Effects of 2,4-D on Non-Target Species in Kerr Reservoir

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ABSTRACT

The butoxyethanol ester formulation of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D BEE) was applied for the control of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in Kerr Reservoir in 1977 and 1978. The only detrimental effect to non-target species that could be attributed to herbicide treatment was a short-term depression of phytoplankton populations in those sites sampled in 1977 where large areas of the reservoir were treated or when the treated areas were in places sheltered from the action of currents and waves. Therefore, within the restraints and conditions of this investigation, it may be concluded that 2,4-D did not adversely affect the non-target components in the sampled ecosystems.

INTRODUCTION

Since the mid 1940's, the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) has been used for the effective control of many troublesome weeds, including Eurasian watermilfoil (*Myriophyllum spicatum* L.) (3, 12, 13). But its effects upon the non-target organisms for the aquatic environment are less well understood (1, 2, 4, 5, 16).

This investigation was designed to study phytoplankton, zooplankton, benthic macroinvertebrate, and vascular macrophyte populations in an effort to ascertain the effects of the 2,4-D treatment upon these important components of the aquatic ecosystem.

MATERIALS AND METHODS

The 1978 program was initiated to control approximately 162 hectares of Eurasian watermilfoil in Robert S. Kerr Reservoir, in the mouth of the South Canadian River, and at the confluence of the Illinois River with Kerr Reservoir. The 1977 program was less extensive, involving only 26 hectares. Table 1 summarizes the programs.

The butoxyethanol ester granular formulation of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D BEE) was applied to the Eurasian watermilfoil at label-recommended rates not to exceed a concentration of 2 ppm in the water. Application was accomplished using a mechanical cyclone spreader mounted on the bow of an airboat.

TABLE 1. PROGRAM FOR CONTROL OF EURASIAN WATERMILFOIL IN KERR RESERVATION, OKLAHOMA.

Site description	1977		1978	
	Site number	Hectares treated	Site number	Hectares treated
Applegate Cove	1	1.5	1	6
Cowlington Point Recreation Area	6	4	2	12
Little Sansbois Recreation Area	3	18	3	24
Tamaha Area	4	1	4	16
Mouth of South Canadian River			5	75
Sandtown Bottom Area			7	22
Sallisaw Creek Recreation Area			8	2
Stony Point	5	1.5		
Short Mountain Cove (Control)	2	0		
Coast Guard Cove (Control)			9	0
Illinois River: Upstream (Control)	7	0	10	0
Mouth			6	4

Triplicate 250 ml water samples for phytoplankton and zooplankton analyses were taken just before treatment; and 5 weeks and 10 weeks after treatment in 1978. The 1977 samples were collected just before treatment and again three weeks after treatment. Samples were collected approximately 15 cm. beneath the surface of the water at established, marked sampling stations in the treatment sites listed in Table 1.

The benthic macroinvertebrate samples were taken using an Eckman dredge to grab 1.0 liter samples of the bottom substrate at each of the sampling stations.

Samples were processed and analyzed according to standard procedures (6, 7, 8, 9, 10, 11, 14, 15). Data were graphically analyzed and displayed.

RESULTS AND DISCUSSION

Allowing for normal sample variations and seasonal fluctuations during 1978, phytoplankton populations in the control and treated sites in the Illinois River were the same (Figure 1). The zooplankton data further support the contention that the herbicide treatment had little, if any, effect on the Illinois River ecosystem. Elevated temperatures in August would account for greater numbers of both phytoplankton and zooplankton in the treated area at the mouth of the Illinois River.

Although environmental influences are the most likely explanations for the benthic macroinvertebrate data presented in Figure 1, experimental evidence does not rule out the possibility of herbicide damage, direct or indirect, to the benthic macroinvertebrate populations in this sampling area.

Sampling site 9 (Figures 2 through 4) was in the Coast Guard Cove. Not treated with herbicide, this site was the control location. Over the study period, there were 21% and 52% decreases in the total numbers of phytoplankton collected from site 9, perhaps a reflection of an earlier succession pattern caused by the very hot weather.

The lake sites treated with 2,4-D, namely Sallisaw Creek Recreation Area, Applegate Cove, Cowlington Point Recreation Area, Tamaha Area, Sandtown Bottom Area, and the Little Sansbois Recreation Area, showed a great deal of variation in total numbers of phytoplankton collected during the three sampling trips. But both the trends and the total numbers of organisms (Figure 2) indicate only

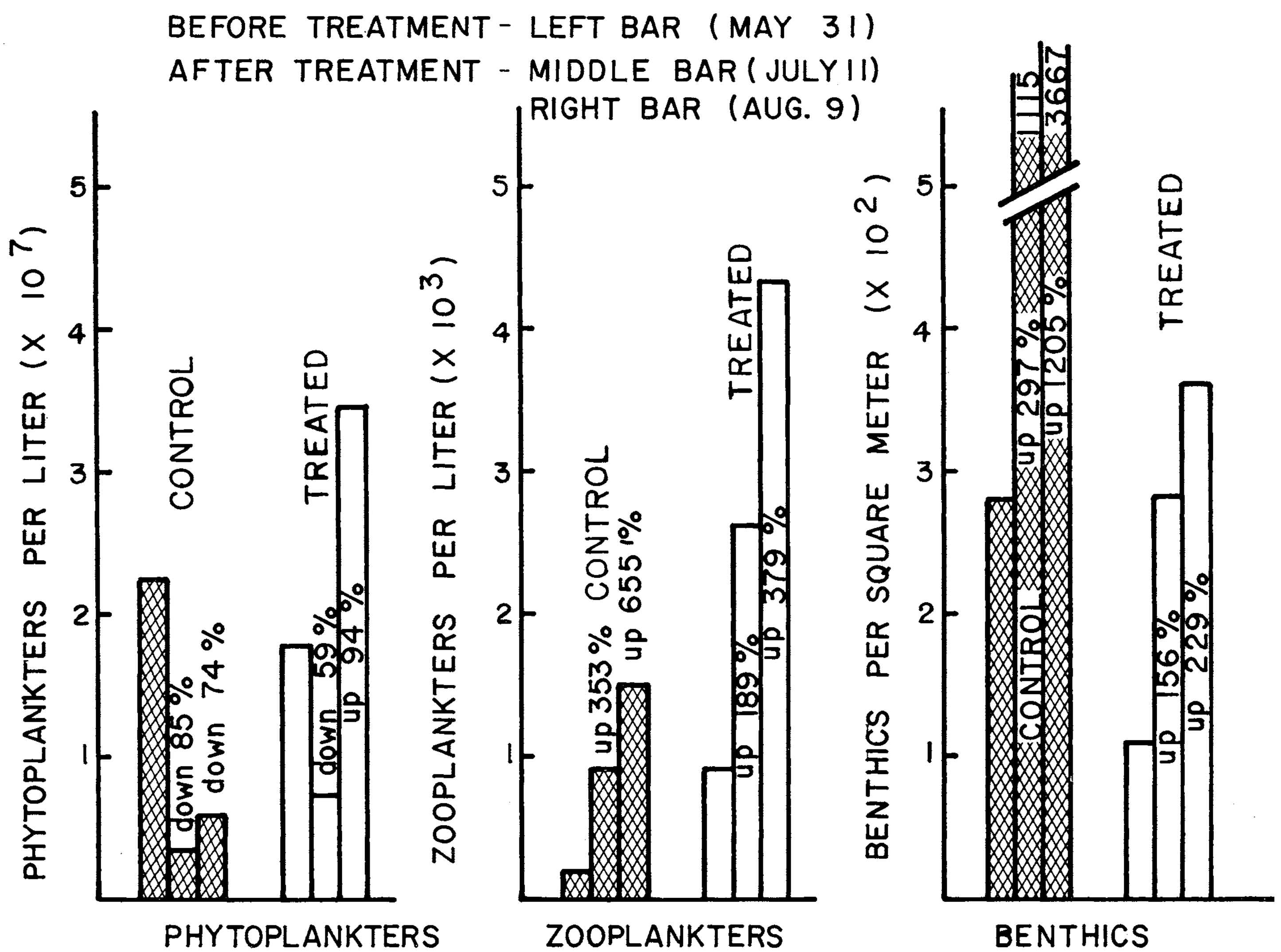

Figure 1. Organisms from sampling sites in Illinois River before and after treatment with 2,4-D. 1978.

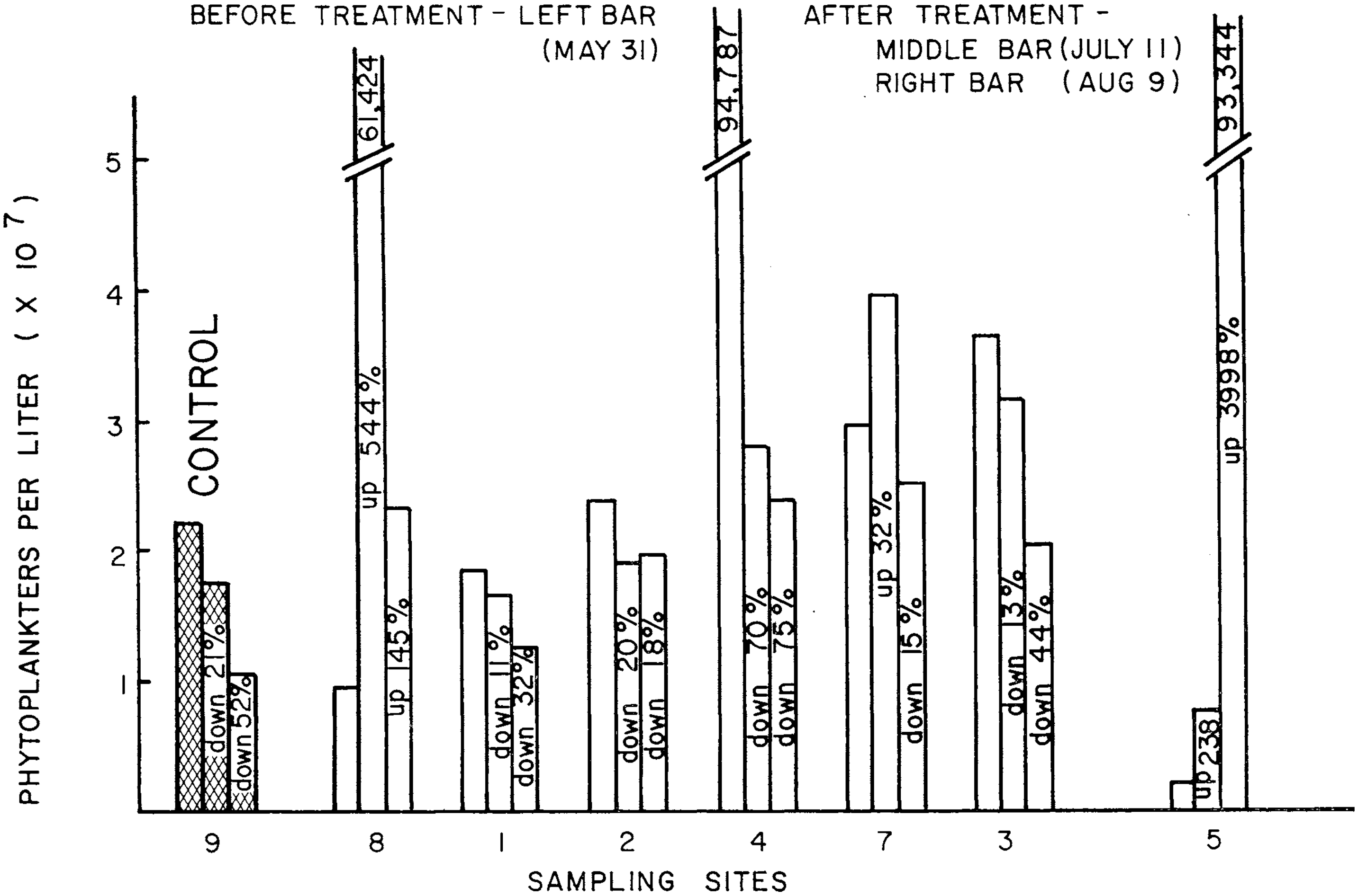

Figure 2. Total phytoplankters per liter from sampling sites in Kerr Reservoir and South Canadian River (5) before and after treatment with 2,4-D.

environmental effects on this component of the ecosystem. None of the variations seem appropriately attributable to herbicide damage to the phytoplankton communities studied.

If the 2,4-D treatment had an effect on the phytoplankton populations and diversities, the effects certainly did not carry over to the first order consumers—the zooplankton (Figure 3). In both the control location and all the treated locations within the lake, the general trend for zooplankton numbers was an upward one throughout the summer. Both number and diversity indices show progressively improving zooplankton communities for all sites (control and treated areas).

The benthic macroinvertebrate populations also increased during the course of this investigation (Figure 4). Nothing was observed that would indicate the benthic communities were damaged in any measurable way by the application of 2,4-D to their environment. Variations observed could be attributed to normal, seasonal environmental influences.

Sampling site 5 (Figures 2-4), the mouth of the South Canadian River, was an unusual site. It was the largest area treated (75 hectares) in the 1978 program. There was a great deal of flow in May as a result of heavy, early-spring runoff being released from Lake Eufaula. Flow decreased throughout the summer. These factors, combined with the unusually hot weather of the summer, complicated the interpretation of data from this location. But the data from sampling site 5 do not lend credence to suggestions of herbicide damage to any of the biotic components studied at this site.

Figures 5 and 6 summarize the numerical data derived from counts of phytoplankton and zooplankton organisms at each sampling site in 1977. The increases and decreases in phytoplankton numbers appeared to be a function of both the number of hectares treated and the geomorphology of the treatment area. The untreated lake sampling area (site No. 2) showed the most marked increase in phytoplankton numbers (60%). The treated sites that were located in coves and other sheltered areas (site numbers 1, 4, and 5) showed the most marked decrease in phytoplankton numbers (43%, 60%, and 40%).

In these same treatment sites, the diversity index increased slightly, probably due to succession of the reservoir flora as a function of increased water temperature. Certain genera were inhibited temporarily by the 2,4-D. The niches occupied by these organisms were quickly filled by genera like *Euglena, Chlorococcum, Achnanthes,* and *Cocconeis.* But some members of the pretreatment algal community such as *Actinastrum, Coelastrum, Closterium, Euastrum, Cos-*

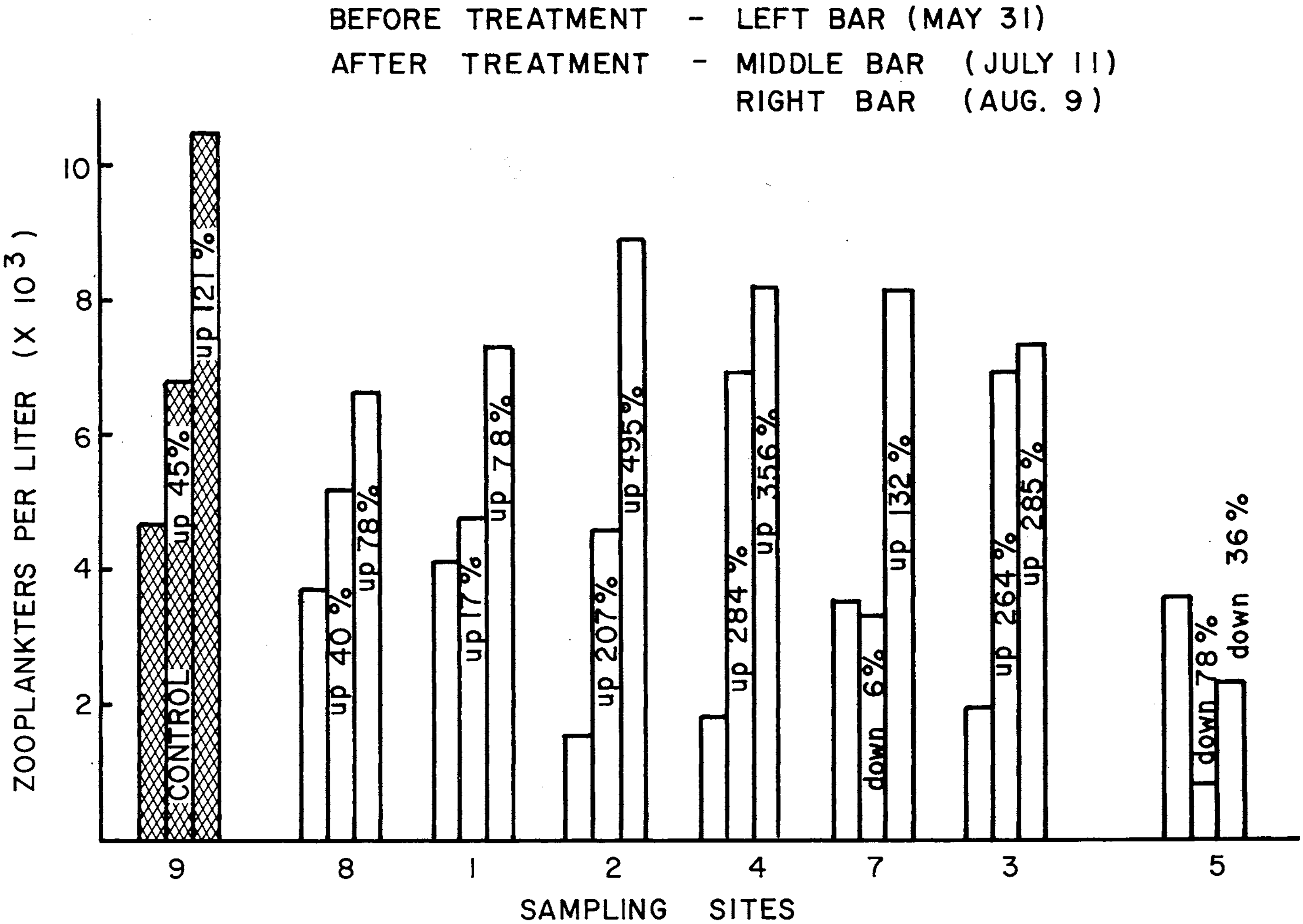

Figure 3. Total Zooplankters per liter from sampling sites in Kerr Reservoir and South Canadian River (5) before and after treatment with 2,4-D.

marium, and *Melosira* were present in ever-increasing numbers in the post-treatment samples. So the combination of the new genera and the increased numbers of the original genera accounted for the increases observed in the diversity indexes at several of the sampling sites.

In contrast to sampling sites 1, 4, and 5, sampling sites 3 and 6 were located in open water where the action of wind and current could dilute and disperse the applied 2,4-D more rapidly. The quicker removal of the inhibitory effect of the herbicide probably allowed the phytoplankton numbers to increase rapidly and maintain ecosystem energy flow.

Total numbers and diversity indexes of zooplankton increased with time in all sampling sites in 1977 indicating nondetectable effects of 2,4-D treatment on this component of the ecosystem.

The aquatic and wetland vascular macrophytes were observed on each of the sampling trips. Only common cattails (*Typha latifolia* L.) were observed in abundance. A 1.0-hectare population of American lotus (*Nelumbo lutea* [Willd.] Pers.) in the Little Sansbois Creek Recreation Area was eradicated by the herbicide treatment in 1977. No other non-target macrophyte damage was observed either year.

Target species Eurasian watermilfoil control was estimated to be 75% each year.

ACKNOWLEDGMENTS

We wish to thank Mr. Kenneth Morris, Oklahoma Water Resources Board, for his cooperation and support with this phase of the study. Oral Roberts University student Marlin Mohrman conducted the phytoplankton analyses.

This study was supported by funds from the Aquatic Plant Control Program of the United States Army Corps of Engineers. Permission to publish this information was granted by the Chief of Engineers. James R. Skaggs and Loren M. Mason, Tulsa District Corps of Engineers, coordinated the project.

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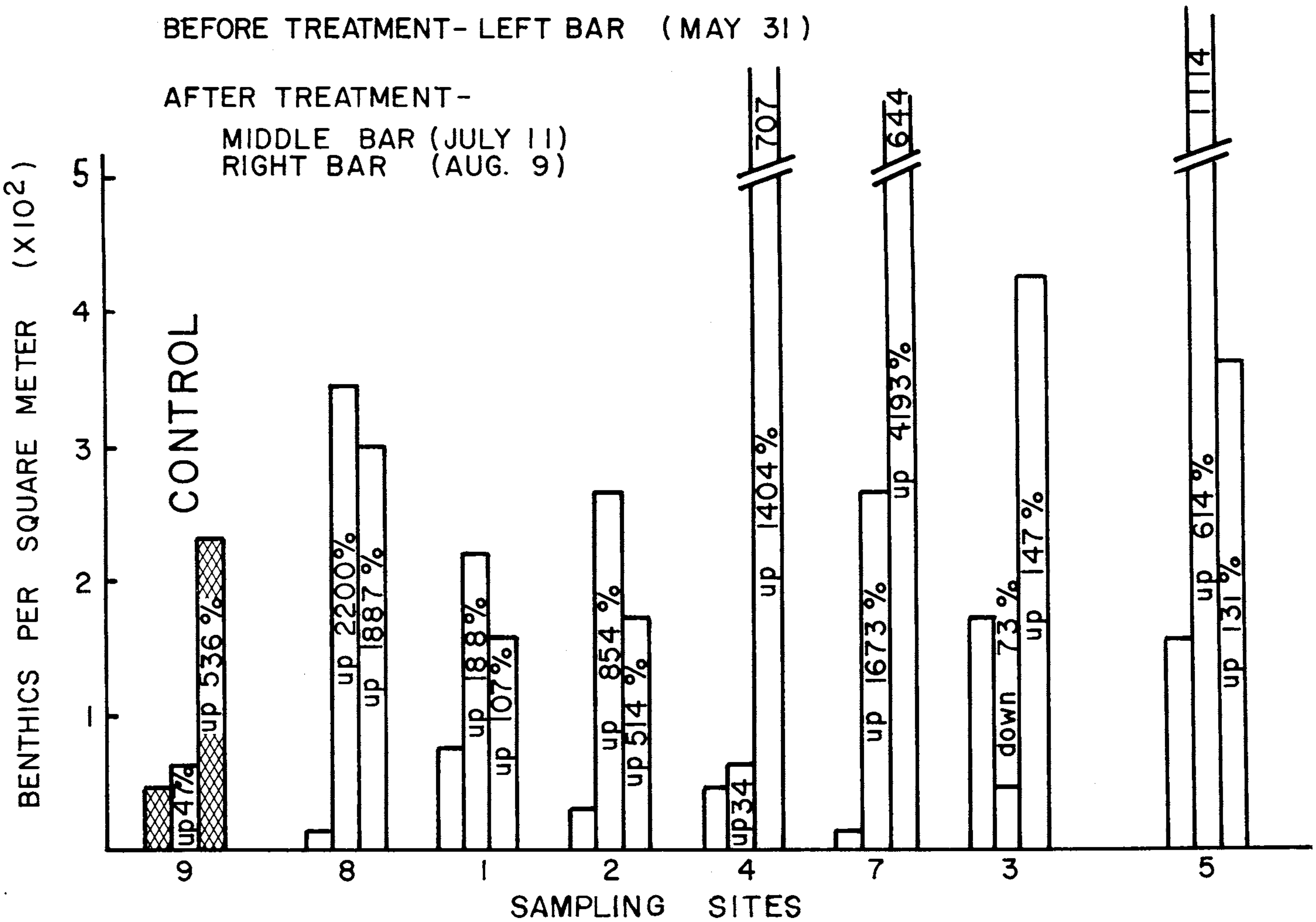

Figure 4. Total Benthis Macroinvertebrates per square meter from sampling sites in Kerr Reservoir and South Canadian River (5) before and after treatment with 2,4-D.

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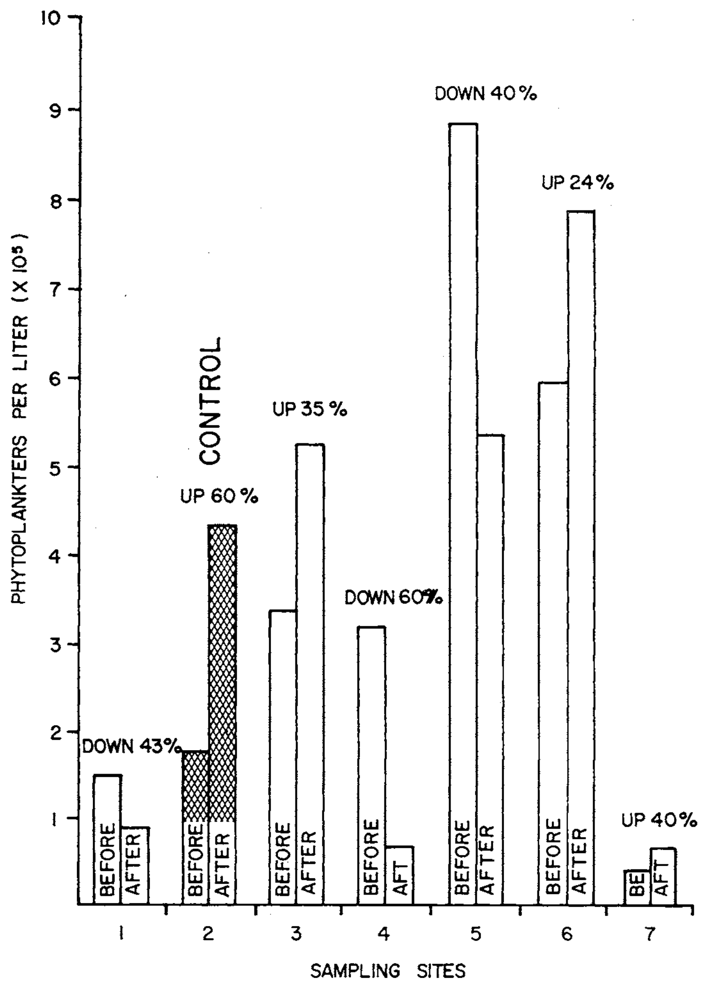

Figure 5. Total phytoplankters from sampling sites in Kerr Reservoir before and after treatment with 2,4-D. 1977.

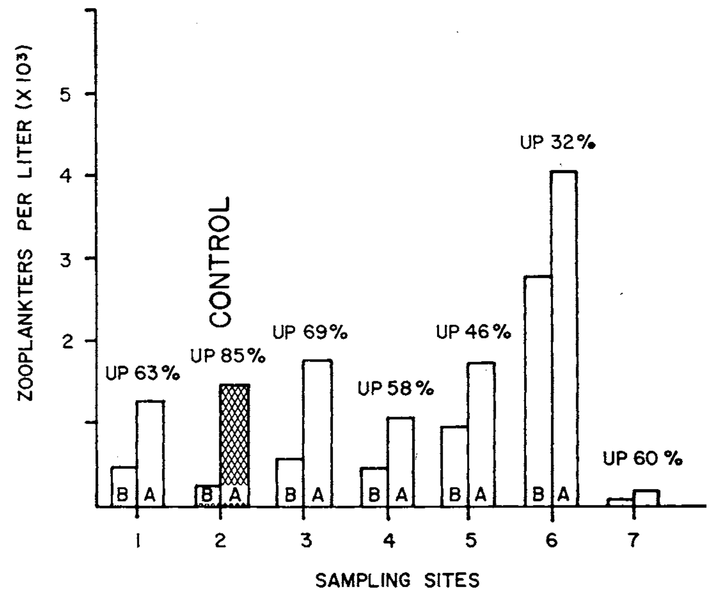

Figure 6. Total zooplankters from sampling sites in Kerr Reservoir before and after treatment with 2,4-D. 1977.