A SUMMARY OF BIOGEOGRAPHICAL DATA OF AQUATIC PLANTS OF THE ADIRONDACK REGION

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I. Introduction

The study of islands and their related biogeography was instrumental in the development of ecological and evolutionary theory. Once the theoretical framework was established by MacArthur and Wilson (1967) it was quickly realized that any geographical unit has an insular nature. Lakes have been modelled as islands, but researchers have primarily focussed on fish (Tonn and Magnuson, 1982) or invertebrates (Browne, 1981).

The effects of acid deposition on freshwater ecosystems has been well established (Schindler, 1988). Furthermore, a relatively large number of aquatic plant surveys have documented altered community structures in acidified lakes (Roberts, *et al.*, 1985; Jackson and Charles, 1988; Yan, *et al.*, 1985; Catling, *et al.*, 1986). While these authors clearly hinted at the idea that acidified lakes contain fewer species, there was no statistical trend correlating lake pH and species richness/diversity. The lack of correlation is likely due to the pronounced effects of lake area on species richness; therefore, I have undertaken a biogeographical investigation of the species-area relationships in lakes of various pH.

II. Methods

A. Sources of data

For the purposes of modelling the aquatic plant species-area relationships of lakes, I collected published data, internally-published data (within the Rensselaer Fresh Water Institute or New York State Department of Environmental Conservation), and internal (to RFWI) unpublished survey data. The data was screened for compliance to the following criteria:

1. Falls within the Adirondack Region
2. Species richness is greater than one
3. Sample sites adequately covered the entire lake area.

The final criterion only applied to RFWI data of a small number of larger lakes, where complete macrophyte surveys were not attempted.

B. Measures of isolation and connectedness

According to island biogeography theory, the equilibrium number of species on an island is based on the overall extinction rate on an island and the immigration rate to that island. Extinction rates are primarily a function of island area. Immigration rates are primarily due to the distance of the island to the source of species on the mainland.

Measurements of lake isolation are not as simple as for oceanic island isolation. Because there is no mainland source of species, lake connectedness is often used as a reciprocal measure of lake isolation. Lake watershed area and the inclusion of the downstream lake watershed area have been used as connectedness measures that amplify the differences between seepage lakes without running outlets and drainage lakes that are in close proximity to large lakes with diverse habitats (Tonn and Magnuson, 1982). Watershed areas were determined using a Leitz model 3651-30 planimeter and USGS topographic maps; the mean of three measurements was used.

Other measures include the distances to the nearest lake(s), measured both aerially and downstream, along the connecting watercourses, and the distances, both aerially and via watercouses to the nearest larger lake(s), (larger lakes probably have a richer community so that the probability that an immigrant species already inhabits the lake of study is lessened). As a measure of average isolation incorporating more than one other lake, the sum of the aerial distances to the nearest three lakes was used. All distances were determined using a Silva type 40 map measurer; the mean of five measurements was used.

III. Results

Fifty-two lakes met the aforementioned criteria, and the data is presented in Table 1. The value ranges are:

	min.	max.
pH	4.4	8.0
Richness	2	48
Area (ha)	0.1	11400

Lake isolation measures are presented in Table 2.

Table 1. Species-area raw data for selected Adirondack lakes with richness >1.

name	source	pH	R	Area(ha)
Eagle	1	8	28	170
Copperas (Fish Cr.)	3	7.8	23	9.2
Huntley	3	7.8	14	15.7
Little Pine	3	7.7	8	2.1
Dunk	3	7.5	10	6.8
Luzerne	2	7.5	27	40
Trout	5	7.4	31	100
Little Shallow	3	7.3	13	2.2
George	7	7.2	48	11400
Giant's Washbowl	3	7.2	8	1.7
Gull	3	7.2	5	5.2
Connery	4	7.1	14	32.8
Pine	3	7	7	18.1
Round	3	7	9	9.1
Loon	7	6.9	29	244
Parch	3	6.9	14	5.6
Deer (2)	6	6.9	29	36.3
Rock	3	6.8	10	10.8
Deer (1)	6	6.6	12	18.1
Frank	3	6.6	12	10.3
Heart	3	6.6	12	11.2
Crane Mtn.	3	6.5	7	5.6
East	6	6.4	13	23.3
Alford	4	6.4	9	13.8
Woods (1989)	-	6.2	20	25.9
Rat	4	6.2	7	11.7
Green	3	6.2	7	7.9
Beaver	4	6	16	55
Stony	6	6	17	31.1
Cowhorn	3	6	9	8.5
Squaw	4	5.8	7	36.4
Goose	4	5.7	12	6.9
Livingston	3	5.5	8	0.8
Twitchell	7	5.5	6	54
Bog	3	5.4	7	0.8
Nicks	3	5.2	9	5.5
South	6	5.1	8	10.4
Cat Mtn.	3	5.1	8	8.4
Elk Pass Bog	3	5.1	4	0.1
Elk Pass West	3	5.1	4	0.3
Bear	3	5	8	22.6
Upper Wallface	3	5	10	5.5
Woods (1981)	6	4.9	16	25.9
High	4	4.9	6	15.8
Oswego	4	4.9	7	3.2

Table 1, continued.

name	source	pH	R	Area(ha)
Lost	4	4.8	4	2.4
Silver	6	4.8	10	23.3
Arnold	3	4.8	8	0.4
Tear of the Clouds	3	4.6	3	0.3
Indian	4	4.5	10	33.1
Shallow	6	4.4	10	5.2
Lyon	6	4.4	10	33.7
Federation	4	4.4	2	2.02

key to sources:

1 Eichler and Madsen, (1990a)
2 Eichler and Madsen, (1990b)
3 Jackson and Charles, (1988)
4 Lyons-Swift, *et al.*, (1989)
5 Madsen, pers. comm.
6 Roberts, *et al.*, (1985)
7 Taggett, (1989)

Table 2. Raw measures of lake isolation and connectedness for selected Adirondack lakes.

name	wsa km²	wsad km²	dd km	ddLL km	ad1 km	ad3 km	adLL km
Eagle							
Copperas (Fish Cr.)	0.42	73.97	0.04	0.04	0.04	0.41	0.04
Huntley	2.52	x	x	x	0.82	3.49	0.82
Little Pine	1.07	2.2	5.4	5.4	0.21	2.01	0.21
Dunk	1.51	x	x	x	1.09	3.58	1.84
Luzerne							
Trout	8.15	662.14	3.04	3.04	2.1	8.68	2.1
Little Shallow	1.13	1.47	0.43	0.43	0.1	0.6	0.2
George							
Giant's Washbowl	0.47	x	x	x	0.54	6.87	0.54
Gull	0.81	x	x	x	0.34	2.5	2.13
Connery							
Pine	0.82	1.07	0.21	5.45	0.21	1.4	0.65
Round	1.51	1.71	0.11	x	0.11	1.76	5.34
Loon	23.4	40.53	2.6	x	1.58	4.86	3.99
Parch	0.86	0.86	x	x	0.48	2.39	1.26
Deer (2)	1.51	95.91	8.9	11.28	0.63	4.43	0.63
Rock	0.96	5.58	0.39	5	0.16	1.48	2.32
Woods (1989)							
Deer (1)	5.09	59.88	1.47	1.47	0.44	2.4	1.32
Frank	0.93	x	0.98	0.98	0.15	1.74	0.15
Heart	0.59	x	x	x	2.8	10.75	6.2
Crane Mtn.	0.94	2.76	2.17	x	0.72	6.97	2.43
East	2.29	12.37	0.5	0.5	0.37	2.71	0.37
Alford	0.93	38.06	7.9	11.75	1.54	9.04	4.78
Rat	0.68	x	x	x	0.51	1.82	0.51
Green	0.85	x	x	x	0.15	0.65	0.15
Beaver	7.42	x	x	x	0.98	5.01	5.86
Stony	1.48	x	x	x	0.24	2.69	7.05
Cowhorn	1.60	x	2.18	x	0.51	2.25	2.18
Squaw	2.78	7.42	1.5	1.5	0.98	2.97	0.98
Goose	1.22	100.18	1.3	1.3	0.46	2	0.46
Livingston	0.14	21.91	0.17	0.17	0.17	1.99	0.17
Twitchell	5.82	11.82	1.41	10.85	0.14	2.26	2.02
Bog	0.04	x	x	x	0.26	1.01	0.26
Nicks							
South	0.73	3	1.58	4.32	0.15	2.06	0.95
Cat Mtn.	0.94	x	x	x	0.29	1.37	0.29
Elk Pass Bog	0.05	x	x	x	0.025	1.13	0.025
Elk Pass West	0.04	x	x	x	0.025	1.07	1.02
Bear	1.17	x	x	x	0.04	0.35	0.26
Upper Wallface	0.61	1.48	0.08	6.4	0.08	0.57	3.0
Woods	2	2.86	1.3	5.1	0.87	4.25	2.04
High	1.12	4.41	1.41	x	0.17	1.13	0.17
Oswego	1.94	5.82	0.91	0.91	0.85	2.73	0.85

Table 2, continued.

name	wsa km²	wsad km²	dd km	ddLL km	ad1 km	ad3 km	adLL km
Lost	0.47	x	x	x	0.48	2.89	0.48
Silver	1.54	11.82	1.12	1.99	0.36	1.67	0.85
Arnold	0.16	11.43	4	4	1.63	7.68	1.6
Tear of the Cluds	0.45	21.91	4.8	4.8	1.3	7.8	1.3
Indian	8.14	x	x	x	0.91	4.56	2.43
Shallow	4.93	480.32	0.95	0.95	0.28	1.35	0.28
Lyon	1.7	4.93	0.91	0.91	0.43	1.28	0.84
Federation	0.12	x	x	x	0.12	0.68	0.12

key

wsa - watershed area
wsad - watershed area of downstream lake
dd - distance along watercourse to nearest lake
ddLL - distance along watercourse to nearest larger lake
ad1 - aerial distance to nearest lake
ad3 - sum of aerial distances to nearest three lakes
adLL - aerial dstance to nearest larger lake
x - denotes no downstream lake; downstream watershed area is equivalent to watershed area, and downstream distances are taken to be infinite.

Missing data is due to a lack of adequate maps.

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