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Distribution of Aquatic Plants in Keokuk Pool (Navigation Pool 19) of the Upper Mississippi River

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Submersed and emergent plants were studied on the lower 42 km of Keokuk Pool (Navigation Pool 19), Upper Mississippi River in 1977. Aquatic plants occurred on a total of 1340 ha. These plants varied in coverage but when aggregated totaled 567 ha, the remainder of the 1340 ha being open water interspersion areas. Submersed species composed 55% of the aquatic plants and emergent species totaled 45%. Dominant submersed species were *Heteranthera dubia, Potamogeton pectinatus, Ceratophyllum demersum* and *Vallisneria americana*. The emergent species documented were *Nelumbo lutea* and *Sagittaria* sp. Five major areas of aquatic plant development occurred in the study area, comprising 79.8% of the total aquatic plant area. The areal coverage of aquatic plants in Keokuk Pool increased in 1977, relative to earlier years, presumably because of increased water stability and clarity.
INDEX DESCRIPTORS: Upper Mississippi River, aquatic plants, Keokuk Pool, Navigation Pool 19, vascular flora.

The Upper Mississippi River has been extensively modified by man during the last century by increased sedimentation, dredging, and navigation structures. However, the greatest alteration occurred in the 1930's when a series of 28 locks and dams were constructed to enhance commercial navigation by providing a 2.7 m deep channel. Since that time, there has been a change in the plant communities within the various navigation pools (Green 1970, Olson and Meyer 1976).

Keokuk Pool (Navigation Pool 19) of the Upper Mississippi River, is an important concentration area for migrating waterfowl, especially diving ducks (Rogers and Korschgen 1966). As a result of the decline in waterfowl food resources of the Illinois River valley (Mills et al. 1966), Keokuk Pool's role as a feeding and resting area for diving ducks has increased dramatically. One important species, the canvasback (*Aythya valisneria*), prefers a diet composed of seeds, root stocks, tubers, and winterbuds of aquatic plants (Perry 1982). Aquatic vegetation has been present in shallow backwater areas in Keokuk Pool for a number of years (Hagen et al. 1977, Thompson 1973). The objectives of this study were to document aquatic plant abundance in Keokuk Pool in 1977, compare aquatic plant production with published data for previous years, and determine potential causitive factors for any differences.

STUDY AREA

Keokuk Pool is a 75 km (46.3-mile) stretch of the Upper Mississippi River between southeastern Iowa and western Illinois. The pool was created in 1913 when a hydroelectric dam was constructed at Keokuk, Iowa. Keokuk Pool is the oldest impoundment on the river and the dam the highest at 11.6 m. Our study was restricted to the lower 42 km of the pool between Dallas City, Illinois (river mile 391.0), and Keokuk, Iowa (river mile 364.3). This portion of the pool is lake-like with few islands and backwater areas in comparison with upper reaches. Extensive sedimentation has occurred throughout the pool, but particularly just above the dam. The sediments support an abundant benthic fauna and, to a lesser extent, emergent and submersed aquatic vegetation.

METHODS

The distribution and abundance of aquatic vegetation in the study area was determined in September 1977 by field surveys and 35 mm aerial photography. Size of aquatic plant beds, species composition, and percent plant coverage of surface area were determined along transects. The number and length of transects were determined by size of the bed. Areas of vegetative cover were drawn on aerial photographs scaled at 1 inch equals 500 feet. Photographs are maintained at the Illinois Natural History Survey, Havana, Illinois. Area was calculated using a compensating polar planimeter. Percent coverage of each plant species in an area was estimated. Area occupied by vegetation was determined by multiplying the percent coverage by hectares of each sub-area. For example, if a 100-ha area had a coverage of 20% *Potamogeton pectinatus*, the area computed for this species would be 20 ha. Coverage classes were grouped into 0-30%, 31-79%, and ≥ 80% categories to compare the aquatic plant coverage in each area. Botanical names follow Fasset [1940] (1975).

RESULTS AND DISCUSSION

The following results are presented in geographical order beginning at the downstream portion of Keokuk Pool and continuing upstream. The southernmost and second largest aquatic plant area was a 2.9-km long bed of vegetation extending from near the dam at Keokuk to Waggoner Creek (Figure 1). This area averaged over 0.40 km in width, and extended over 179.5 ha. Of this total area, 44.3% or 79.7 ha contained aquatic vegetation (Table 1). *Heteranthera dubia* was the most abundant plant comprising 94.7% of the vegetation (Table 2). *Vallisneria americana* was the second most abundant plant, followed by *Ceratophyllum demersum*. Several other plant species occurred more sparingly.

The next area upstream was the third largest and was located just south of the town of Nauvoo, Illinois. Total area of the bed was 137.7 ha. Of the 137.7 ha, 50% was covered with vegetation. *Nelumbo lutea* was the most prevalent emergent plant, followed by *Sagittaria* sp. *P. pectinatus* and *H. dubia* were the most abundant submersed aquatic plants. This area also contained 10.2 ha of moist-soil plants growing on an island 13.7 to 18.3 m offshore.

Aquatic plants at Devil's Creek extended from the south end of Ft. Madison to approximately 1.6 km south of the mouth of Devil's Creek. This area was the largest and covered 749.2 ha. Of this total, 222.5 ha or 29.7% were covered with vegetation. This represented

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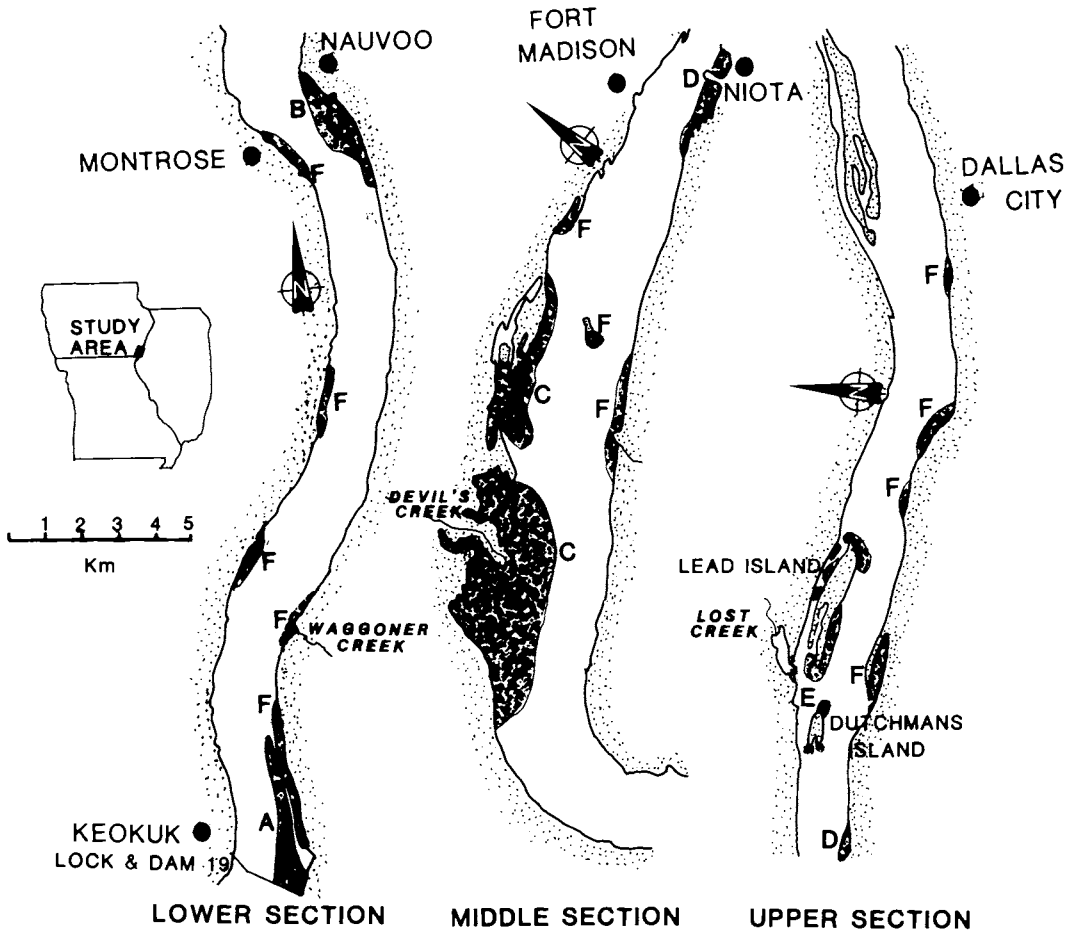

Fig. 1. Locations of study sites in the lower Keokuk navigation pool. Letters refer to locations identified in Tables 1 and 2.

39.3% of the total 566.8 ha of vegetation in the study area. *N. lutea* was the most abundant emergent plant followed by *Sagittaria* sp. Submersed aquatic plants represented 44.6% of the total 222.5 ha of vegetation. *H. dubia* and *P. pectinatus* comprised 90.7% of the submersed aquatic plants in this area.

At Niota, plants extended 1.3 km downstream from a small peninsula 0.3 km north of the Ft. Madison-Niota bridge. The 59.7 ha, of which 80% were covered with vegetation, supported luxuriant plant growth because 3 peninsulas reduced the current, resulting in lacustrine-type habitat immediately downstream. *N. lutea* and *Sagittaria* sp. covered 32.0 and 0.1 ha respectively, 67.3% of the total 47.7 ha of vegetation. *C. demersum* covered 6.3 ha, 40.1% of the total acreage of submersed aquatic plants. This area supported the greatest number of submersed aquatic plant species (10) of all study sites.

The Dutchman and Lead Islands area, the smallest and farthest upstream of the 5 areas, was located at the mouth of Lost Creek 1.1 km north of Ft. Madison (Figure 1). Area of the bed was 49.7 ha, of which 33.4 ha were covered with aquatic plants. Plant coverage in this area was the highest of the 5 major sites inventoried with almost 80% of the plants surveyed in the highest coverage class (Table 1). *N. lutea* covered 13.9 ha and *Sagittaria* sp. 5.3 ha, totalling 57.5% for the total 33.4 ha. *H. dubia* and *P. pectinatus* comprised 78.2% of the total 14.2 ha of submersed aquatic plants.

In addition to the aforementioned plant beds, smaller areas of aquatic vegetation were found adjacent to the shore. The larger of these are delineated in Figure 1. However, these beds were too numerous to mention separately, but when combined totaled 164.2 ha, 70% covered with vegetation. Emergent aquatic plants (24.0 ha of *N. lutea,* 19.4 ha of *Sagittaria* sp.) made up 37.9% of the area covered with vegetation. Ten species of submersed aquatic plants occurred in the shore areas, with *H. dubia* predominating.

Consultations with Frank Bellrose and George Arthur, in conjunction with limited published data on submersed aquatic plants in Keokuk Pool (Hagen et al. 1977), suggested that aquatic plant beds were unusually extensive in 1977. Our 1977 measurements of plant area coverage indicated a substantial increase in submersed plants when compared to similar information for the same portion of the river collected in 1975 by Hagen et al. (1977). Submersed and emergent plants covered 1340 ha in 1977 and 794 ha in 1975. In 1977, submersed plants covered 1075 ha and emergent plants covered 265 ha of the total plant bed area. In 1975, submersed plants covered 486 ha and emergent plants 307 ha of the total plant bed area.

Following construction of the dam at Keokuk in 1913, extensive sedimentation occurred, particularly in the lower portions of the pool (Gale 1969). Outside of the navigation channel, sedimentation filled deep-water areas, creating shallower water depths more conducive to aquatic plant growth. Water depths measured within the vegetation bed (Area A) from the dam north to Waggoner Creek averaged 1.13

Table 1. Area (ha) and coverage class of aquatic plants in the lower portion of Keokuk Pool, September 1977.

Site	Total Area (ha)	Area (ha) by % Coverage Class			Percent of Total Area Containing Aquatic Vegetation
		0-30%	31-79%	80-100%	
Keokuk Dam (A)	179.5	110.7	0	68.8	44.4
Nauvoo Point (B)	137.7	65.5	16.5	55.7	50.3
Devil's Creek (C)	749.2	487.8	127.9	133.5	29.7
Niota (D)	59.7	8.0	14.2	37.5	79.9
Dutchman and Lead Island (E)	49.7	0	10.5	39.2	67.2
Combined Shore (F)	164.2	10.7	95.6	57.9	69.7
TOTAL	1,340.0	682.7	264.7	392.6	42.3

Table 2. Species composition and area (ha) of aquatic plants in the lower portion of Keokuk Pool.

Scientific Name	Common Name	Keokuk Dam (A)	Nauvoo Point (B)	Devil's Creek (C)	Niota (D)	Dutchman and Lead Island (E)	Combined Shore (F)	Total
Submersed species								
Heteranthera dubia	Waterstar Grass	75.4	9.3	47.7	3.9	5.2	54.2	195.7
Vallisneria americana	American Wildcelery	4.2	1.5	4.0	0.2	T	4.4	14.3
Ceratophyllum demersum	Coontail	0.1	1.6	2.6	6.3	0.6	6.6	17.8
Potamogeton pectinatus	Sago Pondweed	T[a]	11.1	42.4	0.5	5.9	4.9	64.8
Potamogeton foliosus	Leafy Pondweed	T	T	1.2	0.6	—	0.5	2.3
Potamogeton nodosus	Longleaf Pondweed	T	—	0.1	1.4	—	T	1.5
Potamogeton crispus	Curlyleaf Pondweed	T	T	—	0.6	—	T	0.6
Najas guadalupensis	Bushy Pondweed	T	5.1	1.3	0.5	T	0.1	7.0
Najas gracillima	Brittle Naiad	T	4.1	—	1.0	0.2	0.2	5.5
Anacharis sp.	Waterweed	—	—	—	0.7	2.3	0.1	3.1
Subtotal		79.7	32.7	99.3	15.7	14.2	71.0	312.6
Emergent species								
Nelumbo lutea	American Lotus	—	30.1	95.1	32.0	13.9	24.0	195.1
Sagittaria sp.	Duck Potato	—	6.5	28.1	T[a]	5.3	19.4	59.3
Subtotal		—	36.6	123.2	32.0	19.2	43.4	254.4
TOTAL for each area		79.7	69.3	222.5	47.7	33.4	114.4	567.0

[a]Trace is less than 0.04 ha

± 0.20 (SD) m.

We believe the main factor responsible for the increased area of submersed aquatic plants was the extremely low and stable water levels of Keokuk Pool during spring and summer 1977. The average difference between high and low water levels for 1973 through 1976 for the April through August growing season at Burlington, Iowa was 3.2 m, whereas in 1977 the difference was only 0.3 m (U.S. Dept. of Commerce, NOAA, unpubl.). Reduced precipitation during 1977 presumably resulted in reduced tributary sediment entering the Mississippi. Increase in water clarity was documented by Sparks (1980) who recorded Secchi disk readings of 80 cm in 1977 compared to 21 cm in 1975 and 40 cm in 1976. Both 1975 and 1976 were years of above normal rainfall and higher river levels. Stable water levels and clear water have been noted as important requirements for aquatic plants by several researchers (Martin and Uhler 1939, Chamberlain 1948, Jackson and Starrett 1959, Kadlec and Wentz 1974, Bellrose et al. 1977).

SUMMARY

Greater stability and increased clarity of the Mississippi River appears to have resulted in expanded areas of aquatic plants from Keokuk, Iowa, to Dallas City, Illinois, during spring and summer 1977. Aquatic plants occurred on 1340.0 ha. Of this total, 567.0 ha were covered with vegetation, the remainder was open water. Five major areas of aquatic plant development totaled 79.8% of the 567.0 ha. Emergent vegetation composed 44.9% or 254.4 ha of this total.

The remaining 55.1% or 312.6 ha consisted of submersed aquatic plants, of which 62.6% was *H. dubia*.

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