Direct and indirect effects of floating vegetation mats on Texas wildrice (Zizania texana)
Author(s): Paula Power
Reviewed work(s):
Source: *The Southwestern Naturalist*, Vol. 41, No. 4 (Dec., 1996), pp. 462-464
Published by: Southwestern Association of Naturalists
Stable URL: http://www.jstor.org/stable/30055212

DIRECT AND INDIRECT EFFECTS OF FLOATING VEGETATION MATS ON TEXAS WILDRICE (*ZIZANIA TEXANA*)

PAULA POWER

Department of Biology, Southwest Texas State University
San Marcos, Texas 78666

Texas wildrice (*Zizania texana*) is a perennial emergent aquatic macrophyte in the family Poaceae. It has long, ribbonlike, submerged leaves and reproductive culms that arise from the base of the plant. Each culm has an emergent terminal inflorescence allowing for wind pollination. *Zizania texana* is endemic to the first 2.4 km of the San Marcos River and Spring Lake in Hays Co., Texas. It commonly occurs at mid-channel in relatively fast-flowing water (Silveus, 1933; Terrell et al., 1978).

Zizania texana is listed as endangered by both U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department (U.S. Fish and Wildlife Service, 1985). Factors that threaten survival of *Z. texana* include reduced spring flow from the San Marcos springs, reduced water quality in the San Marcos River, competition and predation by nonnative species such as *Hydrilla verticillata* and nutria (*Myocaster coypus*), failure to reproduce sexually, and alteration of sediments in the river bottom (Emery, 1967, 1977; U.S. Fish and Wildlife Service, 1994).

More recently, floating and submerged drifting aquatic vegetation have been identified as a potential threat to *Z. texana* plants. Aquatic vegetation, including *Cerataphyllum demersum, H. verticillata, Egeria densa,* is mowed in Spring Lake, the headwaters of the San Marcos River, and despite attempts at harvesting the cuttings, cut vegetation drifts downstream. Cut vegetation combines with drifting macrophyte fragments and tends to accumulate behind obstructions at or above the water surface. Obstructions occur in fast or slow flowing water and can be floating *Z. texana* leaves, emergent *Z. texana* culms, other floating vegetation, fallen tree limbs, trash, or debris. Entangled vegetation can form thick mats over *Z. texana* stands in as little as one week.

Direct negative effects of floating vegetation mats may include shredding of *Z. texana* leaves by serrated leaf margins of some macrophytes (e.g., *C. demersum*) and interference with reproductive culm emergence. Indirect negative effects include blocking sunlight, which interferes with photosynthesis, and slowing current velocity, which may reduce nutrient uptake from the open water (Smith and Walker, 1980; Boeger, 1992). The objective of this research was to quantify direct and indirect effects of vegetation mats on *Z. texana* stands.

An artificial obstruction on which drifting vegetation would become entangled was created with a 1-m long by 0.075-m diameter float constructed of polyvinyl chloride pipe. Floats were anchored to the river bottom perpendicular to the direction of flow, at the leading edge of four *Z. texana* stands in the San Marcos River in July 1995. Each *Z. texana* stand was composed of closely spaced, mature individuals. A control area was marked adjacent to each float. Sites were in areas where current was great enough to wash floating vegetation downstream in the absence of an obstruction. This eliminated the need to remove vegetation mats from control areas. Vegetation accumulated upstream and downstream from the float. Six measurements were recorded in each control and treatment area. The measurements were: water depth; current velocity (measured at 20, 60, and 80% depth with a Marsh-McBirney portable water current meter model 201); photosynthetically active radiation (PAR, measured immediately below the water surface with a Li-Cor light meter model LI-185B with a LI-1935B spherical quantum sensor); leaf length (calculated as the average length of 5 or 6 leaves); stem density (no. of reproductive culms + no. of submerged leaves/100 cm^2); and percent damaged leaves (calculated from 50 leaves inspected for shredding or other signs of mechanical damage). Measurements were taken at the leading edge of each stand in July and mid-August, 1995 (six weeks after construction and placement of floats).

Grab samples of vegetation mats were collected from two replicates at the end of the experimental period. Plant species were separated and identified, and percent species composition of each sample was determined.

TABLE 1—Environmental measurements and *Zizania texana* response (*SD* in parentheses) to vegetation mats. Data were recorded at the beginning of the experiment (initial) and six weeks after construction of floats that created vegetation mats (treatment); adjacent areas lack vegetation mats (control).

	Time of measurement			
	Initial		Six weeks	
Measurement	Control	Treatment	Control	Treatment
Water depth (m)	0.51a[1] (0.133)	0.57a (0.180)	0.52a (0.132)	0.47a (0.160)
Current velocity (m/s)	0.210a (0.059)	0.174a (0.095)	0.232a (0.099)	0.032b (0.009)
PAR (μE/s/m^2)	1800a (316)	1475a (709)	1530a (205)	77b (10)
Leaf length (m)	1.12a (0.278)	1.12a (0.288)	0.95a (0.131)	0.60b (0.100)
Stem density (/100 cm^2)	69.7a (20.0)	66.7a (12.4)	60.2a (12.1)	20.2b (6.40)
Percent damaged leaves	15a (0.007)	16a (0.003)	10a (0.002)	94b (0.034)

[1] Means for a measurement within a time period followed by the same letter are not significantly different ($P > 0.05$); $n = 4$.

Means from treatment and control areas at the beginning of the experiment and after six weeks were compared with a paired *t*-test (Snedecor and Cochran, 1980).

At time zero, there was no significant difference between control and treatment in any category measured (Table 1). After six weeks, current velocity, PAR, stem density, and leaf length were significantly less in the treatment areas compared with the control areas (Table 1). A higher percentage of leaves were damaged in treatment areas compared with control areas. In addition to being shredded, damaged leaves appeared to be paler green in color or achlorotic.

The upstream sample, composed primarily of *C. demersum,* a submerged macrophyte common in Spring Lake, was 0.35 m thick. The downstream sample was composed of vegetation common in the San Marcos River; *Potamogeton* sp. and *Sagittaria platyphylla* were the most abundant species (30% and 35%, respectively; Table 2). The downstream sample was 0.37 m thick.

Current velocity was significantly slower in treatment areas compared to control areas. Stationary objects, such as macrophytes, can reduce current velocities in flowing water (Gregg and Rose, 1982). Dense vegetation mats (occupying about 85% of the water column) obstructed water movement and slowed current velocity in treatment areas. In addition, stem density of plants in treatment areas declined during the study period while stem density of plants in control areas remained unchanged. A number of studies have found a positive relationship between flow and carbon uptake and photosynthetic rates (Smith and Walker, 1980; Madsen and Søndergaard, 1983). Flowing water may also provide mechanical stimulation of meristematic tissue resulting in increased stem density. The decline in stem density observed in this study

TABLE 2—Species composition (%) of vegetation mats sampled six weeks after construction of vegetation floats. Location 1 was downstream from confluence of Purgatory Creek and San Marcos River, adjacent to Centennial Park picnic area. Location 2 was in Sewell Park approximately 30 m downstream from Loop 82 Bridge.

	Composition (%)	
Species	Location 1	Location 2
Cabomba caroliniana	0	2
Cerataphyllum demersum	15	75
Ceratopteris thalictroides	0	1
Egeria densa	10	8
Eichhornia sp.	0	2
Hydrilla verticillata	10	7
Myriophyllum spicatum	0	2
Potamogeton sp.	30	1
Sagittaria platyphylla	35	0
Utricularia sp.	0	2

may be attributed, in part, to the negative effect of decreased current velocity.

Plants in treatment areas had significantly more damaged leaves than control areas. *Ceratophyllum demersum* and *H. verticellata* have serrated leaf margins and when in contact they shred *Z. texana* leaves. Damaged leaves most likely had lower photosynthetic rates than leaves in control areas due to leaf shredding and reduced PAR below mats.

Vegetation mats may also interfere with culm emergence and pollination, contributing to sexual reproductive failure. The effect of vegetation mats on reproduction requires further study.

Other direct mechanical damage to *Z. texana* by vegetation mats may include uprooting of plants. Although uprooting of plants was not observed in treatment areas, it is not uncommon to observe sediments eroding from the base of plants and eventually entire plants become uprooted. It is unknown whether uprooting of plants in the wild is due to disturbance of the sediments or caused by drag on plants from entangled vegetation fragments or some other factors.

Historic photographs of *Z. texana* and the San Marcos River (Silveus, 1933) suggest that vegetation mats are more common in the upstream site today than in the past. The increase in mats may be due to a change in species composition exhibiting a growth form more susceptible to fragmentation and drifting in Spring Lake and the San Marcos River. *Hydrilla verticellata,* a fast growing macrophyte, was introduced to Spring Lake and the San Marcos River, and *C. demersum,* a nonrooted submersed macrophyte, currently has a wider distribution in Spring Lake than historical records would indicate it had in the past (Watkins, 1930; Devall, 1940). In addition, mowing of Spring Lake, a practice initiated as early as the 1900's, releases thousands of kilograms of macrophyte fragments annually.

Finally, reduced flooding due to the construction of flood control dams in the San Marcos River watershed and the resulting absence of scouring of the river bottom, together with reduced spring flows due to over pumping of the Edwards Aquifer, may contribute to conditions in the San Marcos River that favor increased macrophyte growth and abundance, contributing to vegetation mats.

This project was supported by Section 6 grant from U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department. I would like to thank Dr. K. Kennedy, Mr. C. Wood for technical support, and Mr. R. Cobb, Parks and Recreation Department, City of San Marcos for his cooperation.

Literature Cited

BOEGER, R. T. 1992. The influence of substratum and water velocity on growth of *Ranunculus aquatilis* L. (Ranunculaceae). Aquatic Botany 42:351–359.

DEVALL, L. L. 1940. A comparative study of plant dominance in a spring-fed lake. Unpublished M.S. thesis, Southwest Texas State University, San Marcos, Texas.

EMERY, W. H. P. 1967. The decline and threatened extinction of Texas wildrice (*Zizania texana* Hitchc.). Southwestern Naturalist 12(2):203–204.

EMERY, W. H. P. 1977. Current status of Texas wildrice (*Zizania texana* Hitchc.). Southwestern Naturalist 22(3):393–394.

GREGG, W. W., AND F. L. ROSE. 1982. The effects of aquatic macrophytes on the stream microenvironment. Aquatic Botany 14:309–324.

MADSEN, T. V., AND M. SØNDERGAARD. 1983. The effects of current velocity on the photosynthesis of *Callitriche stagnalis* Scop. Aquatic Botany 15:187–193.

SILVEUS, W. A. 1933. Texas grasses, classification and description of grasses. The Clegg Co., San Antonio, Texas, 473–475 pp.

SMITH, F. A., AND N. A. WALKER. 1980. Photosynthesis by aquatic plants: Effects of unstirred layers in relation to assimilation of CO_2 and HCO_3^- and to carbon isotopic discrimination. New Phytologist 86:245–259.

SNEDECOR, G. W., AND W. G. COCHRAN. 1980. Statistical Methods. Eighth ed. Iowa St. Univ. Press, Ames, Iowa.

TERRELL, E. E., W. H. P. EMERY, AND H. E. BEATY. 1978. Observations on *Zizania texana* (Texas wildrice), an endangered species. Bulletin of the Torrey Botanical Club 105:50–57.

U. S. FISH AND WILDLIFE SERVICE. 1985. Endangered and threatened wildlife and plant taxa for listing as endangered or threatened species. Federal Register 5C (188):39526–39584.

U. S. FISH AND WILDLIFE SERVICE. 1994. Draft San Marcos/Comal (Revised) Recovery Plan. Albuquerque, New Mexico.

WATKINS, G. M. 1930. Vegetation of San Marcos Springs. Unpublished M.S. thesis, University of Texas at Austin.