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A PROTOCOL TO IDENTIFY AND PRIORITIZE SIGNIFICANT COASTAL PLAIN PLANT ASSEMBLAGES FOR PROTECTION

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Abstract

A systematic method for establishing priorities for the protection of coastal plain plant species assemblages and their habitat was developed and applied to 49 lakes in Ontario. A list of coastal plain species found in the area was made based on the literature. From herbarium records for these species, 62 candidate lakes were selected for the field survey and priority for investigation was determined by the number of species collected from each. Lake significance for coastal plain plants was initially ranked numerically based on the following score: (total no. of coastal plain species × 4) + (no. coastal plain species nationally rare × 3) + (no. coastal plain species provincially rare × 2) + (no. other nationally/provincially rare species). Ranks for the 12 most significant lakes were then adjusted to reflect the proportion of shoreline harbouring coastal plain plant assemblages and the occurrence of exceptionally large populations of significant species. Priority for shoreline protection was determined by adjusting this secondary rank according to existing protection, disturbance, threats and history of scientific study. The procedure used can serve as a model for evaluating other natural areas and themes.

Keywords: coastal plain, flora, Ontario, conservation, priorities.

INTRODUCTION

It has long been known that a coastal plain plant association occurred in the flora of the Great Lakes area of the United States (Peattie, 1922). In Ontario, a few individual species were collected as early as 1878 (Sharp, 1983); however, it is only recently that botanists have discovered significant assemblages of numerous coastal plain species in the province. Although a few of Ontario's coastal plain species occur in bogs, most are associated with lakeshores, the habitat focus of this study. Many such species are rare, threatened or endangered both within their main range and on the periphery (e.g. *Polygonum careyi*, *Potamogeton confervoides*, *Rhexia virginica*, *Xyris difformis*; Argus *et al.*, 1982–1987). Thus, it is important to protect populations in centres of distribution such as sites in Ontario east of Georgian Bay.

To date, work on coastal plain plants in Ontario has included reporting species occurrences (e.g. Reznicek & Whiting, 1976; Simpson, 1976; Hanna, 1979; Brunton, 1980) and ecological studies (Keddy, 1981, 1982, 1983, 1985; Keddy & Reznicek, 1982; Nicholson & Keddy, 1983; Sharp, 1983, 1984; Posluszny *et al.*, 1984; Sharp & Keddy, 1985; Wilson *et al.*, 1985). These studies have shown that coastal plain species are most abundant on gently sloping, sandy or peaty shorelines, at lakes where water levels fluctuate annually or every few years. Sites with these features are becoming rare in the Georgian Bay area due to water level regulation to satisfy the recreational needs of cottagers and to maintain navigable waterways, and due to disturbance for cottages, swimming areas, holiday resorts and marinas.

Evaluation and protection of natural features is often done on an *ad hoc* basis where popular sites are first considered, although they may not be the most significant. Without an inventory to document the distribution of coastal plain plant assemblages and a method to evaluate the results, there is no basis for determining site significance or representation and protection agencies cannot set priorities for action. To ensure that the best sites would be protected, a rigorous, systematic methodology was developed to identify and prioritize sites with coastal plain plant assemblages in Ontario (Keddy & Sharp, 1989). The methodology described can be applied to similar plant communities in other areas and can be considered as a model for setting conservation priorities for other significant natural features.

Nomenclature follows Argus *et al.* (1982–1987), Voss (1972, 1985) and Gleason and Cronquist (1963).

METHODS

Selection of lakes for reconnaissance

The following species were selected as indicators of coastal plain assemblages: *Dichanthelium spretum*, *Eleocharis olivacea*, *Elatine minima*, *Juncus militaris*, *Linum striatum*, *Polygonum careyi*, *Potamogeton bicupulatus*, *P. confervoides*, *Rhexia virginica*, *Rhynchospora* *capitellata*, *Triadenum virginicum*, *Xyris difformis*. These species represent a variety of habitats, are known to occur with other coastal plain species, and have easily accessible distribution maps and herbarium records (Argus *et al.*, 1982–1987).

The lakes from which these species were known were compiled and grouped according to their geographic affinity (1:50,000 topographic map number). The number of indicator species known from each lake was recorded and used in determining priority (high, medium, low) for assessment. Proximity of lakes to one another, accessibility and the existence of reliable existing data were then factored in to determine the list of lakes to be surveyed. To maximize actual reconnaissance time we endeavoured to visit lakes that were close to each other. Thus if a 'low'-ranked lake was on the route to a 'high'- ranked lake they were both investigated. In a few instances, lakes not on the list were examined if they were easily accessible and looked likely to support coastal plain plants. Lakes for which reliable data already existed were not visited.

Field reconnaissance

The shoreline of a lake was canoed to search for sites with suitable habitat or coastal plain plants, from 10 to 20 August 1988. Each site found was examined on foot to describe the vegetation and physical habitat characteristics, record the species present (noting exceptionally large populations) and determine on-site and potential disturbance or threats. As much of each lake as possible was examined to assess its suitability as coastal plain habitat considering evidence of water level fluctuations, degree of shoreline development and shoreline appearance. For logistical reasons the entire shoreline was not investigated for most lakes The portion of shoreline examined was marked on a topographic map and the length estimated using dividers. Voucher specimens of coastal plain plants were collected from each lake and deposited in the herbarium at the University of Toronto, Erindale College (TRTE). Field data were supplemented with data from reports or publications and personal communications where possible.

Selection of coastal plain plants for lake/site evaluation

A literature survey was undertaken to ascertain those species that occur in the Georgian Bay area which could be considered to have coastal plain affinities (Table 1 in Keddy & Sharp, 1989). This liberal list of 45 coastal plain plants was amended to produce a conservative list (one upon which most botanists could agree) based on the following criteria: habitat must be restricted to shorelines or shallow water, centre of distribution should occur on the Atlantic coastal plain and inland distribution should be restricted. The 23 species used to evaluate lakes included the 12 used for selecting lakes for reconnaissance as well as *Bartonia paniculata* ssp. *paniculata*, *Cladium mariscoides*, *Drosera intermedia*, *Eleocharis robbinsii*, *Gratiola aurea*, *Nymphoides cordata*, *Panicum rigidulum* var. *rigidulum*, *Rhynchospora fusca*, *Utricularia cornuta*, *U. purpurea* and *Woodwardia virginica*.

Assessment of lake significance

Three criteria were used to assess lake significance in the first phase:

(1) *coastal plain species representation*: the total number of species present on the evaluation list;

(2) *rare coastal plain species*: the number of species that are rare in Canada (Argus & Pryer, 1990) or Ontario (Argus *et al.*, 1982–1987); and

(3) *other rare species*: the number of rare species (based on references above) other than coastal plain species.

The significance of the coastal plain assemblage of a lake was initially ranked based on a score obtained as follows. The total number of coastal plain plants was multiplied by four and added to three times the number of coastal plain species rare in Canada, plus two times the number rare in Ontario, plus the number of other nationally/provincially rare species. This method puts more weight on species representation than rare species and more weight on rare coastal plain species than other rare species. The top 12 lakes ranked this way fell out as a group (there was a 10-point gap between the twelfth and thirteenth lake).

In the second phase of lake ranking, the initial ranks for the top 12 lakes were adjusted to reflect additional qualitative information such as relative population sizes of individual species and the relative extent of shoreline supporting coastal plain species. For example, a rank would be increased if the lake had an exceptionally large population of a coastal plain species and/or a large portion of its shoreline supported coastal plain assemblages.

Priority for lake protection

After lakes were ranked using the second-phase methods, the following criteria were then used to order the lakes in terms of priority for protection: existing protection (ecological reserve, park nature reserve, etc.), habitat disturbance (habitat quality), existing and potential threats, and history of scientific study.

Within-lake site selection

For the 12 lakes with the most significant coastal plain assemblages, representative sites were selected for protection using the following criteria: minimize the number of sites needed to include all coastal plain species on the lake, minimize inclusion of shorelines with unnatural disturbance, minimize distance among sites, and maximize species abundance.

RESULTS

Lake inventory

Based on the occurrence of the 12 indicator species, listed under Methods, 62 lakes were identified as candidates for assessment, of which 32 were visited in the field. An additional 12 sites were visited while *en route* to these lakes for a total of 44 lakes. A total of 121 km of shoreline was inventoried by canoe or on

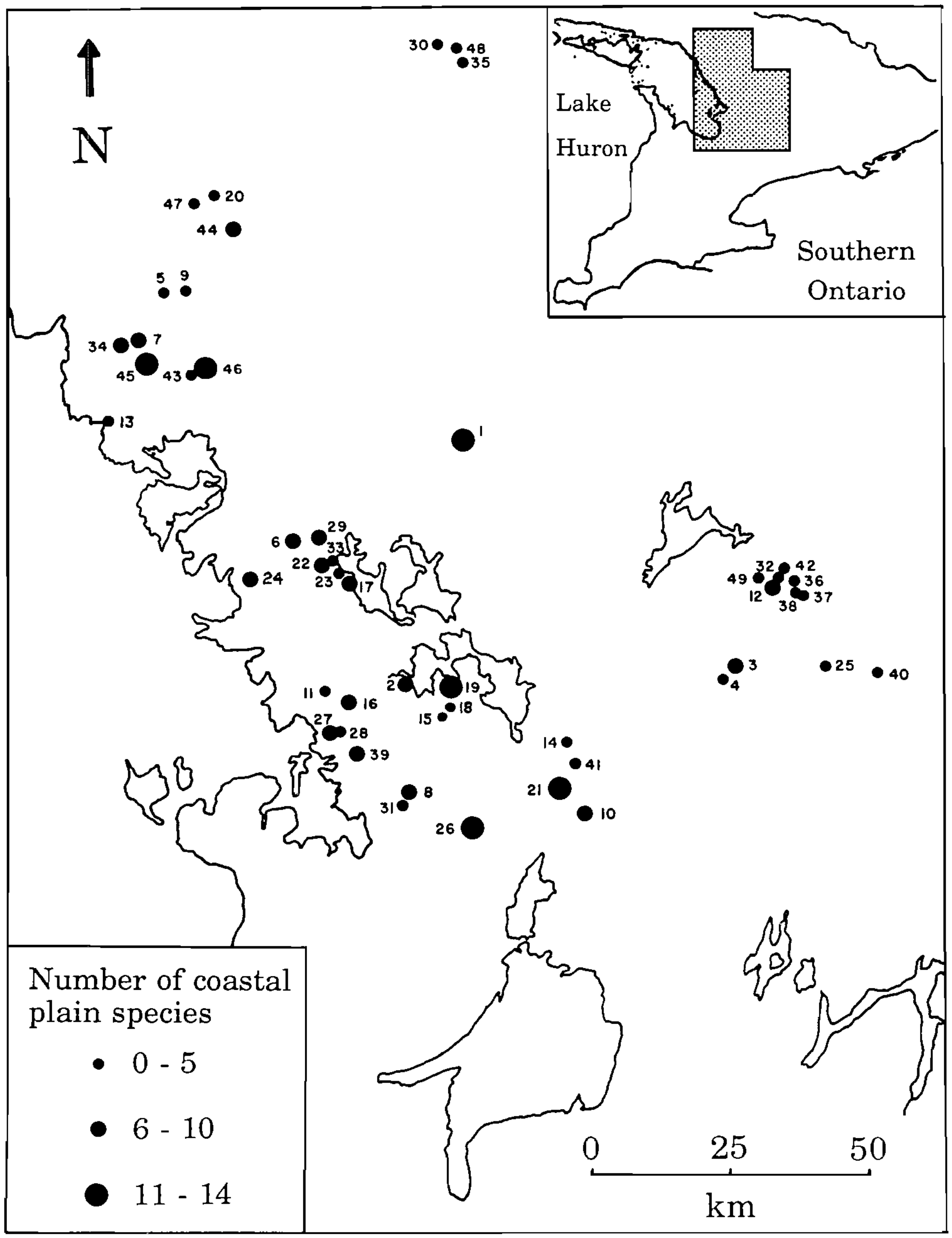

Fig. 1. Geographical distribution of lakes and coastal plain species richness. Lake codes: (1) Axe, (2) Bala, (3) Bentshoe, (4) Big East, (5) Black, (6) Blackstone, (7) Black Oak, (8) Burrows, (9) Clear, (10) Clearwater, (11) Coldwater/Swan, (12) Dawson, (13) Dillon, (14) Doe, (15) Echo, (16) Gibson, (17) Greens Bay, (18) Gullwing, (19) Hardy, (20) Island, (21) Kahshe, (22) Krapek, (23) Lake Joseph, (24) Little Blackstone, (25) Little Boshkung, (26) Matchedash, (27) McCrae, (28) McDonald, (29) McKechnie, (30) McQuaby, (31) Otter, (32) Plastic, (33) Portage, (34) Rock Island, (35) Ruth, (36) Sherborne, (37) Silver Buck, (38) Silver Doe, (39) Six Mile, (40) Soyers, (41) Three Mile, (42) Unnamed, (43) Upper Marsh, (44) Wahwashkesh, (45) Wiwassasegen, (46) Wolf (41H/9), (47) Wolf (41H/16), (48) Wolfe (31L/4), and (49) Wren. (After Keddy & Sharp, 1989).

foot. A total of 49 lakes was assessed, five based on existing data. This work yielded a raw data matrix of 27 species by 49 lakes (Table 3 in Keddy & Sharp, 1989).

Figure 1 shows the geographic distribution of lakes and coastal plain species richness. Within the group of coastal plain species, there are differences in distribution. For example, *Juncus militaris* does not occur in the most southerly lakes while *Potamogeton bicupulatus* is found only in these lakes. Species richness is lower at the easterly lakes.

In most lakes, coastal plain species were found only in pockets of suitable habitat in bays scattered around the shoreline, although in some (e.g. Matchedash and Wahwashkesh) coastal plain habitat was continuous. Most lakes contained a variety of shoreline types and coastal plain plants were found in boulder, gravel, sand, peat, and muck substrates on gentle to moderate slopes. No species were found in shade cast by shoreline trees although a few species occurred in the shade of sparse shrubs. The richest assemblages occurred on open, gently sloping sand or gravel mixed with peat shorelines. At three lakes where extreme water level fluctuation occurred to feed the Trent–Severn Waterway (Soyers, Sherborne, Little Boshkung), only one coastal plain species was found.

Table 1. Assessment and ranking of lakes using only species numbers and significance (score = col. 4 × 4 + col. 5 × 3 + col. 6 × 2 + col. 7 + col. 8); only the top 17 lakes are shown

Rank	Lake	Score	Species: Coastal plain: Total (×4)	Species: Coastal plain: Rare in Canada (×3)	Species: Coastal plain: Rare in Ontario (×2)	Species: Others: Rare in Canada	Species: Others: Rare in Ontario
1	Axe	72	15	2	3	0	0
2	Matchedash	68	13	2	4	2	0
3	Hardy	63	13	1	4	0	0
4	Kahshe	59	11	1	5	1	1
5	Wiwassasegen	57	11	1	5	0	0
6	Gibson	53	10	1	5	0	0
7	Wolf (41 H/9)	53	11	1	3	0	0
8	Wahwashkesh	52	10	1	4	0	1
9	Black Oak	50	10	0	5	0	0
10	Bentshoe	48	10	0	4	0	0
11	Gullwing	46	9	0	5	0	0
12	Krapek	46	10	0	3	0	0
13	Burrows	36	7	0	4	0	0
13	Clearwater	36	7	0	4	0	0
15	Rock Island	35	7	1	2	0	0
16	Dawson	34	7	0	3	0	0
17	Bala	34	6	2	2	0	0

Table 2. Ranking of the top 12 lakes based on species richness and rarity (Table 1), followed by an adjustment of this rank to reflect population size and assemblage extent, and finally a modification of the latter to reflect conservation priority

The lower the number, the greater the significance. Rank rationale is explained in the text.

Lake	Significance Rank: Species richness/rarity	Significance Rank: Population/ assemblage size	Significance Rank: Conservation priority
Axe	1	2	2
Matchedash	2	1	1
Hardy	3	3	12
Kahshe	4	8	11
Wiwassasegen	5	5	5
Gibson	6	6	7
Wolf (41 H/9)	6	7	4
Wahwashkesh	8	4	3
Black Oak	9	9	6
Bentshoe	10	10	8
Gullwing	11	11	9
Krapek	11	11	10

Assessment of lakes with coastal plain species

The results of the first phase of lake ranking, based on the number and relative significance of coastal plain species present and the occurrence of other rare species, is shown in Table 1. Scores for all 49 lakes varied from 0 to 72. Because the top 12 sites formed a group, separated from the remainder by 10 points, they were chosen for additional assessment.

The results of the second phase of assessment for the top 12 lakes, which takes into account population sizes and the extent of coastal plain assemblages, is shown in Table 2. The rank for Matchedash was increased because the coastal plain plant assemblage covers almost the entire shoreline and it has the largest known population of *R. virginica*. The rank of Wahwashkesh was increased because a large portion of the shoreline supported coastal plain plants and the total extent of the assemblage was greater than that for Wiwassasegen. The rank of Kahshe was decreased because the assemblages of coastal plain species were small in extent and scattered on the highly developed shoreline.

Priority for protection, based on existing protection, habitat disturbance, existing or potential threats and history of scientific study, is shown in Table 2. The main factors contributing to priority assignment of the top five lakes are as follows: (1) Matchedash—rich coastal plain species assemblage along most of shoreline; under immediate threat from proposed cottage development; long-term study of shoreline vegetation (Geomatics International, Inc. & Keddy, 1991); (2) Axe—richest assembly of coastal plain species; lakeshore almost pristine with only one cottage; extensive scientific research has been conducted on vegetation; not protected from development but threats lower than at Matchedash; (3) Wahwashkesh—good example of coastal plain assemblage with several species most abundant on this lake; considerable sections of habitat are undisturbed and threats from cottage development and all-terrain vehicles are moderately high; (4) Wolf—rich assemblage scattered around shoreline; adjacent to proposed nature reserve; (5) Wiwassasegen—fairly rich coastal plain assemblage; access difficult resulting in low disturbance and threats; within candidate nature reserve.

The number of sites selected within a lake to represent the coastal plain assemblage varied from two to six depending upon lake size and the dispersion of species making up the assemblage (additional site details can be found in Keddy and Sharp (1989)).

DISCUSSION

Single-season field surveys are often used in determining the relative significance of natural areas. The appearance and detectability of coastal plain plants, however, is closely related to water level which typically varies considerably among years. As well, not all species will occur at all low-water years (Reznicek, this issue; Sutter & Kral, this issue). The methodology used in this paper to evaluate lake significance for coastal plain plant conservation makes use of both field survey results and historical species records.

Numerous threats to coastal plain plant assemblages were identified during the field survey, including shoreline development (cottages, marinas, docks), shoreline alterations (dredging, infilling), swimming beach creation and maintenance ('weed' clearing, raking, lawns), excessive power boat use, shoreline recreation (camping, trampling by fishermen, all-terrain vehicle use) and water level stabilization (for developing fish habitat, maintaining navigable waterways). The first poses the greatest threat. The degree of threat varied depending upon accessibility. Impacts resulting from these threats were recurrent throughout the study area and have no doubt been responsible for the demise of many coastal plain assemblage remnants. Priority for protection was increased where threats were high, provided a significant portion of the shoreline still remained undisturbed (e.g. Wahwashkesh). Priority for Kahshe, although under high threat, was reduced because the extent and quality of the remaining habitat was diminished by existing development.

Only three of the 12 most significant lakes currently has some form of protection (Axe, Matchedash, Hardy). A variety of options for protecting other sites identified on the most significant 12 lakes was examined including acquisition, nature reserve designation (crown land), area of natural and scientific interest (ANSI) designation and landowner agreements (Hilts *et al.*, 1986). A landowner contact program and the use of landowner agreements was considered an essential component for site protection.

Protection does not stop at site evaluation and designation but must be supported by a management program. Management of lakes for coastal plain plant assemblage protection has to address not only details pertaining to specific sites, but whole lake management. Management recommendations for all lakes stressed the need to maintain natural water level fluctuations (Keddy & Reznicek, 1982; Nicholson & Keddy, 1983; Sharp & Keddy, 1985) and prohibit stabilization for recreational purposes (Keddy & Sharp, 1989).

CONCLUSION

The methods presented give managers an easy, consistent tool for evaluating sites and establishing priorities for protection. They also provide a framework for documenting the decision-making process that often becomes important historical background information for hearings and planning. To be effective in protecting coastal plain plant assemblages, the results of this assessment must be followed by conservation action involving the preparation and implementation of management plans for specific sites as well as entire lakes. We hope to see similar approaches used elsewhere.

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