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Comparing Spring Treatments of 2,4-D with Bottom Fabrics to Control a New Infestation of Eurasian Watermilfoil

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ABSTRACT

Control of Eurasian watermilfoil (*Myriophyllum spicatum* L.) at Beulah Lake, southeastern Wisconsin, was compared using a single treatment of 2,4-D (2,4-dichlorophenoxyacetic acid) in May 1993 at 80% of the maximum rate and polyvinyl-chloride bottom fabrics (0.50 mm thick) applied for 45 days from mid-May through early July 1993. A plastic curtain suspended across the outlet of each treatment cove kept 94 to 98% of the herbicide from drifting into open water. Both control methods eliminated Eurasian watermilfoil from treatment sites within 4 to 6 weeks. The bottom fabrics eliminated all species of rooted, submerged aquatic plants. The 2,4-D treatments initially reduced the mean standing crop of coontail (*Ceratophyllum demersum* L.), elodea (*Elodea canadensis Michaux*), variable-leaf watermilfoil (*Myriophyllum heterophyllum* Michaux), and wild celery (*Vallisneria americana* Michaux) by 14 to 85%. These native plants, however, recovered about 80 to 120% of their standing crops within 10 to 12 weeks after herbicide treatments, while transplants of these species showed poor colonization on sites previously covered with bottom fabrics. Herbicide concentrations in the water column at the treatment sites dropped 37 to 48% within 3 weeks of treatment and 70 to 82% within 6 weeks of treatment.

Key words: herbicide, submersed macrophytes, *Elodea*, *Vallisneria*, *Myriophyllum spicatum*, *Potamogeton*.

INTRODUCTION

Herbicides have been used to control Eurasian watermilfoil since the species first invaded southern Wisconsin lakes in the early 1960s (Engel 1993). The systemic herbicide 2,4-D (2,4-dichlorophenoxyacetic acid) has been widely used against dicotyledonous plants like Eurasian watermilfoil, destroying both shoots and attached roots but leaving viable fragments and root crowns in underlying sediments (Getsinger et al. 1982) to sprout after treatment and establish new plant beds. Manual and mechanical harvesting have been used also to control Eurasian watermilfoil (Grinwald 1968, Engel 1990), especially to offset herbicide treatments in shallow water, though root crowns, stems, and vegetative fragments are left to regrow. A variety of bottom fabrics (e.g. plastic sheets, spunbonded blankets, and fiberglass screens) have been secured to lake bottoms for creating boat lanes or beaches along shore (Engel 1984). Firmly anchored, these fabrics block sunlight penetration and hasten microbial decomposition of underlying plant tissue (Perkins et al. 1980), thus preventing subsequent growth. To date, comparison of various methods for Eurasian watermilfoil control has been infrequently documented, particularly for managing new infestations that are still relatively small.

We compared 2,4-D and a bottom fabric for Eurasian watermilfoil control in separate basins of a southeastern Wisconsin lake. Our objectives were to compare early-season applications of 2,4-D and bottom fabrics for (1) selective control of Eurasian watermilfoil, (2) regrowth of native submersed macrophytes, and (3) establishment of native plant beds from transplanted cuttings.

STUDY SITE

Beulah Lake is a 337-ha impoundment, averaging 5.2 m deep, on the Mukwonago River in Walworth County, Wisconsin. It has clear, alkaline, and mineral-rich water (mean pH 8.5, total alkalinity 187 mg $CaC0_3$/L, and specific conduc-

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tance 436 μS/cm at 25C) typical of drainage lakes in southeastern Wisconsin. The lake has three main basins that were separate but interconnected glacial lakes until a dam was built prior to 1900 (Fenneman 1910). Each basin today has shallow coves where native aquatic macrophytes are thickest (Dionne and Helsel 1994). Elodea, coontail, and pondweeds within shallow coves were chemically treated for decades, sometimes to control swimmer's itch (Lueschow 1972), but have been exclusively harvested by machine since the mid-1980s. First observed from one of these coves in 1990 (Glen Kreinbrink, East Troy Sanitary District, pers. comm.), Eurasian watermilfoil has spread to four coves within 2 years (total of 0.79 ha) and now occupies five other sites in the north and central basins. Three of these coves lie in the central basin: Fritz Cove along the east shore is 0.11 ha in surface area, 0.95 m in maximum depth, and 0.45 m in mean depth; Mueller Cove along the south shore is 0.22 ha in surface area, 0.45 in maximum depth, and 0.35 m in mean depth; and Dunn Cove along the north shore is 0.7 ha in surface area, 1.50 m in maximum depth, and 0.75 m in mean depth.

MATERIALS AND METHODS

Fritz and Mueller coves were treated on 20 May 1993 with a granular butoethyl-ester formulation of 2,4-D (Aquakleen®[4]), hand dispersed at 89 kg/ha (80% of the maximum U.S. Environmental Protection Agency label dose of 111 kg/ha). Water temperatures ranged from 14.3C to 15.1C (3C less than the manufacturer's label recommended water temperature of 18C). To minimize herbicide and fragment drift, as well as to ease riparian concerns about herbicide use, the mouth of each cove was sealed off with a polyvinyl-chloride curtain (0.76 mm thick) tacked to a metal or wooden frame anchored into the bottom sediments with sandbags. Boaters were kept out of the coves until the curtains were removed on 1 July 1993. Herbicide (2,4-D) concentrations (American Public Health Association 1976) were measured from the center of each cove and about 1 m from the lake side of each curtain starting 24 hours after treatment and lasting through July. Sediment samples from the center of each cove were also analyzed for 2,4-D residue concentrations. The lake water and sediment samples were stored in amber glass bottles, held in the dark at 4C until analyzed 24 to 48 hours after collection.

Dunn Cove was covered on 23 May 1993 with polyvinyl-chloride Palco® liners[4] of 0.50-mm (20-mil) thickness. Scuba divers anchored the liners to the lake bottom using cement bricks and iron rebar. Each liner covered an area 6.6 by 15.2 m for a total of 675 m^2 (nearly 100% of the cove area). The bottom fabrics were removed 45 days after installation, when all vegetation beneath them had showed chlorosis and disintegrated easily when disturbed. The site was then planted with cuttings of native submersed plants taken from a mechanical harvester working elsewhere in Beulah Lake; the cuttings were weighed down in contact with the bottom sediments with iron rebar.

Above-ground standing crop was measured on aquatic plants sampled by SCUBA divers using a hoop and net sampler of 0.059 m^2 diameter. Four random samples were collected from each treatment site in Fritz and Mueller coves, starting 2 weeks before treatment and continuing every 3 to 5 weeks through the summer. Plant samples in Dunn Cove were collected only before positioning the bottom fabrics, because plants failed to grow beneath or above the bottom fabric. All plant samples were separated by species, washed of attached algae and detritus, and dried in an oven at 104C to

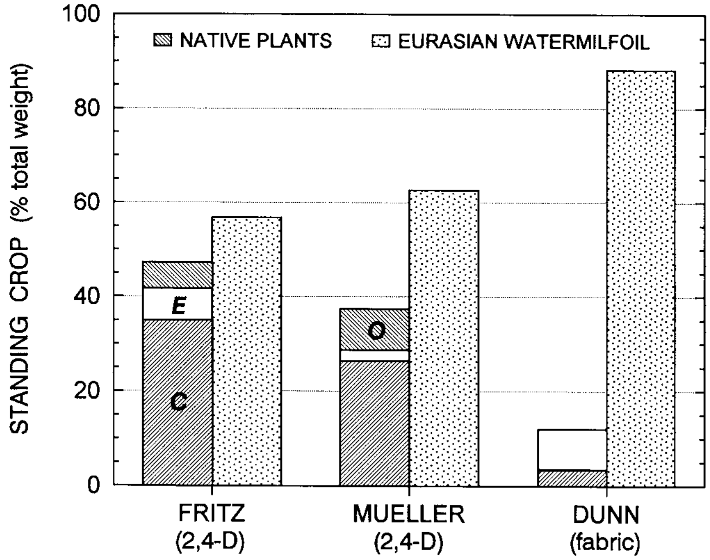

Figure 1. Relative standing crop of native plants and Eurasian watermilfoil in Fritz, Mueller, and Dunn coves on 12 May 1993 before treatment. Native plants are identified as coontail (*C*), elodea (*E*), and other species (*O:* curly-leaf pondweed, flatstem pondweed, muskgrass, naiads, northern watermilfoil, sago pondweed, variable-leaf watermilfoil, water crowfoot, water stargrass, whitestem pondweed, and wild celery).

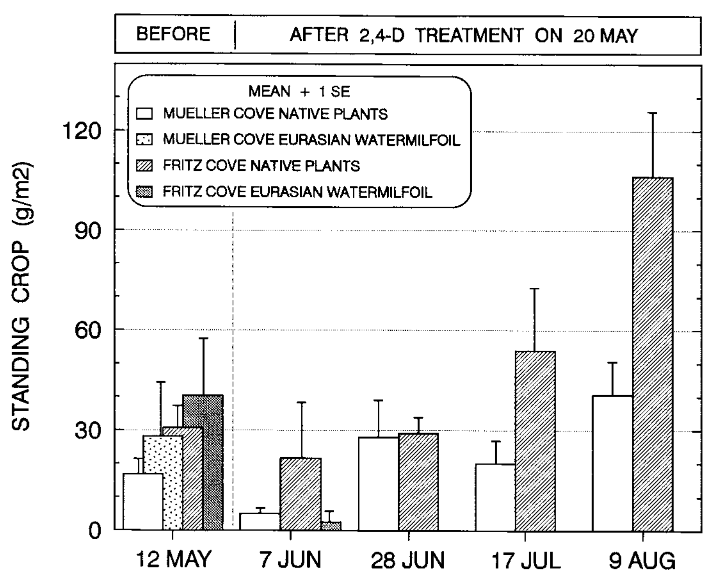

Figure 2. Dry-weight standing crop (mean + 1 SE) of native plants (coontail, curly-leaf pondweed, elodea, flatstem pondweed, muskgrass, naiads, northern watermilfoil, sago pondweed, variable-leaf watermilfoil, water crowfoot, water stargrass, whitestem pondweed, and wild celery) and Eurasian watermilfoil in Fritz and Mueller coves before (12 May) and after (6 June-9 August) chemical treatment in 1993.

[4]Reference to commercial products does not imply an endorsement by the Wisconsin Department of Natural Resources.

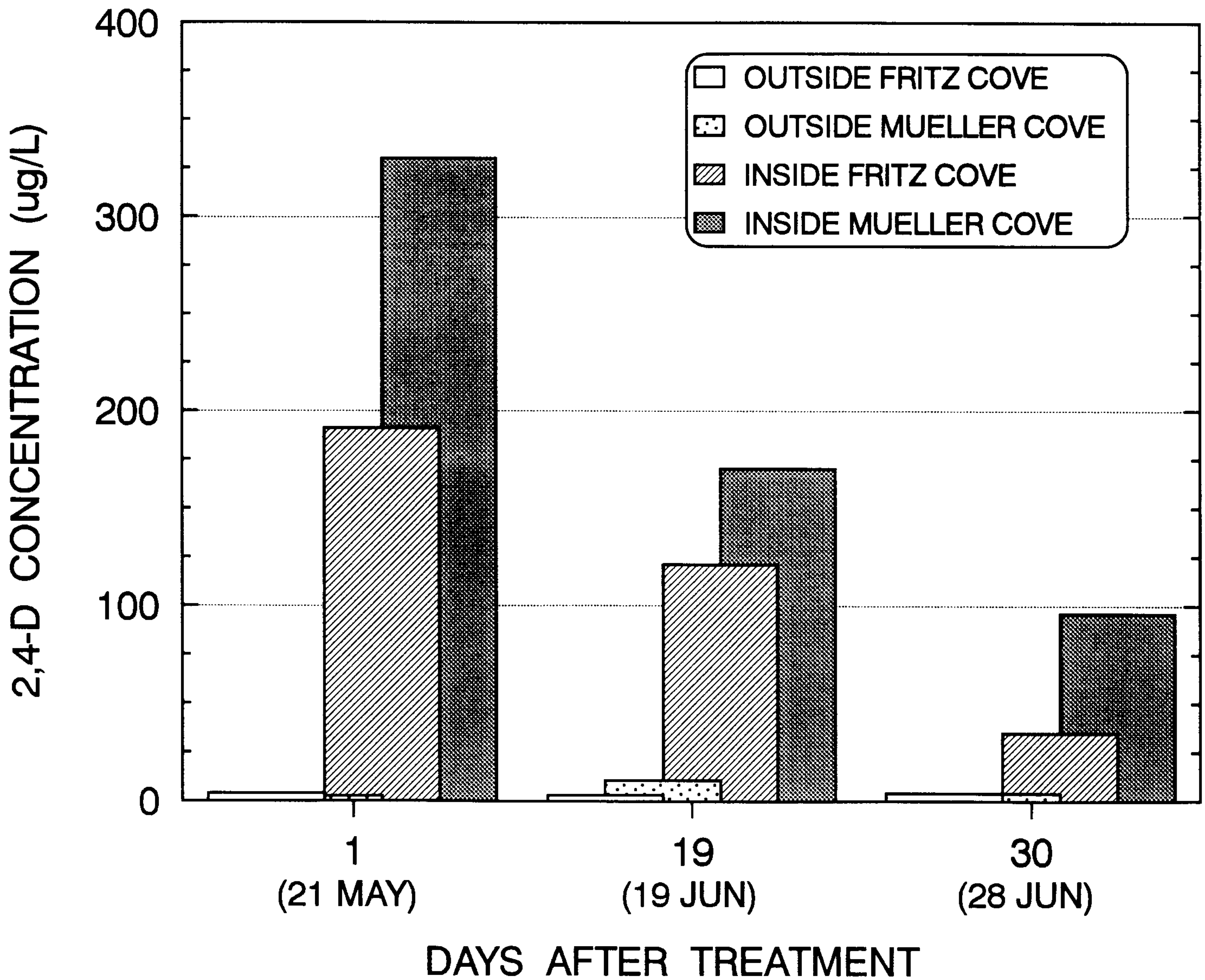

Figure 3. Mean concentrations of 2,4-D in the water column both within the treatment areas and lakeside of the drift barrier at Fritz and Mueller coves 1, 19, and 39 days after day after treatment.

constant weight (24 to 72 hours). Qualitative observations were made from a boat in August 1994 to describe percent plant cover and species recolonization.

RESULTS AND DISCUSSION

Two weeks before the May 1993 treatments, Eurasian watermilfoil dominated the plant community in all three coves, ranging from 56% of total standing crop in Fritz Cove to 88% in Dunn Cove (Figure 1). Each cove had 4 to 8 of the 13 submersed macrophyte species found in Beulah Lake: muskgrass (*Chara vulgaris* L.), coontail, curly-leaf pondweed (*Potamogeton crispus* L.), elodea, Eurasian watermilfoil, flatstem pondweed (*P. zosteriformis* Fernald), naiads (*Najas flexilis* [Willd.] Roskov and Schmidt and *N. quadalupensis* [Sprengel] Mangus), northern watermilfoil (*Myriophyllum sibiricum* Komarov), sago pondweed (*P. pectinatus L.*), variable-leaf watermilfoil (*M. heterophyllum* Michaux), water crowfoot (*Ranunculus longirostris* Godron), water stargrass (*Zosterella dubia* [Jacq.] Small), whitestem pondweed (*P. praelongus* Wulfen), and wild celery (*Vallisneria americana* Michaux).

The 2,4-D eliminated all Eurasian watermilfoil from Fritz Cove within 6 weeks and from Mueller Cove within 3 weeks of application (Figure 2). Native submersed plants also declined within the first 5 weeks of treatment, but regained 80 to 120% of their pretreatment standing crop by late August. Wild celery, however, replaced coontail as the dominant native plant.

Herbicide concentrations in lake water 1 day after treatment were 190 µg/L at Fritz Cove and 330 µg/L at Mueller Cove (Figure 3). These concentrations decreased 37 to 48% within 3 weeks and 70 to 82% within 6 weeks. Herbicide con-

TABLE 1. AREAL COVER (%) BY TREATMENT COVE FOR SURFACE COVER (VISUAL ESTIMATES) OF AQUATIC MACROPHYTES IN FRITZ, MUELLER, AND DUNN COVES IN AUGUST 1994 TWO GROWING SEASONS AFTER TREATMENT WITH 2,4-D OR BOTTOM FABRICS.

Plant species	2,4-D Fritz	2,4-D Mueller	Bottom Fabric Dunn
Total plant cover	100	70	100
Eurasian watermilfoil	5	3	60
Wild celery	35	0	0
Elodea	20	10	0
Coontail	10	5	10
Other species[1]	30	30	30

[1]Other species are curly-leaf pondweed, flatstem pondweed, muskgrass, naiads, northern watermilfoil, sago pondweed, variable-leaf pondweed, water crowfoot, water stargrass, and whitestem pondweed.

centrations were less than 9.8 µg/L at about 1 m from the lake side of the drift curtains.

When installed, the bottom fabrics covered all vegetation in Dunn Cove, except for two 0.3 by 6.6 m strips of Eurasian watermilfoil that grew between adjacent sections of bottom fabrics. Within 45 days, the aquatic plants beneath the bottom fabrics showed complete chlorosis and had decomposed; however, some coontail plants appeared to be surviving beneath the bottom fabric sections.

Within weeks of removing the bottom fabrics, cuttings of native plants (mainly elodea, chara, and wild celery) were collected from a mechanical harvester and anchored to the bottom sediments with iron rebar. Within 2 weeks of transplantation, none of the wild celery or elodea cuttings had successfully rooted. Many of the cuttings had uprooted and floated to shore.

The next summer (1994), Eurasian watermilfoil dominated sites (some >200 g/m^2 dry weight) covered the previous summer with bottom fabrics. However, the exotic milfoil covered less than 5% of both cove areas previously treated with 2,4-D. Native plants like wild celery, elodea, and naiads instead covered 95 to 100% of the total area treated with herbicides but less than 40% of the area lined with bottom fabrics (Table 1).

Spring applications of 2,4-D resulted in concentrations effective for controlling Eurasian watermilfoil (Getsinger et al. 1982) and permitted regrowth of native submersed macrophytes within 10 to 12 weeks of treatment. Sublethal changes in native foliage were observed after herbicide treatment. Within 3 weeks of treatment, the standing crop biomass of native aquatic plants was reduced, while petioles of white waterlily (*Nymphaea odorata* Aiton) both curled and elongated. Such damage, however, disappeared within 6 weeks of treatment and the native plants fully recovered.

Drift curtains minimized herbicide movement into non-target sites and maintained lethal concentrations of 2,4-D in lake water for at least 2 weeks, providing thorough control of Eurasian watermilfoil. A slight increase in herbicide concentration was found near the curtains, probably from leakage caused by wave action. The native plant community after herbicide treatment became dominated by wild celery, a species tolerant of low light that can grow from seeds and dormant buds (Titus and Adams 1979).

Our study shows 2,4-D and bottom fabric were effective in controlling new infestations of Eurasian watermilfoil. The 2,4-D controlled just the Eurasian watermilfoil, enabling the native plants to recolonize the two coves. Bottom fabric, left in place for 45 days, proved non-selective and also affected native plants. Replanting native aquatic macrophytes remained unsuccessful within 1 year of removing the bottom fabrics, partly because of the ineffective planting technique used and the disturbed area continued to be exposed to fragments of Eurasian watermilfoil (Engel 1993). More effective replanting techniques are needed to establish native plant beds that can suppress regrowth of Eurasian watermilfoil following removal of bottom fabrics.

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