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DECLINE OF WILDCELERY BUDS IN THE LOWER DETROIT RIVER, 1950–85

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Abstract: American wildcelery buds (*Vallisneria americana*), an abundant food eaten by diving ducks (Aythini) during migrations, decreased in the lower Detroit River of the Great Lakes from 1950 to 1985. Bud densities decreased at 2 (−14 and −18 buds/m²) of 5 locations and were similar at 3 (−2, +2, and +3 buds/m²) of 5 locations. Net change in all 5 areas combined, however, was a decrease of 36,720,000 buds, a 72% decline. Estimated potential losses of waterfowl feeding days caused by the decreased bud densities were 147,000 for canvasbacks (*Aythya valisineria*), 241,000 for redhead ducks (*A. americana*), or 664,000 for lesser scaup (*A. affinis*). Thus, the decline of wildcelery in the Detroit River may have contributed to decreased use of Michigan migration routes by some waterfowl species between 1950 and 1985.

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American wildcelery is a valuable waterfowl food throughout many areas of the United States (Cottam 1939, Martin and Uhler 1951). Although waterfowl use of this plant recently has decreased in some areas (Perry and Uhler 1982), winterbuds of wildcelery are among the most important foods of many diving ducks, and wildcelery beds are an indicator of good feeding areas for waterfowl in the lower Detroit River (Miller 1943, Jones 1982).

Hunt (1957) and Schloesser and Manny (1982) have indicated that wildcelery is the most frequently found submersed macrophyte in the lower Detroit River. However, these studies indicate that the relative frequency of occurrence of wildcelery plants during fall decreased from 78% in 1954 to 58% in 1978. This decrease in vegetation in fall may also have decreased the density of buds available to diving ducks that feed in the Detroit River system during fall, winter, and spring (Jaworski and Raphael 1978, Jones 1982). We determined the densities of wildcelery buds in spring at 5 locations of the lower Detroit River frequented by migrating waterfowl in 1984–85 and compared them with the spring densities reported in 1950–51 (Hunt 1957).

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METHODS

Sediments containing winter buds of American wildcelery were collected at Ballard, Sugar Island, Humbug, North, and Swan Island bars in the lower Detroit River from 7–10 May, 1984 and 1985 (Fig. 1). Samples were collected in spring to be directly comparable with Hunt's (1957:45–46) previous study. Sampling locations were based on descriptions and depth contours of areas in shallow water where waterfowl were observed feeding in 1950–51 and 1984–85. Mean monthly water elevation for the lower Detroit River was 174.2 m in May 1950 and 174.5 m

in May 1984 at Fater's Point, Quebec. Water depth ranges sampled in 1950–51 were 0.9–2.1 m at Ballard Bar, 0.9–2.1 m at Sugar Island Bar, 0.9–1.8 m at Humbug Bar, 0.9–2.4 m at North Bar, and 0.9–2.4 m at Swan Island Bar (Hunt 1957).

In 1984 and in 1985 we collected 20 samples along 5 evenly-spaced, east-west transects in each of the 5 sampling areas (n = 200). All samples were collected with a Peterson grab (area = 0.07 m^2) to ensure consistency with Hunt's (1957) studies in 1950–51. One sample was collected along each of the 5 transects at depth contours of 1.0, 1.5, 2.1, and 2.8 m, except when rocks prevented sampling. The size of the areas sampled, determined by electronic planimetry (Brown and Manny 1985), at each location was 1.7 km^2 at Ballard Bar, 0.8 km^2 at Sugar Island Bar, 0.2 km^2 at Humbug Bar, 0.2 km^2 at North Bar, and 0.2 km^2 at Swan Island Bar.

Submersed macrophytes were separated from sediment residue over a 3-mm sieve, identified, and then quantified visually according to Schloesser and Manny (1984). Wildcelery buds were cooled to 10 C, taken to the laboratory, and separated into whole buds and bud parts. Because Hunt (1957) counted only whole buds, bud parts in a sample were counted as whole buds when basal stolon and turions matched. Mean volume per bud, as measured by water displacement (nearest mL), was determined for 653 and 58 buds in 1950–51 and 1984–85, respectively. The arithmetic mean of whole buds/m^2 of substrate was based on the total number of samples collected from each area, each sampling year.

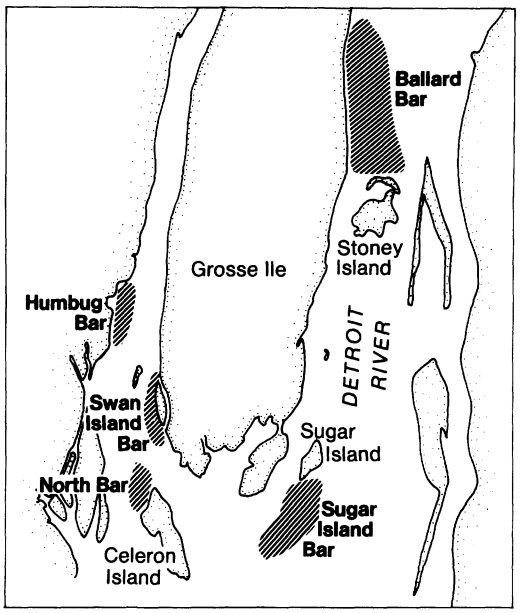

Fig. 1. Five sampling locations (hatched areas) in the lower Detroit River where winter buds of wildcelery were collected in May 1950–51 and 1984–85.

RESULTS

Densities of American wildcelery buds were substantially lower at 2 locations, slightly lower at 1 location, and slightly higher at 2 locations in 1984–85 compared to 1950–51 (Table 1). Overall the total net change in the 5 areas combined was a decrease of 36,720,000 buds from 1950–51 to 1984–85 (Table 2). Although the largest change in the number of buds/m^2 was at the Sugar Island Bar ($-18/m^2$), the largest net change in buds per area (-24.03×10^6) was at Ballard Bar. The total net decrease of 36,720,000 buds at 5 locations is equivalent to 11,540,000 mL of buds.

In addition to American wildcelery winter buds found in 35 of 200 samples, we found waterstar mud plantain (*Heteranthera dubia*) in 13, curlyleaf pondweed (*Potamogeton crispus*) in 5, Richardson pondweed (*P. richardsonii*) in 5, Canadian waterweed (*Elodea canadensis*) in 2, and narrow-leaf pondweed (*Potamogeton* spp.) in 1 of 200 samples. Field observations of the relative abundance of plants indicated that wildcelery was the second most abundant species. Waterstar mud plantain, consisting of decaying vegetation from the previous growing season that passed through the sieve, was the most abundant taxon. The 4 other infrequently-found taxa consisted of relatively little decaying vegetative material.

DISCUSSION

The declines of wildcelery buds documented in our study represent residual buds not eaten by migrating or overwintering diving ducks. Therefore, estimates of actual declines probably are low because more grazing of wildcelery buds by ducks would have occurred in 1950–51, when more divers migrated over Michigan, than in 1984–85 (Hunt 1957, Martz et al. 1976). Fall and early winter numbers of canvasbacks in the Detroit River have declined steadily from more

Table 1. Mean number (N/m^2) of winter buds of American wildcelery at 5 locations in the lower Detroit River in May 1950–51 (Hunt 1957; no SE available) and May 1984–85 (our study).

Location	Yr 1950	Yr 1951	Yr 1950–51	Yr 1984 $\bar{x}$	Yr 1984 SE	Yr 1985 $\bar{x}$	Yr 1985 SE	Yr 1984–1985 $\bar{x}$	Yr 1984–1985 SE	Net change 1950–51 to 1984–85
Ballard Bar	19	18	19	5	3.4	5	2.3	5	2.0	−14
Sugar Island Bar	12	32	23	7	4.3	3	2.1	5	2.4	−18
Humbug Bar	2	2	2		0		0		0	−2
North Bar	2	ns[a]	2	4	2.2	5	2.3	4	1.6	+2
Swan Island Bar	2	ns	2	5	2.5	5	2.7	5	1.8	+3

[a] ns = not sampled.

than 200,000 in the mid–late 1950's when aerial survey counts began in a systematic manner, to between 9 and 2,900 from 1976–85. Unless ducks stayed longer on the river in the 1980's, when wildcelery densities were low, than in the early 1950's, when bud densities were high, the bud decreases reported here are underestimated.

Causes for declines in abundance of buds at the locations sampled are unknown. Hunt (1963) could find no relationship between the degree of water and sediment pollution and the distribution and abundance of wildcelery in the early 1950's. However, other studies suggested that pollution, siltation, eutrophication, and feeding by rough fishes cause declines in abundance of submersed macrophytes such as wildcelery (Perry 1974, Trauger and Serie 1974, Davis 1985).

Oil is toxic to freshwater marsh vegetation, particularly wildcelery (Moffitt and Orr 1938, Burk 1977), and no buds were found in any of our samples that contained oil (n = 14 at Humbug Bar, n = 4 at Swan Island, n = 3 at North Bar, and n = 2 each at Ballard and Sugar Island bars). Large amounts of waste oil were spilled in the Detroit River, resulting in the deaths of up to 12,000 ducks per year (Hunt 1957). Indeed, in the 1940's, the Trenton Channel of the lower Detroit River was characterized as "the sewer for metropolitan Detroit" owing to the large amount of effluent added to this stretch of the river by the Detroit sewage treatment plant and numerous industries (ENCOTEC 1974:12). By 1980, however, the discharge of oil into the Detroit River had decreased by 82%, and ducks were no longer being killed by oil discharges (Mich. Dep. Nat. Resour. 1982).

Much of the Detroit River area had already been exposed to industrial pollution before the 1950–51 survey by Hunt (1957), and no earlier records of bud densities are available. However, bud densities of 100–200/m^2 have been reported from optimum, unpolluted habitats in the upper Mississippi River (Donnermeyer and Smart 1985, Korschgen et al. 1988). The low bud densities (2–23/m^2) reported by Hunt (1957) indicate that historical pollution of the Detroit River probably affected wildcelery before the early 1950's. The Detroit River was polluted badly with sewage by 1913 (ENCOTEC 1974:10) and with industrial pollution in 1946 (Hunt 1957).

Densities of buds increased in 2 of 3 locations

Table 2. Calculated number of winter buds of American wildcelery ($\times 10^6$) at 5 locations in the lower Detroit River in May 1950–51 and May 1984–85.

Location	Area (km^2)	1950–51	1984–85	Net change 1950–51 to 1984–85	Net change in volume of winter buds[a] (mL) 1950–51 to 1984–85
Ballard Bar	1.717	32.62	8.59	−24.03	−7.58
Sugar Island Bar	0.745	17.14	3.73	−13.41	−4.25
Humbug Bar	0.228	0.46	0	−0.46	−0.15
North Bar	0.237	0.47	0.95	+0.48	+0.18
Swan Island Bar	0.234	0.47	1.17	+0.70	+0.25
Totals	3.161	51.16	14.44	−36.72	−11.54

[a] In 1950–51, volume/bud = 0.323 mL, n = 653 (Hunt 1957) and in 1984–85, volume/bud = 0.345 mL, n = 58.

(North and Swan Island bars) along the Trenton Channel west of Grosse Ile. In 1957, Hunt (1957) recommended that plants and invertebrates in the Trenton Channel be protected from further pollution to provide food for overwintering and early spring migrating waterfowl. He predicted that if the cooperation of industry were secured, the abundance of plants and invertebrates would increase in the Trenton Channel. However, although densities of wildcelery buds have increased in 2 areas over the last 35 years, the increases have been small and have not equaled losses in 3 other areas (Table 2).

This overall decline in wildcelery is especially important because it is a better food for ducks than the other vegetation we found. For example, waterstar mud plantain, probably the most abundant submersed plant in the lower Detroit River in late fall and early spring, is not eaten by most waterfowl. The 4 other plant taxa we found are not abundant in fall or spring (Schloesser and Manny 1982, Schloesser et al. 1985), and therefore are probably not important food for migrating waterfowl. Perry and Uhler (1988) indicated that diets of canvasbacks in the Chesapeake Bay have changed dramatically, from primarily plants in the early 1900's to exotic benthic clams in the 1970's. Such a shift in the diets of diving ducks did not occur in the Detroit River and may be attributable to the lack of benthic animals caused by pollution (Jones 1982, Thornley and Hamdy 1984). However, if wildcelery declines further in the Detroit River, the diets of diving ducks may shift to exotic benthic clams such as the Asian (*Corbicula fluminea*) and zebra (*Dreissena polymorpha*) clams that now exist in the river system.

The quantity of food constituting a meal for a duck is highly variable and generally depends on the caloric content of the food eaten (Martin et al. 1951, Jordan 1953). However, some ducks such as canvasbacks may be unable to adjust intake rates to compensate for energy content of food (Perry et al. 1986). In the Detroit River, a mean daily meal (feeding twice a day) of wildcelery buds is 78.47 mL for a canvasback, 47.96 mL for a redhead, and 17.39 mL for a lesser scaup (Hunt 1957). Therefore, the net loss of 11,540,000 mL of winter buds from the 5 sampled areas represents potential losses of 147,000 waterfowl feeding days in the spring for canvasbacks, 241,000 feeding days for redhead ducks, or 664,000 feeding days for lesser scaup. These estimates represent maximum potential losses of waterfowl feeding days because other waterfowl foods are present in the lower Detroit River. However, many of these other potential foods are not preferred, are low in energy content, or are not abundant in the Detroit River (Jones 1982, Hiltunen and Manny 1982, Thornley and Hamdy 1984, Perry et al. 1986).

The low net density of wildcelery buds may have reduced migrating and overwintering populations of waterfowl in the Detroit River. Migration routes and numbers of overwintering ducks are believed to depend partly on foods available along the flyways (Perry and Uhler 1982, Serie et al. 1983). For example, up to 200,000 migrating canvasbacks stopped on the Detroit River enroute to Chesapeake Bay in the 1950's (Martz et al. 1976). However, by the mid-1970's, peak numbers of canvasbacks rarely exceeded 10,000 birds. The decline of preferred foods such as fennelleaf pondweed (*Potamogeton pectinatus*), wildcelery, and fingernail clams (Sphaeridae) has been cited as a possible cause for the disappearance of canvasbacks from formerly used areas (Trauger and Serie 1974, Perry et al. 1981). Extensive studies of canvasbacks in the upper midwest have shown that declining food supplies in portions of the Atlantic and Mississippi flyways caused a major portion of the canvasback population to abandon traditionally used wintering areas (Trauger and Serie 1974, Munro and Perry 1983, Serie et al. 1983).

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