The flow in Princes Lake was in excess of 2 million gph, however, the Sub-Surface Placement Technique provided 90% submersed weed control for a diquat cost of $52 per surface acre. In comparison, the ppm or total water column technique for applying diquat in Princes Lake would cost $217 to treat an acre of water which averages 6 ft in depth.

The invert carrier of diquat provided a significant reduction in the amount of herbicide applied per surface acre, i.e., a reduction from 8.4 gal in the above illustration to 2 gal in Princes Lake or a reduction from 12.6 gal in Canal 31 with an average depth of 9 ft to 2 gal. The gate in the dam structure in Canal 31 was not opened during the course of this study; consequently, the 0.4-mile of canal responded similarly to a long, narrow lake or pond since there was little or no water flow in the canal.

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Control Of Egeria In A Virginia Water Supply Reservoir[1]

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ABSTRACT

A 1:1 mixture of 6,7-dihydrodipyrido[1,2-*a*:2′,1′-c]pyrazinediium ion (diquat) and 7-oxabicyclo[2,2,1]heptane-2,3-dicarboxylic acid (potassium endothall) was used at 0.11 and 0.17 ppmw active ingredient respectively to control egeria (*Egeria densa* Planch.) in Chickahominy Reservoir, a Virginia water supply lake. Herbicide efficacy was evaluated in two quadrants selected to represent shallow and deep water conditions. Plant sampling with a cylindrical sampler before, and 42 and 360 days after treatment yielded a quantitative index of plant die-off. Egeria was reduced 94% after 360 days in the deep quadrant and only 6% in the shallow quadrant. The quantity of filamentous algae increased following treatment.

INTRODUCTION

Walker's Dam Impoundment (Chickahominy Reservoir) is a 1093-ha water supply reservoir located between Richmond and Williamsburg, Virginia. The reservoir supplies water to the city of Newport News, Virginia, and is used extensively for boating and fishing. Reservoir depth is relatively shallow, with 55% less than 0.91 m. Water retention time in the reservoir is great, the impoundment is eutrophic, and water temperatures exceed 30 C during the summer. These conditions have been optimal for the establishment of egeria and most areas less than 1.83 m deep were choked with this hydrophyte. Other floating and submerged plants occurring to a lesser extent were duckweed (*Lemna minor* L.), watermeal (*Wolffia* sp.), coontail (*Ceratophyllum demersum* L.), bladderwort (*Utricularia inflata* Walt., and *U. gibba* L.), milfoil (*Myriophyllum* sp.) yellow water lily (*Nuphar adventa* Ait.), and an oscillato reacous bluegreen algae *Lyngbya* sp.

[1]Investigation funded jointly by U. S. Army Corps of Engineers, Contract No. DAW 65-74-C-0013, and the Virginia Commission of Game and Inland Fisheries.

A monitoring program encompassing biological and chemical evaluation of treatment effects on the reservoir ecosystem included the development of a quantitative index of submerged plant biomass in selected areas of the reservoir before and after treatment. This paper reports the results of the changes in plant biomass.

METHODS AND MATERIALS

Herbicide application was carried out using methods similar to those employed in a 1967 pilot study (1). A 1:1 mixture of diquat and endothall was applied as a surface spray by airboat. An application rate of 1.14 liters of each chemical per ha (0.11 ppmw diquat cation and 0.17 ppmw endothall acid) was used.

Two quadrants were chosen for intensive study (Figure 1). One quadrant (First Water Quadrant, FWQ) was chosen to represent deeper areas of the reservoir such as the main reservoir body and major tributaries. This quadrant was approximately 11.3 ha and was located within a creek having a moderately irregular shoreline composed of dense stands of loosestrife (*Decodon verticulatus* (L.) Ell.). Mid-channel depths in the creek reached 3.66 m and thick mats of egeria were established along each shoreline to a depth of 1.83 m. The other quadrant (Second Water Quadrant, SWQ) was selected to represent areas of the reservoir such as shallow bays, inlets, and shoreline areas. Average depth of the egeria infested water in this 14.2-ha quadrant was 0.91 m.

Plants were sampled with an open-ended cylinder which had a radius of 0.157 m and a length of 2.13 m from which the plants were collected with a rake. This type of sampler has been used by other authors (3, 5). Small pieces of plant remaining in the water enclosed within the cylinder were collected by dropping a 2.54-cm wire mesh seive vertically into the cylinder, leveling the seive to a horizontal position and then retrieving the seive. Samples were drained for approximately 1 hr. After draining, wet weight and species composition were determined and recorded. Plant sampling was conducted 3 days before treatment and 42 and 360 days after treatment. In FWQ, 35 stations were sampled; 36 were sampled in SWQ. The index for each species in each quadrant prior to treatment was reported in wet weight per m^3 and was compared with the post-treatment index for that species in the same quadrant. Daily visual observations were recorded in addition to this quantitative analysis.

Reliability of the plant sampler was determined by collecting nine samples from a 6.1-m-square portion of a shallow bay. The bay was of uniform depth and supported a uniform growth of egeria. Mean weight and standard deviation for the samples were computed.

RESULTS AND DISCUSSION

The cylindrical plant sampler proved very reliable. Standard deviation of nine samples having a mean weight of 324 g was 39 g.

Field inspections revealed that egeria near the surface reacted to the chemicals in only 2 days. Chlorosis was readily apparent in the leaves after 5 days, and plants had disappeared from the water column by day 14, although healthy looking plants could be found near the bottom. Dredge samples collected 22 days after treatment revealed

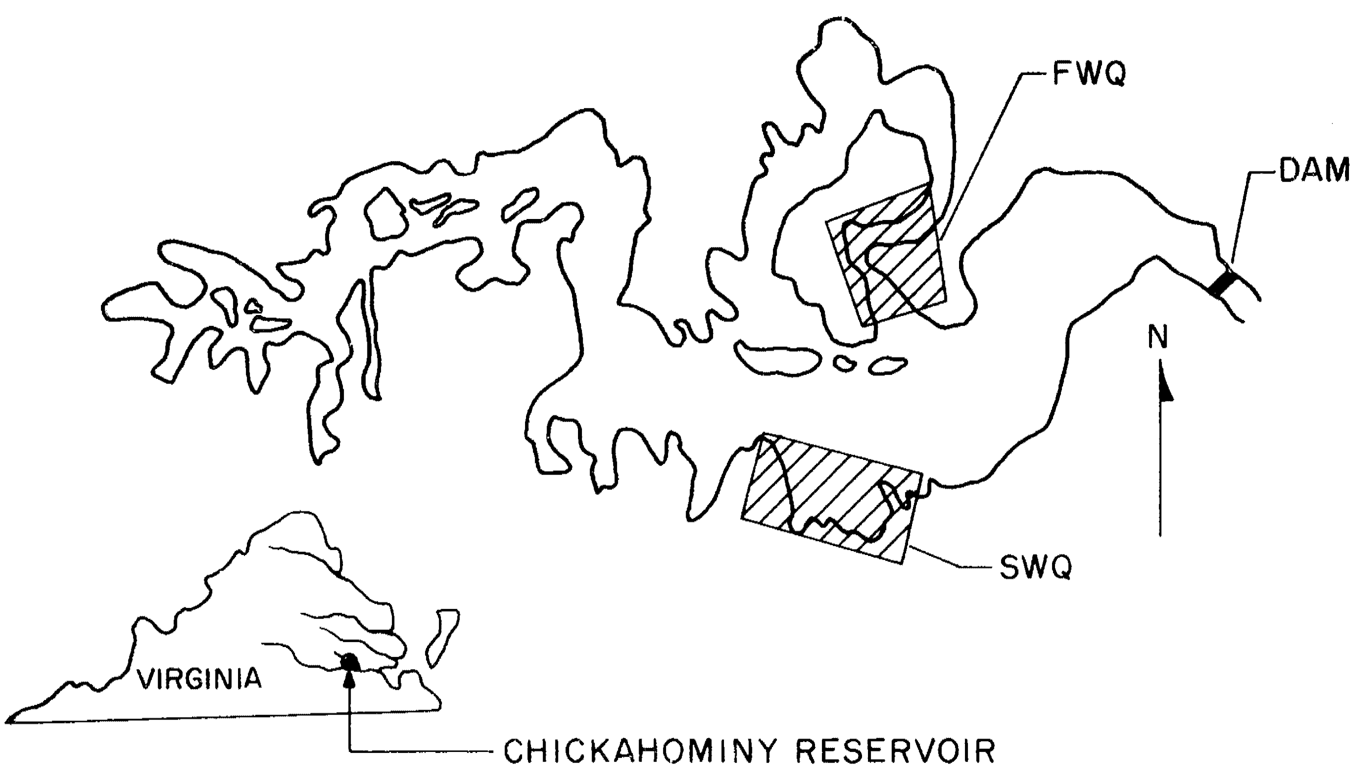

Figure 1. Map of Chickahominy Reservoir showing location of First (FWQ) and Second (SWQ) Water Quadrants.

only occasional green plants, many brown stems, and much plant detritus. Some of these apparently dead stems exhibited sprouts of new growth. New sprouts from leafless stems have also been reported by others (2).

Plants in some untreated areas of the reservoir also died indicating that lateral diffusion or flow of herbicide had taken place. For example, in one small inlet treated only near its confluence with the reservoir proper, egeria mats located 30.5 m from the treated area eventually showed effect of the treatment.

A review of the egeria index in FWQ showed that 98% of the wet weight of the macrophyte had been removed after 42 days (Table 1). For comparative purposes, the wet weight-dry weight relationship was $Y = -0.015 + 0.075X$ and the wet weight-ash weight relationship was $Y = -0.009 + 0.015X$. After 360 days, the regrowth was still only 6% of the pretreatment levels. *Lyngbya* was found in measurable quantities in three stations before treatment, 7 stations 42 days after treatment, and 20 stations 360 days after treatment. The index showed that quantities of *Lyngbya* increased approximately 24 times.

Egeria was reduced in the SWQ by 84% after 42 days (Table 1). The egeria index after 360 days was approximately equal to that found before treatment. However, spatial distribution was different in that reoccurrence of egeria in deeper water was slight. Coontail was reduced 66% after 42 days and 97% after 360 days. *Lyngbya,* which did not appear in significant amounts in this quadrant prior to treatment, increased in quantity after treatment, although it was found at relatively few stations.

Reduction of duckweed and watermeal was not determined by the plant sampler because these floating plants turned brown and had essentially disappeared 4 days after treatment. Within 60 days after treatment, quantities of duckweed and watermeal increased. Other authors have noted similar rapid reappearance of duckweed (4). Bladderwort and milfoil occurred in such sparse quantities that herbicide effect could not be determined. Stands of yellow water lily were unaffected by the treatment.

The difference in plant response between the two quadrants was apparently influenced by water depth and extent of the original kill. Egeria was able to re-establish large stands in SWQ the following summer because of suitable habitat, i.e. shallow water, and smaller quantities (84%) of plants killed initially as compared to FWQ (98%). *Lyngbya* increased significantly in FWQ because it was more abundant in this quadrant than in SWQ prior to treatment and competition from regrowth of egeria was less than in SWQ. Increases in quantities of other algae following herbicide applications have been reported by others (6, 7).

TABLE 1. PLANT INDEX IN FIRST (FWQ) (SWQ) WATER QUADRANTS BEFORE AND 42 AND 360 DAYS AFTER TREATMENT WITH (1:1 MIXTURE OF DIQUAT AND ENDOTHALL.

		Wet Weight (g/m^3)		
	Aquatic	Before	Days after Treatment	
Quadrant	Plants	Treatment	42	360
FWQ	Egeria	2303	35	124
	Lyngbya	29	718	716
SWQ	Egeria	2757	441	2527
	Coontail	587	197	15
	Lyngbya	0	5	66
	Other[a]	6	10	0

[a] Bladderwort, milfoil, duckweed, and watermeal.

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