of Biology, University of Ottawa,
Ottawa, Ontario, Canada K1N 6N5

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ABSTRACT

The distribution of wetland plant species was described along a standing crop and litter gradient at Wilsons Lake, a nationally significant wetland habitat in Nova Scotia, Canada. Disjunct populations of rare and endangered Atlantic coastal plain species were found to contribute most to total standing crop when biomass was low. A similar distribution for isoetids, a group of stress-tolerant shoreline plants, indicates that low biomass areas are also infertile. The rarity of the coastal plain flora seems to be related to the lack of low biomass/infertile shorelines within the flora's geographical range. Conservation of the flora therefore involves preserving the remaining habitat and maintaining the current processes of flooding, wave wash, and ice scour that are maintaining infertility.

INTRODUCTION

The Atlantic coastal plain of eastern North America is a broad expanse of low-lying land adjacent to the Atlantic shoreline. A distinctive flora found nowhere else in the world occurs throughout this region (Fernald, 1942). The species of the coastal plain flora, almost without exception, grow only in moist or wet freshwater areas. The most common habitat in which they occur is on gently sloping sand and gravel beaches (Roland, 1976). The flora's range extends from Texas, along the northern border of the gulf of Mexico, along the Mississippi lowlands, and in a narrow band up the eastern seaboard to New England. Disjunct populations occur in Wisconsin,

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Michigan, Ontario and in southwestern Nova Scotia (Peattie, 1922; McLaughlin, 1932; Fernald, 1942; Roland & Smith, 1969; Voss, 1972; Keddy, 1981).

Within this limited geographical range, wetland habitat is becoming increasingly rare. Urbanisation along the eastern seaboard has caused extensive habitat loss. Half of all wetlands in the United States have already been destroyed (Frayer *et al.*, 1983) and eutrophication may be threatening what remains of the low standing crop wetlands (Ehrenfeld, 1983; Morgan & Philipp, 1986).

Even though many members of the flora are either endangered, threatened, or rare (Argus & Pryer, 1987), little is known about the ecology and distribution of Atlantic coastal plain species. Previous work has established the importance of wave disturbance (Keddy, 1984; Wisheu & Keddy, in press) and seed banks (Keddy & Reznicek, 1982; McCarthy, 1987) in maintaining populations of these species.

The principal objective of this paper is to document the distribution of disjunct populations of coastal plain species in a nationally significant habitat at the northern limit of their range in Nova Scotia, Canada. We describe the flora's distribution along a standing crop gradient, and discuss what the distribution implies about the conservation of the species. Standing crop gradients have previously been used to describe wetlands (Vermeer & Berendse, 1983; Wheeler & Giller, 1982;Wisheu, 1987; Day *et al.*, 1988), and they have proven to be useful variables in developing general models for ecology and conservation (Grime, 1977, 1979; Moore *et al.*, 1989).

STUDY SITE

Our study centred on the Tusket River Nature Reserve at Wilsons Lake (43° 55′ N, 65° 53′ W) in the Tusket River system, Yarmouth County, Nova Scotia. A section of the lake shoreline has been protected because of the large number of rare plants that the area supports (Keddy, 1985). There are eight species at the lake that are either endangered, threatened, or rare, seven of which are characteristic of the coastal plain (Table 1). Much of the Wilsons Lake shoreline is typical coastal plain habitat—gently sloping gravel and sand. Standing crop is low on rock or gravel beaches and highest where thick mats of *Cladium mariscoides* develop (Fig. 1). Occasionally, sections of the *C. mariscoides* mats dislodge and wash away, leaving gravel shoreline exposed. This periodic removal of the high biomass sites seems due to winter ice scour and to floods which occur in the Tusket River system several times each growing season.

Low fertility may also be responsible for keeping biomass low. The

TABLE 1

Selected Groups of Species from Wilsons Lake, Nova Scotia

The list of coastal plain species was modified from Roland & Smith (1969), and that of isoetids is from Boston & Adams (Table 1, 1987). Eight significant species occurred on the shoreline, including *Rhexia virginica* which is rare in Canada (Argus & Pryer, 1987) but secure worldwide (5). Global rankings are given in parentheses

Atlantic coastal plain species	*Carnivorous species*	*Isoetids*
** *Coreopsis rosea* (3)	*Drosera intermedia*	*Elatine minima*
+ *Euthamia galetorum* (?)	*D. rotundifolia*	*Eleocharis acicularis*
** *Hydrocotyle umbellata* (5)	*Utricularia cornuta*	*Eriocaulon septangulare*
Lycopodium appressum (5)	*U. purpurea*	*Gratiola aurea*
+ *Panicum rigidulum pubescens* (?)	*U. resupinata*	*Isoetes tuckermani*
	U. vulgaris	*Juncus pelocarpus*
+ *Platanthera flava flava* (4?)		*Lobelia dortmanna*
		Myriophyllum tenellum
* *Sabatia kennedyana* (3)		*Ranunculus reptans*
+ *Xyris difformis difformis* (?)		

\+ Nationally rare.
* Nationally threatened.
** Nationally endangered.
? Undetermined.

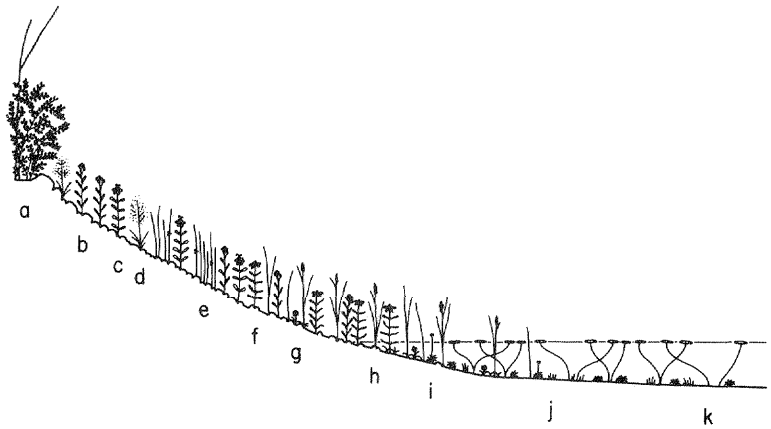

Fig. 1. Shore profile at Wilsons Lake, Nova Scotia. The diagram, compressed horizontally 4×, contains the following species: (a) *Myrica gale*, (b) *Euthamia galetorum*, (c) *Sabatia kennedyana*, (d) *Agrostis perennans*, (e) *Juncus filiformis*, (f) *Coreopsis rosea*, (g) *Ranunculus reptans*, (h) *Cladium mariscoides*, (i) *Isoetes tuckermani*, (j) *Eleocharis acicularis*, and (k) *Hydrocotyle umbellata*. A typical summer's water level is shown.

substrate at Wilsons Lake is low in both organic content (average 8·8%) and in silt and clay content (average 23·7%, Wisheu, 1987; Wisheu & Keddy, in press), two measurements which indicate fertility (Thompson & Troeh, 1973; Keddy, 1984). Overall infertility of the Wilsons Lake shoreline is also indicated by the large number of carnivorous species that occur (Table 1). These species, which tend to be restricted to nutrient-poor habitats (Givnish *et al.*, 1984) occur throughout the length of the standing crop gradient.

METHODS

From 1–26 August 1984, 121 quadrats were positioned along the Wilsons Lake shoreline. Since the quadrats had to represent the complete standing crop and litter gradient, quadrat locations were not chosen randomly, but were selected from a distance on the basis of a visual approximation of the standing crop and litter present. Within each of the 121 0·25 m^2 quadrats, all above-ground biomass was collected, sorted to species, dried and weighed.

Species names follow Roland & Smith (1969) except for the coastal plain species whose nomenclature was updated using Kartesz (1985). Rare species were identified using Argus & Pryer (1987). Canadian statuses of threatened or endangered were designated by COSEWIC, the Committee on the Status of Endangered Wildlife in Canada (Argus & Pryer, 1987). Global rankings were from the Nature Conservancy (1987), and are from 1 to 5, with a designation of 1 indicating critical imperilment.

RESULTS

Species richness

The Wilsons Lake shoreline was found to support a very diverse flora, with as many as 23 species in a single 0·25 m^2 quadrat. Maximum species richness typically occurred at levels of standing crop and litter in the range of 25 to 75 g 0·25 m^{-2} (Fig. 2). The sampled quadrats were, however, never of very high standing crop. Total biomass at the lake was as low as 0·1 g 0·25 m^{-2} and did not exceed 150 g 0·25 m^{-2} as compared to values greater than 500 g 0·25 m^{-2} found in *Typha* stands (Fig. 2).

Species distributions

Atlantic coastal plain species are present throughout the standing crop and litter gradient but, as shown in Fig. 3, the contributions of these species to

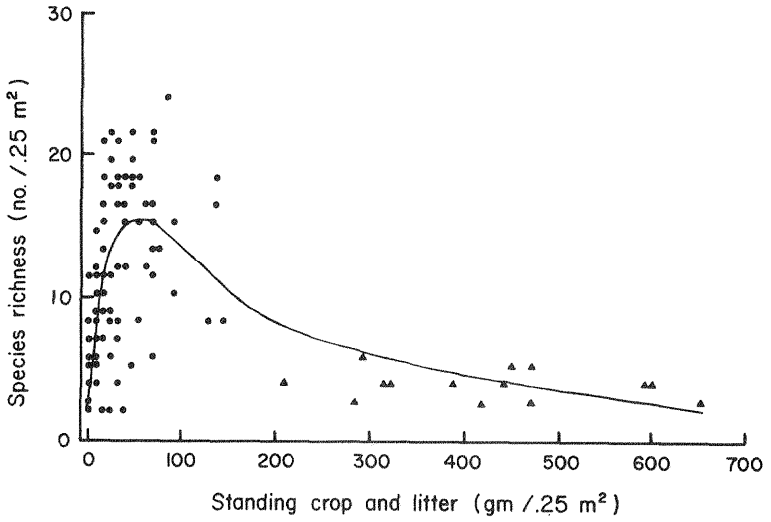

Fig. 2. Changes in species richness along a standing crop and litter gradient. ●, values from Wilsons Lake, Nova Scotia; ▲, values from a *Typha*-dominated wetland at Presqu'ile Provincial Park, Ontario, Canada (Moore *et al.*, 1989) and are representative of fertile *Typha* wetlands at this latitude (Day *et al.*, 1988; Moore *et al.*, 1989). The line was drawn using robust locally weighed regression methodology (Cleveland, 1979).

total standing crop is greatest when biomass is low. Figure 3 shows a similar distribution for those species that have been classified as either endangered, threatened, or rare, and for those species that are isoetids (Table 1).

Isoetids, a taxonomically diverse group of species, all share a common morphology and habitat. They are small, slow-growing species with very short stems and rosettes of short stiff leaves, and are characteristic of infertile wetlands (Hutchinson, 1975, Boston & Adams, 1987). Their presence throughout Wilsons Lake indicates that it is less fertile than lakes without as many isoetids. Their within-lake distribution suggests that the low standing crop areas are less fertile than the high biomass sites.

DISCUSSION

Rarity of flora

The distributions of species along the Wilsons Lake shoreline suggest that the coastal plain flora is most abundant in infertile, low standing crop habitats. The rarity of the flora may then be explained by the lack of such habitat within the flora's geographical range. Few low standing crop

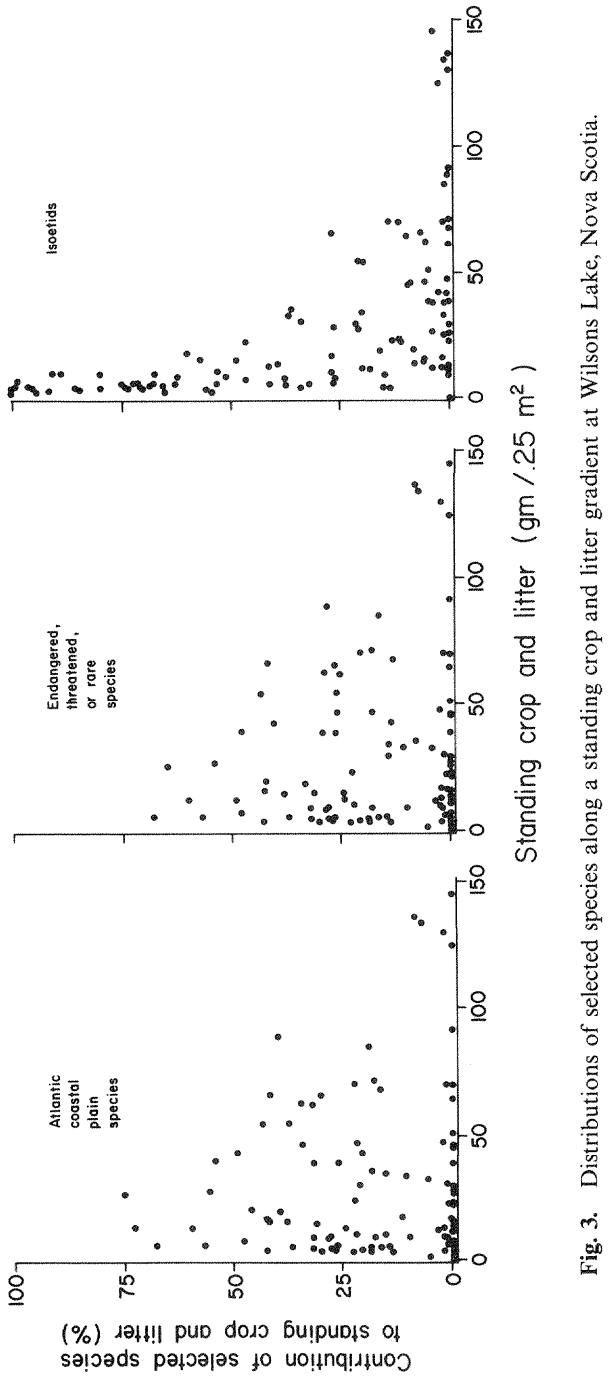

Fig. 3. Distributions of selected species along a standing crop and litter gradient at Wilsons Lake, Nova Scotia.

shorelines occur. Many more fertile wetlands support large herbaceous species such as *Typha* or *Phragmites*. More infertile wetlands in Nova Scotia often become peat bogs dominated by ericaceous shrubs; this successional sequence in coastal plain communities has also been observed in Ontario (Keddy, 1981). Conserving the rare coastal plain flora therefore involves (1) preserving the remaining habitat; (2) understanding those characteristics of the habitat which are important for maintaining the flora; and (3) maintaining these processes.

Persistence of flora

The major characteristics of Wilsons Lake are the infertility of its shorelines and the high levels of natural disturbance that the shores experience. Erosion from ice and wave scour probably maintain infertile conditions by reducing both the organic content and the silt and clay content of the shoreline (Spence, 1982; Keddy, 1983, 1985; Wisheu & Keddy, in press). This low fertility likely restricts the development of high biomass plant communities (Day *et al.*, 1988; Moore *et al.*, 1989). Periodic flooding combined with erosion may prevent the establishment of peat bogs. In the absence of high biomass species, plant competition may be reduced (McNaughton, 1967; Grime, 1979; Wilson & Keddy, 1986), allowing a greater variety of species to co-exist.

The foregoing processes also determine the kind of species found. The abundance of insectivorous species has already been noted. Isoetids, considered by Boston & Adams (1987) to be stress-tolerators, are also adapted to these shorelines. Their short stature and creeping habit make them resilient to wave wash (Spence, 1982) while their slow growth rates and evergreen tissue allow them to grow in nutrient-poor soil (Boston, 1986). These slow-growing species can survive both infertility and long periods of submergence, and Boston & Adams (1987) consider them to be stress tolerators (*sensu* Grime, 1977, 1979). The overlap in distribution between isoetids and coastal plain species (Fig. 3) indicates that the disjunct species may also be stress-tolerators. While perhaps unable to tolerate competition for light and nutrients with taller, faster growing species, the coastal plain flora can survive infertility and floods.

Conservation

If present populations of coastal plain species are to persist, then current levels of fertility and natural disturbance should be maintained. Fertility, for example, would increase if logging or agriculture were intensified in the watershed resulting in enriched runoff. Such soil enrichment could prompt the establishment of larger, more potentially dominant species that could, in

time, outcompete the rare flora. Such a change has already occurred in the New Jersey Pine Barrens (Ehrenfeld, 1983; Morgan & Philipp, 1986), where developed areas have fewer rare species than pristine sites.

Another threat to the coastal plain flora would be if natural disturbances at the lake were decreased. If, for example, the lake's water level was stabilised, there would be less disturbance and less regeneration from buried seeds, a process known to be important in coastal plain communities in Ontario (Keddy & Reznicek, 1982) and New Jersey (McCarthy, 1987). In Ontario, water level manipulation is being practised as a management technique to maintain this flora (Keddy *et al.*, in press). In the absence of disturbance, the coastal plain community would probably be replaced by a higher standing crop community that does not contain as many rare species (Keddy & Reznicek, 1982; Keddy *et al.*, in press).

At present, the greatest threat to the coastal plain vegetation is an increase in human-induced disturbances. Cabin development and the accompanying shoreline landscaping are destroying large tracts of coastal plain habitat—the vegetation opposite the Wilsons Lake Reserve site was recently eliminated by bulldozing.

Another serious threat comes from the increasingly frequent passage of all-terrain vehicles which destroy vegetation. The slow growing, stress-tolerant species are resilient to the existing levels of wave disturbance, but may not be able to recover from the repeated tissue removal that all-terrain vehicles cause, particularly when it occurs during summer periods of growth. At nearby Gillfillan Lake, one of the largest stands of *Sabatia kennedyana* in Canada (Keddy, 1985) has been nearly destroyed by the frequent passage of the vehicles, and surveys have shown that within the last five years, 90% of the stand has been replaced by barren vehicle tracks.

CONCLUSION

Given that many of these species also have declining status in the United States (Keddy & Wisheu, in press), there is a need for planning for the conservation management of these species at a continental scale. If the results from Nova Scotia can be generalised, then the location and conservation of infertile and disturbed shorelines should be a conservation priority throughout North America's Atlantic coastal plain.

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