Control of Waterhyacinth by Winter Drawdown

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Abstract: A winter drawdown was evaluated to control waterhyacinth (*Eichhornia crassipes*) in B. A. Steinhagen Reservoir in southeast Texas. A 1.8-m drop in water level was initiated on 15 December 1993 and maintained through 17 February 1994. Freezing temperatures were recorded on 19 days during the drawdown with the lowest temperature −6.7 C. A significant ($P < 0.0001$) reduction in waterhyacinth frequency of occurrence was indicated in line transects. Waterhyacinth areal coverage was reduced from 1,476 ha in June 1993 to 26 ha in June 1994.

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Waterhyacinth is a free-floating perennial aquatic plant which is native to the Brazilian Amazon region of South America (Penfound and Earle 1948). Waterhyacinth were first introduced into the United States at the 1884 New Orleans Cotton Exposition (Wunderlich 1962, Zeiger 1962). Waterhyacinth from this event eventually found their way into public waters. Within 10 years, boat traffic in many southeastern rivers and lakes was obstructed by mats of waterhyacinth (Wunderlich 1962). In the early 1900s, the plant was reported in Texas and is currently common in rivers and reservoirs of the Texas Coastal Plain and up to about 400 km inland.

Eliminating or controlling waterhyacinth has been a major problem. The plant population can double every 11–15 days through vegetative reproduction by stolons which grow beneath the water surface from rhizomes; 10 plants could effectively populate 0.40 ha within 1 growing season (Penfound and Earle 1948). This does not include reproduction from up to 112 million seeds produced by each ha of waterhyacinth (Zeiger 1962).

The tremendous reproductive ability and invasive characteristics of waterhyacinth have caused numerous problems in aquatic environments. Impeded navigation and access have been the biggest problems (Hitchcock et al. 1949, Zeiger 1962, Langeland 1987). Other problems include increased sedimentation and detrital accumulation (Brower 1980, Center and Spencer 1981, Joyce 1985), increases in disease vector organisms such as mosquitoes (Ingersoll 1964, McVea and Boyd 1975), decreased oxygen and increased carbon dioxide levels under dense mats (McVea and Boyd 1975, Schreiner 1980), excess evapotranspiration (Timmer and Weldon 1967, Van Der Weert and Kamerling 1974, Snyder and Boyd 1987), and degradation of fish and wildlife habitat (Langeland 1987, Cheater 1992). Of particular concern at B. A. Steinhagen Reservoir, Texas, was a deterioration of the aquatic habitat and a reduction in public access/use of the resource caused by waterhyacinth. By late summer 1993, 8 of 12 boat ramps on B. A. Steinhagen Reservoir were blocked. The most productive waterfowl hunting and sportfishing areas had become, for the most part, inaccessible.

Options available for the control of waterhyacinth include chemical, mechanical, biological, and environmental methods. In Texas, primary control has been achieved through the application of herbicides. However, water level manipulation is an accepted method to manage aquatic environments for fish and wildlife. It has been used to regulate predator-prey ratios in fish populations (Lantz et al. 1964, Heman and Campbell 1969, Wegener and Williams 1974), encourage production of desirable food plants for waterfowl (Singleton 1965), and retard the aging process in reservoirs by consolidating accumulated organic material (Thayer et al. 1988). Winter drawdowns have been successfully used to control overabundant submersed aquatic plants (Hestand and Carter 1975, Richardson 1975, Davis and Brinson 1980). This management technique utilizes both freezing and desiccation of exposed plants to effect control.

Distribution of waterhyacinth in the United States is restricted to warmer southern latitudes (Hitchcock et al. 1949). Thus, winter drawdowns to target waterhyacinth may not have been considered a viable management option. Since the range of waterhyacinth in the United States occurs primarily within the relatively flat coastal plains, a lack of drawdown capability also often exists.

The objective of this study was to evaluate the effectiveness of a single winter drawdown for controlling waterhyacinth in a southeast Texas reservoir with a substantial waterhyacinth infestation.

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Methods

B. A. Steinhagen Reservoir is a 6,811-ha impoundment on the Neches River in southeast Texas. It was constructed by the USAE in 1951 to provide water for municipal, industrial, and recreational purposes. The reservoir lies within the East Texas Timberland Land Resource Area. It is very shallow with

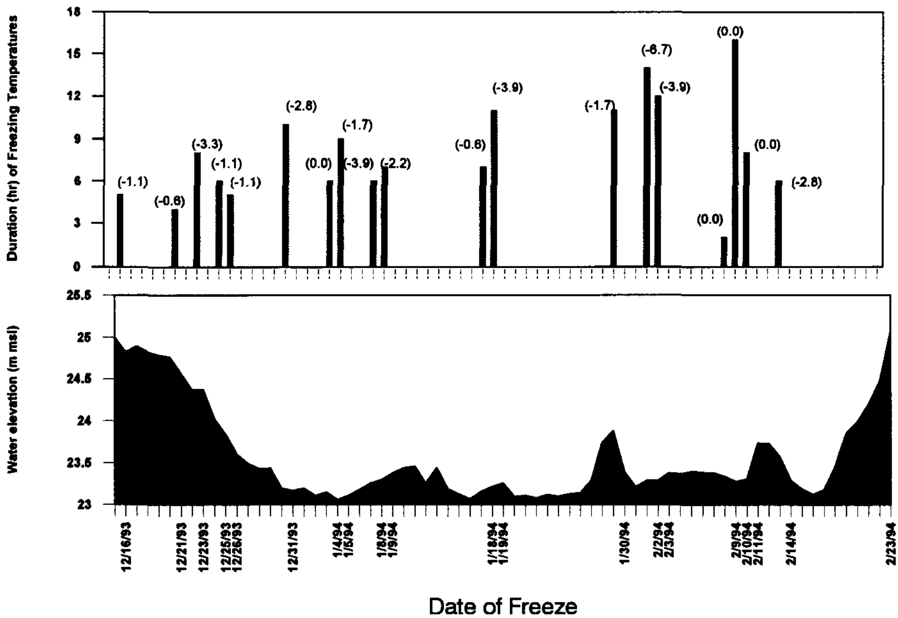

Figure 1. B. A. Steinhagen Reservoir, Texas, water elevation, date, and duration of freeze events, 15 December 1993 through 23 February 1994. Numbers in parentheses represent minimum air temperatures (C) during freeze events.

the littoral zone (water depth ≤4.6 m) accounting for approximately 95% of the area (Seidensticker and Parks 1993).

Drawdown of B. A. Steinhagen Reservoir from 25 m above mean sea level (msl) began on 15 December 1993. Reservoir elevation was lowered over a 16-day period (approximately 11.3 cm per day) until 23.2 m msl was attained on 31 December 1993. Water level was gradually lowered to minimize movement of waterhyacinth mats. This effectively stranded waterhyacinth on mud flats and around the shoreline. The entire plant, including the rhizome tip, was exposed as recommended by Penfound and Earle (1948). The reservoir elevation was held at approximately 23.2 m msl for 49 days (Fig. 1). Daily water elevations were obtained from the reservoir's USAE project office.

Waterhyacinth areal coverage in the reservoir was estimated in June 1990, 1993, and 1994 using comprehensive survey procedures described in Texas Parks and Wildlife Department (1989). Each year all areas containing waterhyacinth were plotted on a 7.5-minute series grid U.S. Geological Survey topographic map. Aerial photography using both 35-mm and VHS video cameras was used to help delineate areas containing waterhyacinth. Waterhyacinth coverage estimates were determined from the topographic maps by use of a digital planimeter.

Waterhyacinth frequency of occurrence was estimated using a variation of the line transect method described by Madsen and Bloomfield (1993). In November 1993, 6 50-m transect lines marked at 1-m intervals were established within waterhyacinth mats. Exact positions and compass bearings were recorded. Line intercept data were recorded within each 1-m sampling interval as "present" if a plant was beneath a stretched line or "not present" if not. The line transect procedures were repeated in April and November 1994. April transect data provided some assessment of the drawdown's immediate impact at the beginning of the growing season. It was considered that dormant seed germination and egress of waterhyacinth from areas unaffected by the drawdown (potholes and upstream areas) could influence waterhyacinth abundance. A substantial increase in dormant seed germination has been reported to occur following a drawdown (Richardson 1975). November pre- and post-drawdown line transect data were tested for homogeneity using Pearson's χ^2. Threshold statistical significance was set at $P = 0.05$.

Hourly air temperatures were recorded 15 December 1993 through 23 February 1994 with a PTC chart recording thermometer. The thermometer was located at the Texas Parks and Wildlife Department's Jasper Fish Hatchery, 6.4 km from the study area.

Results and Discussion

In June 1990, areal coverage of waterhyacinth was 748.3 ha. By June 1993, prior to drawdown, areal coverage of waterhyacinth was 1,476.0 ha; most of the upper end of the reservoir was a continuous mat of waterhyacinth (Fig. 2). This 97% increase in waterhyacinth occurred despite winter conditions similar to those experienced during the drawdown. No appreciable winter mortality was noted with water levels at or near normal. The 1993–94 winter was typical of the past winters according to data recorded by the Office of the Texas State Climatologist (K. Gleason, pers. commun.). In June 1994, after drawdown, areal coverage of the plant decreased 98% to 26.3 ha (Fig. 2).

In November 1993, prior to drawdown, waterhyacinth was present within all 300 transect intervals (Table 1). In April 1994, 2 months after drawdown, only 4 of the 300 transect intervals (1.33%) contained waterhyacinth. By November 1994, only 24 of the 300 transect intervals (9.33%) contained waterhyacinth. This represented a significant ($P \leq 0.0001$) reduction for all 6 transects (Table 1). The plants observed were seedlings arising from seed germination. Large, mature waterhyacinth were eliminated by the drawdown.

Air temperature was recorded at or below freezing on 19 days during the drawdown. Duration of freezing temperatures ranged from 2 to 16 hours (Fig. 1). Individual freeze events became increasingly more severe during the study period. The coldest temperature (−6.7 C) occurred on 2 February with subfreezing duration of 14 hours. Penfound and Earle (1948) studied the survivability of small waterhyacinth exposed to varying sub-freezing temperatures for various time intervals. In their experiment, plants placed in 7.6 cm of water were

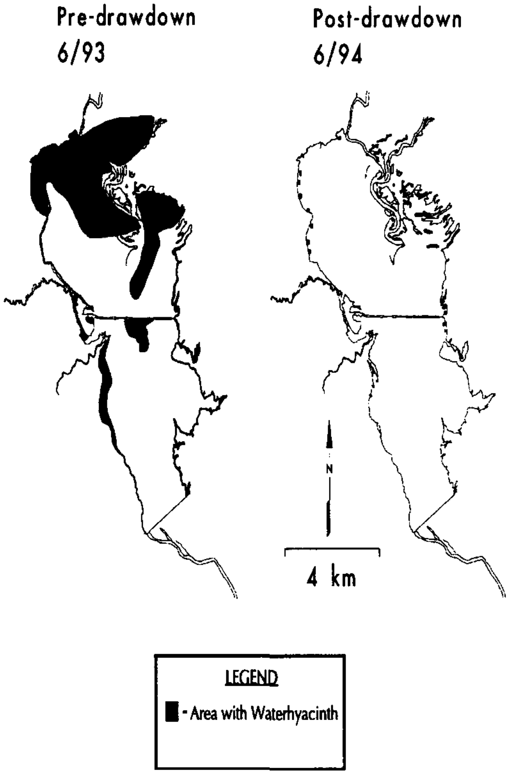

Figure 2. B. A. Steinhagen Reservoir, Texas, showing areal coverage of waterhyacinth in June 1993 and 1994, before and after winter drawdown.

Table 1. Waterhyacinth occurrence (number of intercepts), percent frequency, χ^2, and change in line transects before (November 1993) and after (April and November 1994) winter drawdown on B. A. Steinhagen Reservoir, Texas.

		Transect						
Date		1	2	3	4	5	6	Total
Nov	Count	50	50	50	50	50	50	300
93	(%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)
Apr	Count	3	0	1	0	0	0	4
94	(%)	(6%)	(0%)	(2%)	(0%)	(0%)	(0%)	(1.33%)
Nov	Count	3	0	13	0	0	12	28
94	(%)	(6%)	(0%)	(26%)	(0%)	(0%)	(24%)	(9.33%)
	$\chi^{2\,a}$	88.68	100.00	58.73	100.00	100.00	61.29	497.56

[a]χ^2 values represent comparisons between individual transect and overall differences for November counts; all were significant ($P \leq 0.0001$).

killed after exposure to −5.0 C for 48 hours. A freeze event of this severity rarely occurs in southeast Texas. Penfound and Earle (1948) also reported complete plant mortality if the rhizome froze and a high mortality if plants were subjected to repeated freezing air temperatures for short durations. Apparently the conditions encountered in this study were sufficient to effect complete eradication of mature waterhyacinth.

The winter drawdown combined with freezing temperatures offered an effective management strategy for reducing waterhyacinth in B. A. Steinhagen Reservoir. The drawdown eliminated the cost of manpower, equipment, and chemicals that would have been needed for herbicide control. A conservative estimate of $70,000 in savings was realized. In addition, eradication of waterhyacinth was achieved quickly (2 months), rather than the projected 3 years required for herbicide control.

Control of waterhyacinth by the drawdown was considered extremely successful. Access was restored to previously congested areas of the reservoir. Numerous anglers were observed fishing areas which had been completely choked by waterhyacinth prior to the drawdown. Greater waterfowl hunting opportunities were afforded the public as a result of access to habitat being made available by the drawdown. In addition, reservoir use at shoreline parks appears to have been greatly enhanced. Data from Martin Dies, Jr. State Park located along the eastern shore of the reservoir indicated a 19% increase in park visitation in 1994 (post-drawdown) over 1992 (pre-drawdown). The reduction in waterhyacinth achieved by the drawdown likely contributed, at least in part, to this increase in park usage.

Resource managers faced with noxious aquatic vegetation problems require solutions which are cost-effective and achieve the desired result. Because of the winter drawdown's effectiveness for control of waterhyacinth, this management strategy is a viable option.

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