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A PRELIMINARY ANALYSIS OF WATER POLLUTION SURVEILLANCE SYSTEM PLANKTON DATA for the NORTHWEST REGION

CLEAN WATER

FEDERAL WATER
POLLUTION CONTROL
ADMINISTRATION
NORTHWEST REGION

PORTLAND, OREGON

A PRELIMINARY ANALYSIS OF WATER POLLUTION SURVEILLANCE SYSTEM PLANKTON DATA FOR THE NORTHWEST REGION

Prepared by

Pollution Surveillance Branch

Office of Technical Programs

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Conclusions or recommendations made or inferred in this working paper are tentative and subject to reconsideration as research proceeds on this subject.

CONTENTS

INTRODUCTION

The Water Pollution Surveillance System (WPSS) was established in 1957 to collect, evaluate and disseminate water quality data for application to programs for the prevention, control and abatement of water pollution.

Consultations with water quality management and resource development agencies revealed that plankton measurements were a necessity in meeting the biological objectives of the program. It was hoped that variations in water quality would be evidenced by monthly and yearly differences in population cycles and community structure.

Nationally 50 sampling locations were initially authorized, with plans for future establishment of approximately 400. Sampling stations were selected on the basis of the following criteria: (a) major waterways, (b) interstate, coastal and international boundary waters, and (c) waters on which water management activities may have an impact. Fourteen of these stations were established in the Pacific Northwest.

Passage of the Water Quality Act of 1965 gave increased emphasis to certain water uses and called for the establishment of water quality standards for the maintenance and improvement of interstate and coastal waters. Pollution surveillance, in addition to obtaining basic data, dealt with the more comprehensive task of evaluating water quality with regard to water quality standards and specific pollution problems.

Purpose

The purpose of this paper is to present a preliminary evaluation of plankton data collected in the Pacific Northwest Region and to make recommendations regarding the advisability of continuing this data collection for pollution surveillance purposes.

CONCLUSION

Under the proper conditions, plankton data can be a useful parameter in itself; however, its present role is to lend support to chemical and physical data. These plankton data have provided almost ten years of "baseline" data at certain points in the Northwest Region. At a later date, if needed, these data could prove to be of historic value if and when a comparison needed to be made between two periods of time to determine water quality changes.

However, it is recommended that routine plankton sampling be discontinued as a Pollution Surveillance Branch function until a biological sampling program can be designed which will best meet the immediate needs of the Branch.

DESCRIPTION AND EVALUATION

Study Area and Stations

The Columbia River drains an area of approximately 259,000 square miles, of which 3,000 square miles are lakes, reservoirs and channels. Water use varies greatly, depending on the area of the basin. Generally, the industrial use is concentrated in the lower river, while agricultural activities predominate in the upper river. Hydroelectric interests, both public and private, have constructed many dams along the river. Figure 1 shows the location of dams and WPSS plankton sampling stations within the basin. Table 1 presents the dates of initiation and termination of plankton sampling at these stations along with their "river mile" location, and Table 2 shows the total storage and year of construction of each hydroelectric facility on the Columbia River.

Because of limitations imposed on the establishment of stations, only six were initiated along the 745 miles of Columbia River flowing within the United States. Since the start of this program, plankton sampling at Bonneville Dam, McNary Dam and Wenatchee, Washington has been terminated. Elimination of these stations increased the distance between the remaining stations on the Columbia River main stem as follows: Clatskanie to Pasco, 275.2 river miles, and Pasco to Northport, 416.0 river miles.

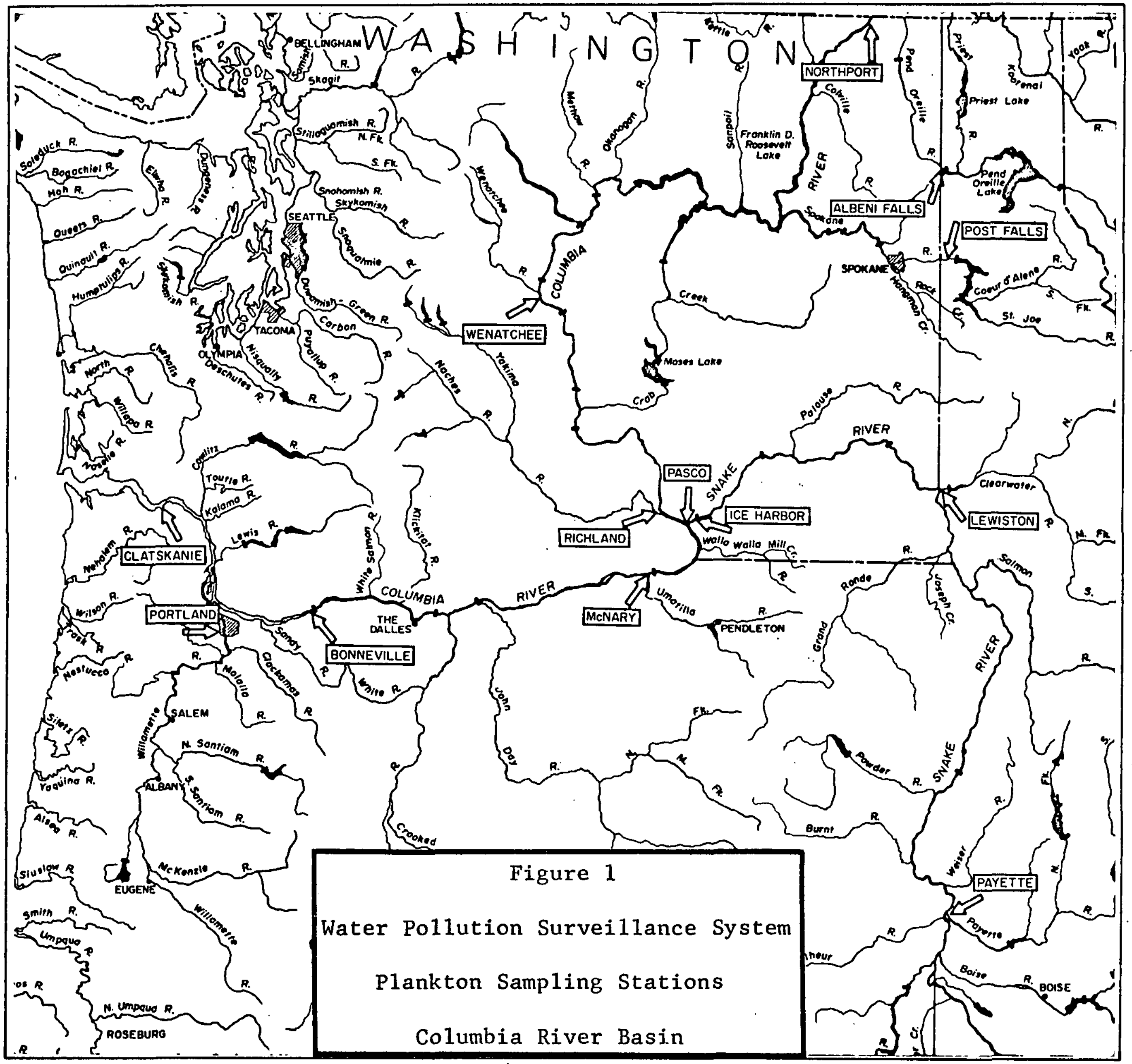


Figure 1

Water Pollution Surveillance System

Plankton Sampling Stations

Columbia River Basin

TABLE 1

PLANKTON SAMPLING STATIONS IN THE COLUMBIA RIVER BASIN

MAP STATION NUMBER	STATION NAME	RIVER	RIVER MILE	TRIBUTARY TO	DATE BEGAN	DATE ENDED
1	Clatskanie	Columbia	53.8	Pacific Ocean	4/58	9/67
2	Bonneville	Columbia	146.1	Pacific Ocean	3/57	7/65
3	McNary	Columbia	292.0	Pacific Ocean	4/61	7/65
4	Pasco	Columbia	329.0	Pacific Ocean	1/58	9/67
5	Wenatchee	Columbia	458.2	Pacific Ocean	9/58	7/65
6	Northport	Columbia	745.0	Pacific Ocean	5/62	9/67
7	Portland	Willamette	8.5	Columbia	8/62	9/67
8	Ice Harbor	Snake	9.7	Columbia	5/62	9/67
9	Payette	Snake	365.6	Columbia	11/61	8/67
10	Lewiston	Clearwater	2.0	Snake	10/61	9/67
11	Richland	Yakima	3.0	Columbia	4/61	9/67
12	Post Falls Dam	Spokane	102.1	Columbia	5/62	9/67
13	Albeni Falls Dam	Pend Orielle	90.1	Columbia	5/62	8/67
*14	Wawawai	Snake	110.7	Columbia		

* Plankton Data not available for this station

TABLE 2

DAMS ON THE COLUMBIA RIVER

FACILITY	RIVER MILE	STORAGE (Acre Feet)	DATE COMPLETED
Bonneville	146.1	719,000	1938
The Dalles	191.5	332,500	1957
John Day	215.6	2,100,000	1968
McNary	292.0	1,350,000	1957
Priest Rapids	397.1	198,700	1960
Wanapum	415.0	669,700	1963
Rock Island	453.4	8,600	1953
Rocky Reach	474.5	101,400	1961
Wells	516.6	330,000	1967
Chief Joseph	545.1	518,000	1955
Grand Coulee	596.6	9,562.000	1941

Noting the dates of dam construction and the date of station iniation (Table 1), it can be seen that the addition of more sampling points might have improved the adequacy of the data. For example, the Pasco station initially monitored the discharge from Rock Island Dam and the Hanford Reservation along an uninterrupted stretch of river. By 1963 Wanapum and Priest Rapids Dams had been completed and had converted a large portion of the river into a lentic environment still monitored only by the Pasco station. Under these and other circumstances, the relocation or addition of stations would have been desirable.

Other sampling stations with the exception of the one at Lewiston, Idaho on the Clearwater River, were located on major tributaries to the Columbia.

Collection and Analyses of Samples

Sample bottles, each containing a proper volume of Merthiolate preservative, were shipped in mailing containers to the stations. After filling the sample bottle and completing the sample identification tag, the local cooperator promptly shipped the package to the Water Laboratory at Cincinnati, Ohio.

Plankton samples were collected directly from reservoirs, rivers or water plant intakes at a depth between 2 and 15 feet. Depending on the type of analysis to be performed the sample volume varied from one to three liters, but for most purposes one liter was sufficient.

Immediately prior to analysis the plankton sample was mixed by inverting the sample bottle at least seven times and a 50 to 100 ml aliquot was poured into a beaker. The contents of the beaker were again mixed, a one ml subsample was placed in a Sedgwick-Rafter plankton counting cell and allowed to settle for 15 minutes. If the sample was too dense or a large amount of silt present, the sample was diluted 5 to 10 times to facilitate counting.

Two "strip counts" across the chamber were made and the organisms identified to genus, or to species if possible, and recorded on a standardized bench sheet. With the exception of notations made of the number of empty diatom frustules only live cells were counted. For those samples which contained organisms too small to identify under the conventional magnification, a "wet mount" was made of the material and the count was completed.

From a centrifuged aliquot of the sample a permanent slide was prepared for the diatom species proportional count. Data from these counts were also tabulated on bench sheets and stored for reference.

Evaluation of Data

To facilitate preliminary data analysis, summaries of the bench sheets were made on the basis of major algal groupings. The summary pages were columned as to date of sample, coccoid green, filamentous green, coccoid blue-green, filamentous blue-green, "other algae", centric diatoms, pennate diatoms and the total number of live cells in the sample. No further taxonomic breakdown was considered on these sheets.

The number of total live algae, coccoid green algae, centric diatoms and pennate diatoms were used in all of the preliminary analyses. The other groups did not appear as frequently or as abundantly.

The aquatic environment undergoes seasonal changes and with these changes the floral and faunal communities change in individual numbers and types. For this reason, these data have been grouped by seasons of the year. "Seasons" were defined as:

Winter:	November, December, January
Spring:	March, April
Summer:	June, July
Fall:	September, October

Seasons in which the months of February, May and August were included depended strictly upon the weather. As an example, February was included with January where winter months are severe, but was included with March when winter conditions are moderate. A seasonal average was arrived at by dividing the total number of cells in a particular group for a given season by the number or samples collected during the season.

The plankton data for all stations were plotted on the basis of: (a) total live algae by dates, (b) live algae by season, (c) coccoid green algae by season, (d) centric diatoms by season, and, (e) pennate diatoms by season.

Results

Plankton data for the period of record, using the figures prepared according to total numbers and major groups, indicated a general increase in plankton numbers at most of the stations. This trend was verified by plotting both maximum and minimum seasonal values from the total live algae data (Appendix A).

The figures in Appendix A point out other features of the data. For example, the figure prepared for Clatskanie indicates a rapid increase in plankton numbers during 1962 which declined in 1963. This peak shows the influence of one sample, collected in the fall, which contained a large number of coccoid blue-green algae, *Coccochloris sp.* This alga appeared at an abundance of 108,032 cells/ml., on September 4, 1962. No other mass occurrence of this alga was observed in the data. The Snake River station at Payette, Idaho also exhibited a peak in plankton numbers during 1962. However, this station exhibits consistently high counts of centric diatoms and the 1962 peak is not the result of one sample or of high production during a particular season, but rather the production of centric diatoms through the entire year.

Also, from Appendix A, a sharp rise in plankton numbers was noted at the Columbia River stations of Clatskanie, Pasco and Northport, in 1965. Plankton summary sheets showed that this increase occurred at Northport during the spring and summer seasons.

At Pasco and Clatskanie the increase extended from summer into the fall season. There was no specific algal form found to be responsible for the increase, but rather an increase in total production was noted for the year.

Chemical and physical data have been compiled and stored with the plankton data. Most of the data are in the form of the Public Health Service WPSS Annual Compilation of Data booklets, through 1963, and the remainder available through the STORET system of data handling. Preliminary analyses using the parameters of pH, temperature, flow, alkalinity and total dissolved solids indicated no correlations with fluctuations in plankton numbers. Due to insufficient data on nitrogen and phosphorus no conclusions could be drawn.

DISCUSSION

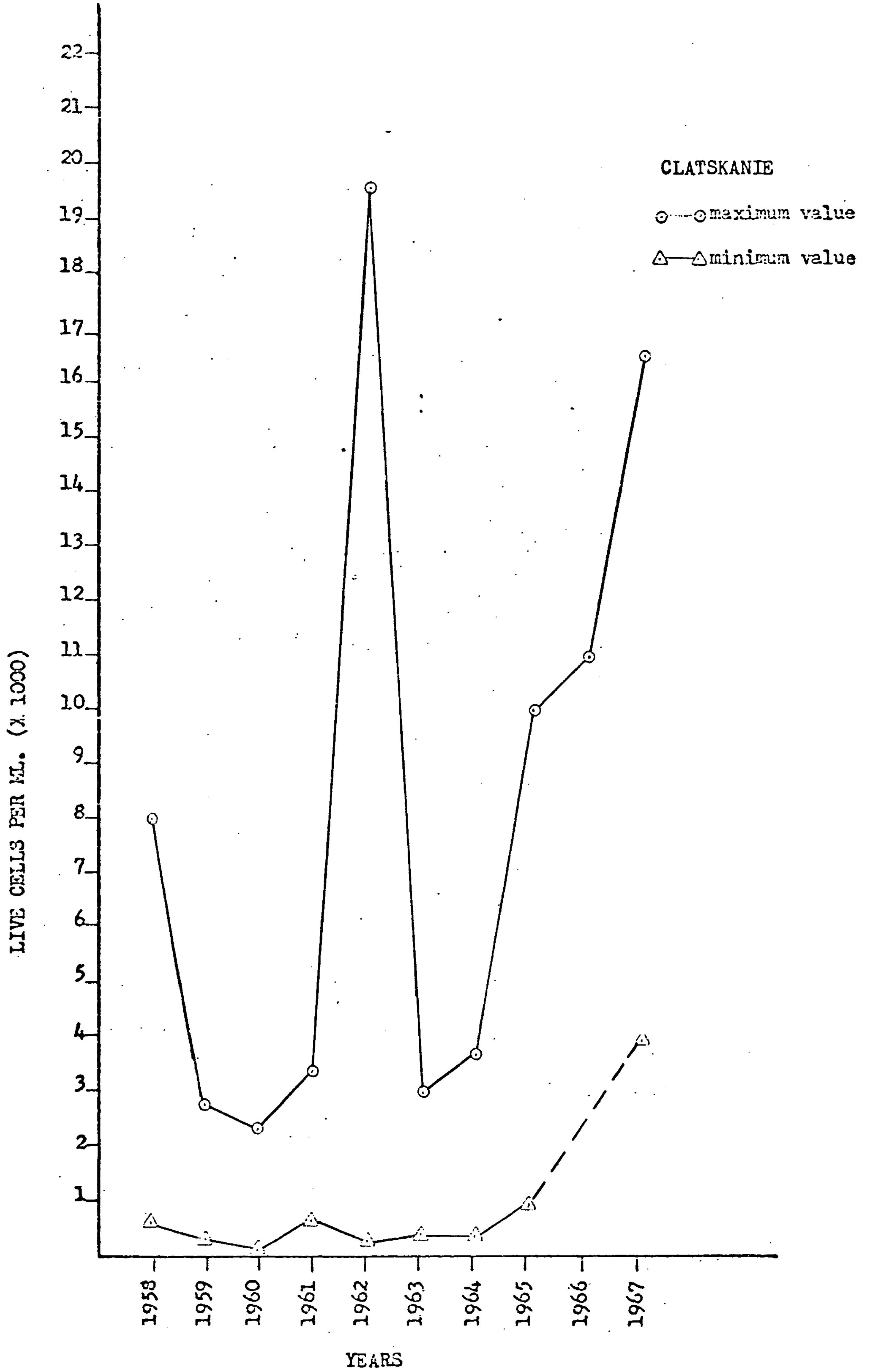
Irregularities in sampling frequency, questions concerning the use of sufficient preservative and practices employed for sample dilution tend to suggest false trends in the data. As previously mentioned, the collection of plankton samples was based on a local cooperator's assistance and in several instances difficulty in obtaining routine samples was encountered. For example, an examination of the seasonal data indicated a sharp increase in plankton numbers during 1967, but as few as three samples were collected at some stations, making the value of the data questionable for that year. A "defined" sampling program conducted by FWPCA personnel would provide more desirable data. Sampling programs must be tailored to meet the objectives of the study with due consideration being given to any factors which might modify the initial conditions. Periodic evaluations of data to note changes in species composition and population structures would be in order. Also, updating of information on changes in water use, such as dam construction or establishment of new irrigation programs, would be in order. By following this plan, alterations in sampling and, if needed, new sampling stations could be added to properly assess the situation.

It is difficult to use plankton data in a Pollution Surveillance program which emphasizes the compliance (or lack of compliance) with water quality standards. This is primarily true because there is no written water quality standard for plankton levels. With the development of a written standard, plankton data could assume a more influential role in Pollution Surveillance programs.

Plankton organisms can be defined as microscopic, weak swimming or passively floating plant or animal life which are subject to the action of waves or currents. As such, the unattached nature of these organisms reflect upstream water quality conditions at downstream locales. Plankton samples are, however, easy to collect but require highly skilled personnel for accurate analysis. Other methods of biological water quality evaluation, such as periphyton or benthic invertebrate analyses, would require as much or more effort but would better illustrate water quality at a given sampling point.

APPENDIX A

YEARLY MAXIMUM AND MINIMUM VALUES FROM SEASONAL LIVE ALGAE DATA AT EACH COLUMBIA BASIN SAMPLING STATION



CLATSKANIE
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1958
1959
1960
1961
1962
1963
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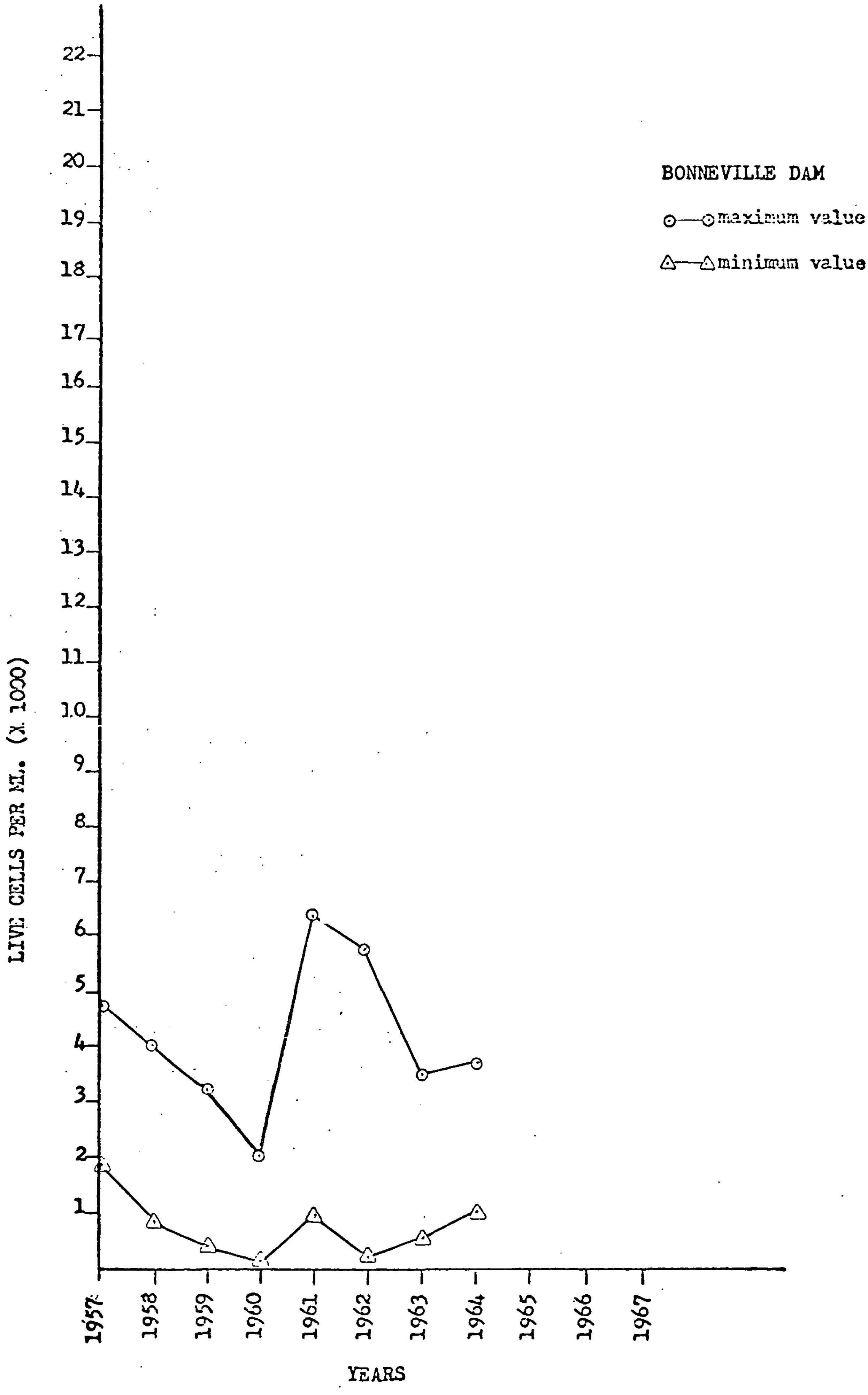
1965
1966
1967
YEARS



BONNEVILLE DAM
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1957
1958
1959
1960
1961
1962
1963
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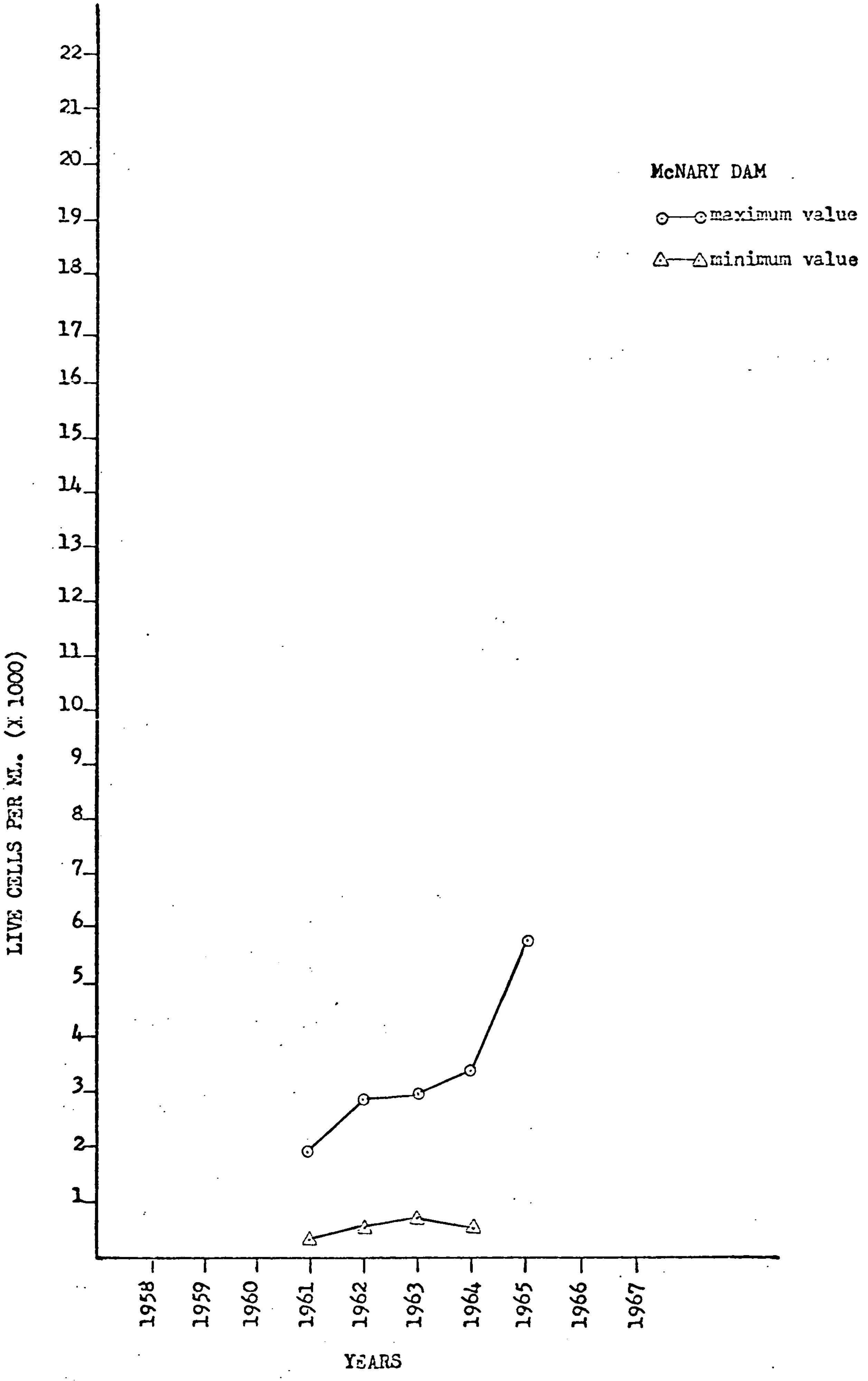
1965
1966
1967
YEARS



McNARY DAM
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
20
19
18
17
16
15
14
13
12
11
10
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8
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6
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1958
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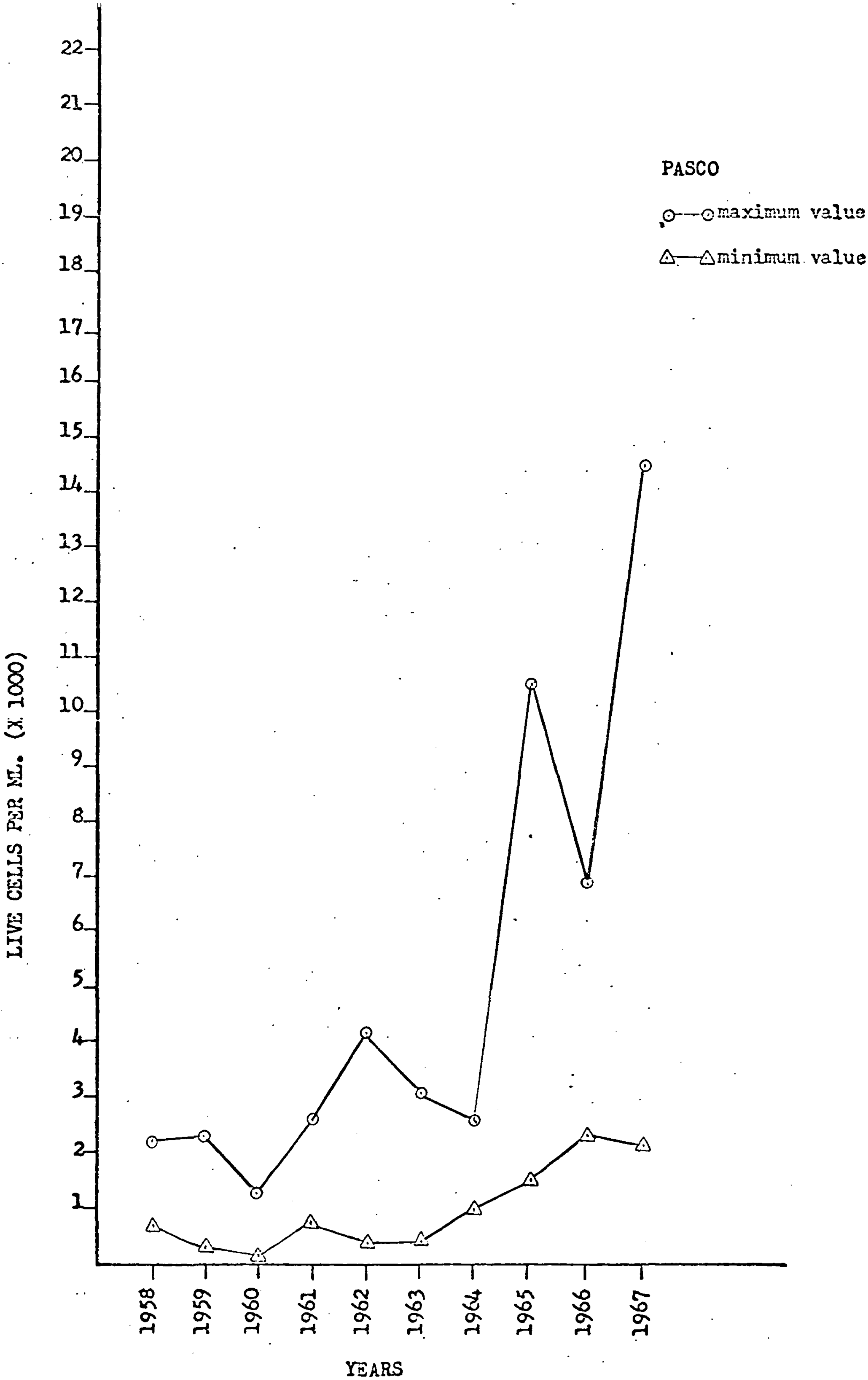
1967
YEARS



PASCO
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
20
19
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16
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14
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12
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1958
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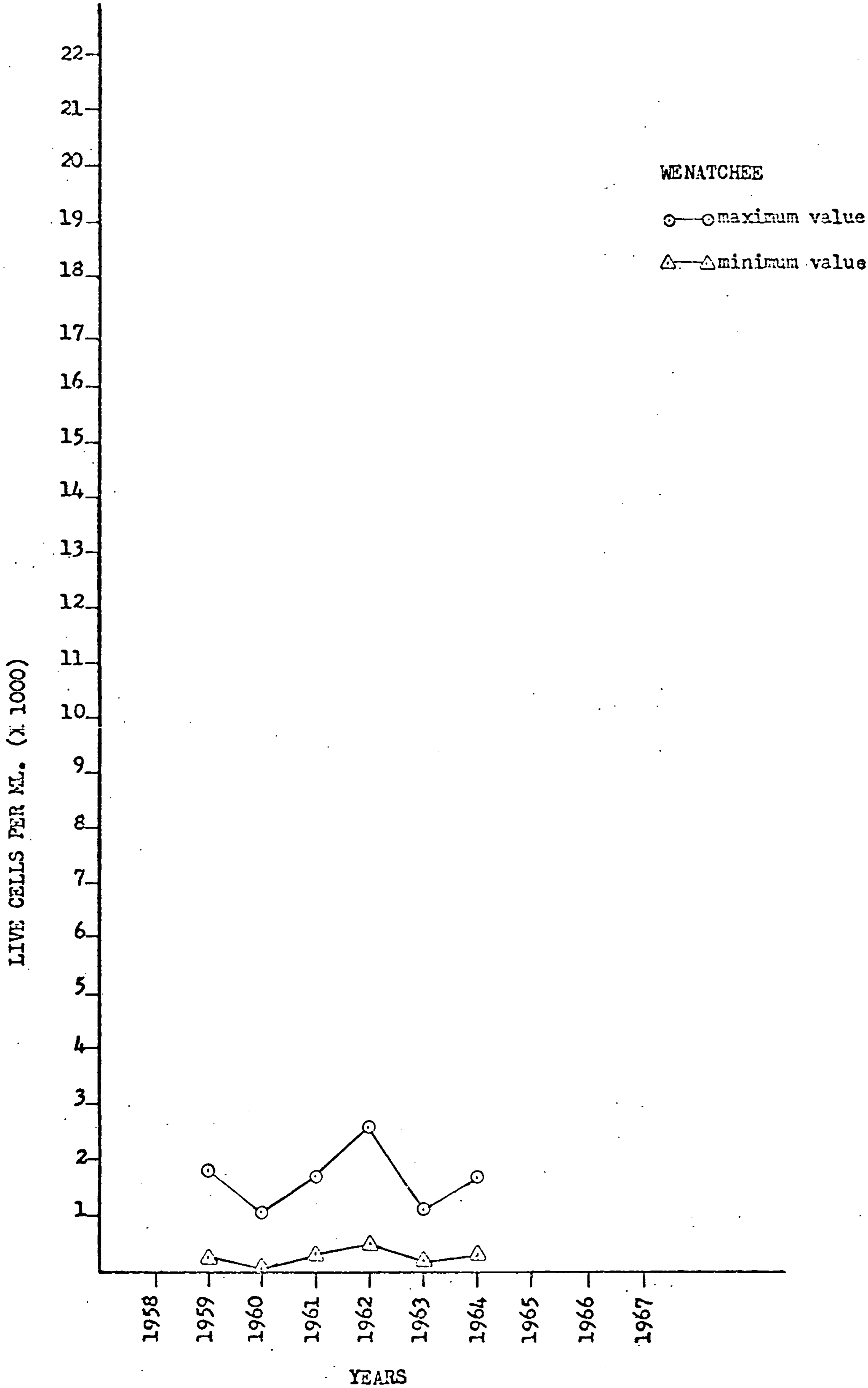
1966
1967
YEARS



WENATCHEE
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
YEARS
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1
2
3
4
5
6
7
8
9
10
11
12
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14
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16
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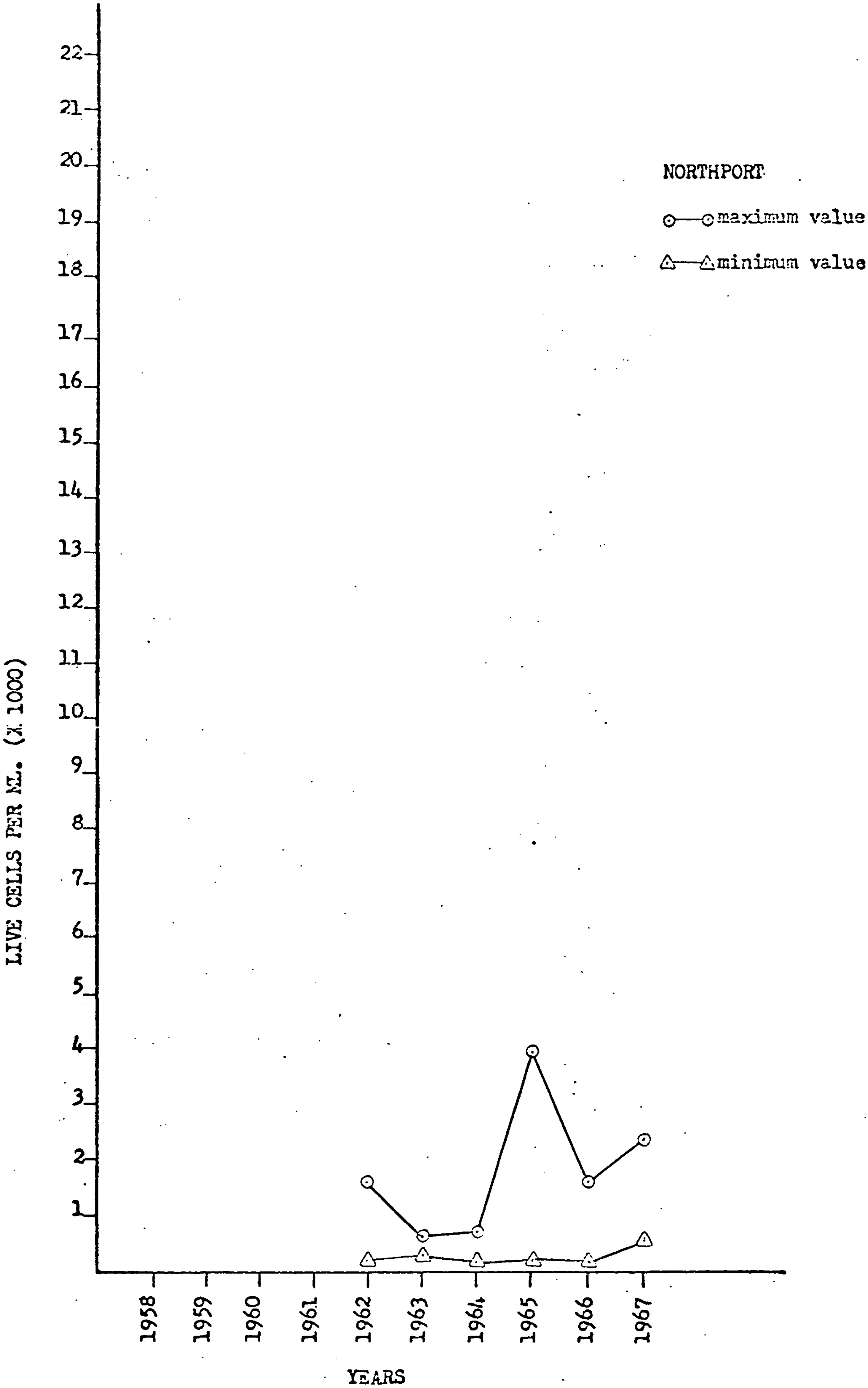
21
22


NORTHPORT
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
20
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18
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16
15
14
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12
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10
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1959
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1961
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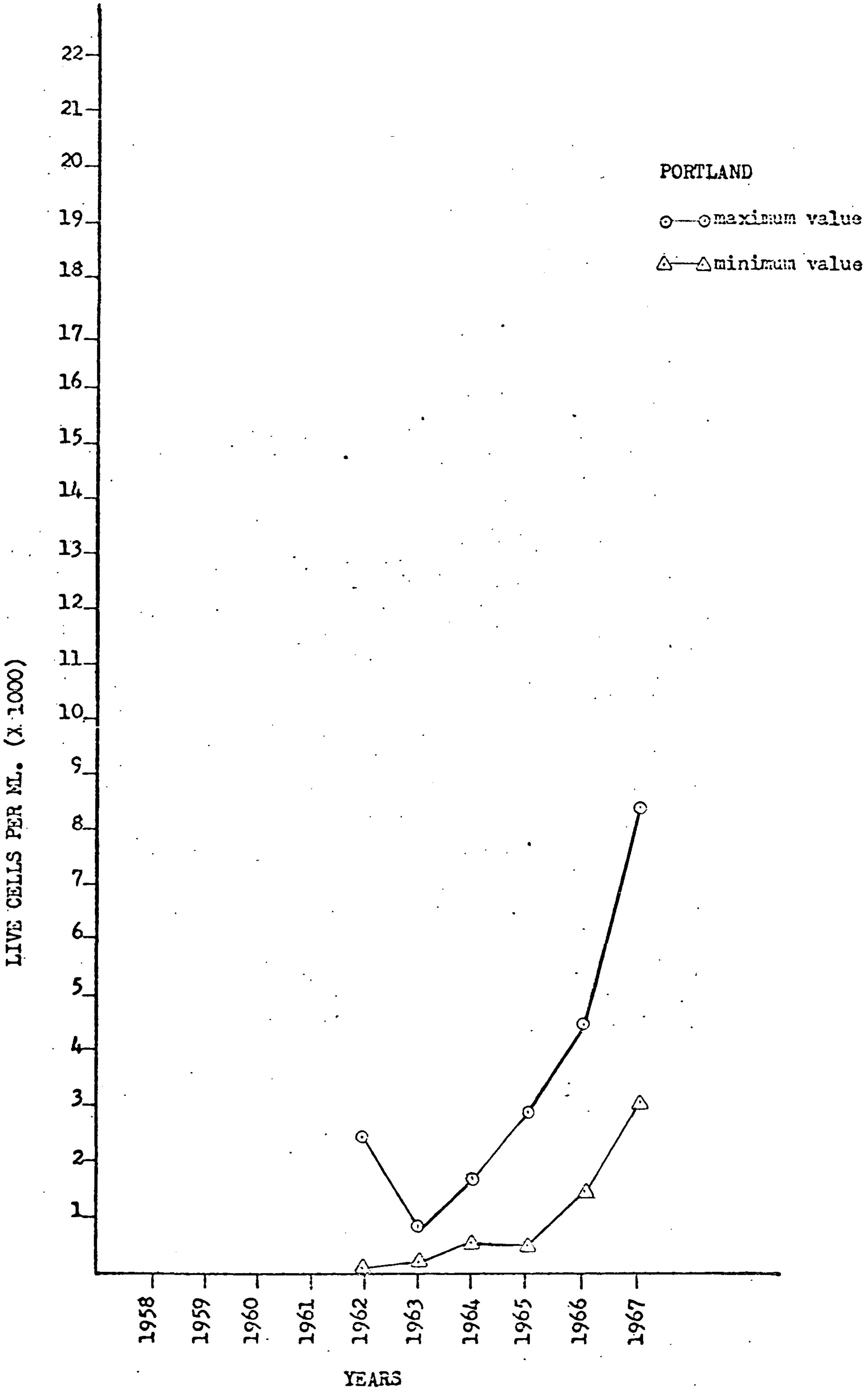
1964
1965
1966
1967
YEARS


PORTLAND
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
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12
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1958
1959
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1961
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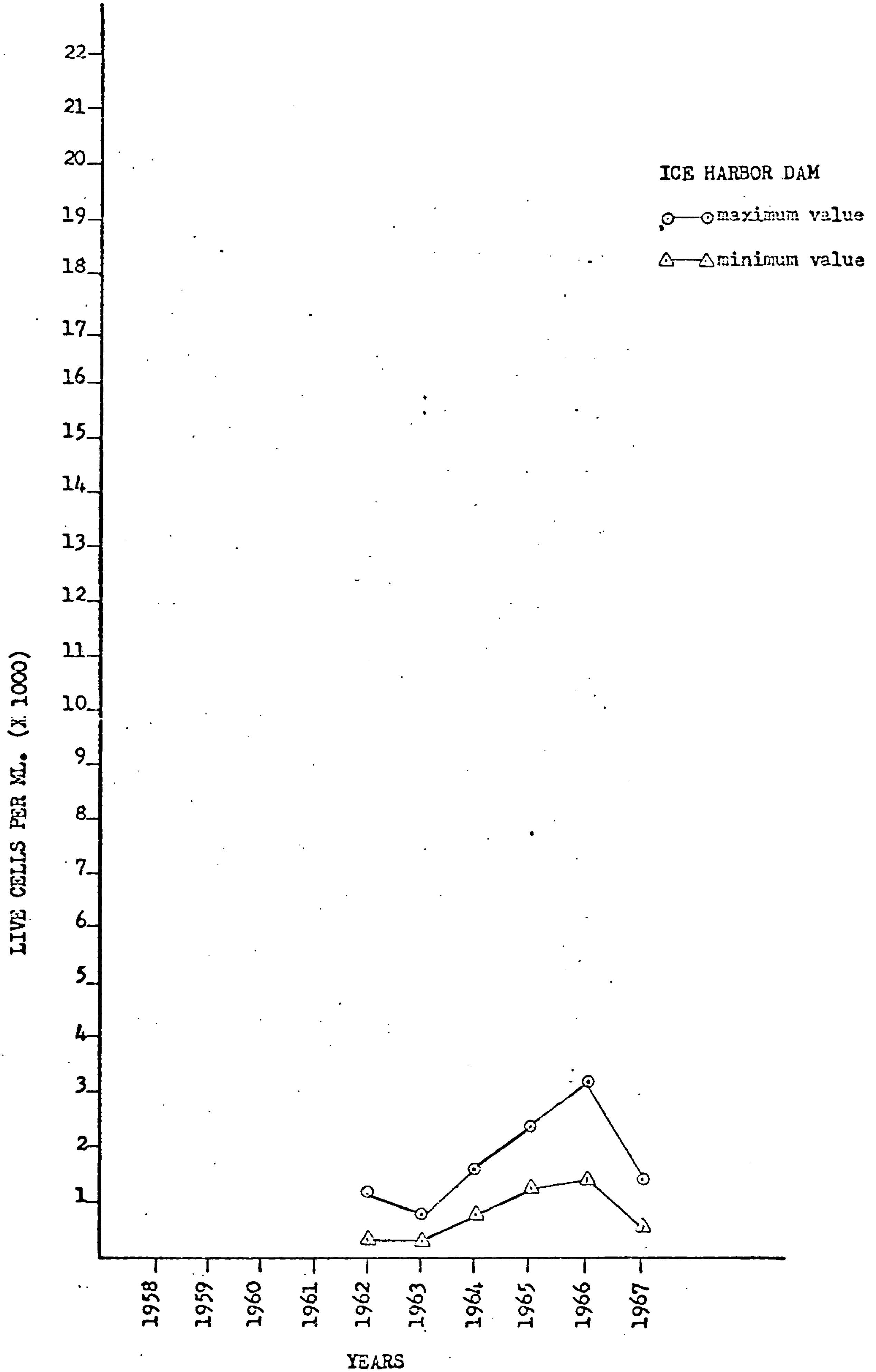
1966
1967
YEARS



ICE HARBOR DAM
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
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19
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16
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11
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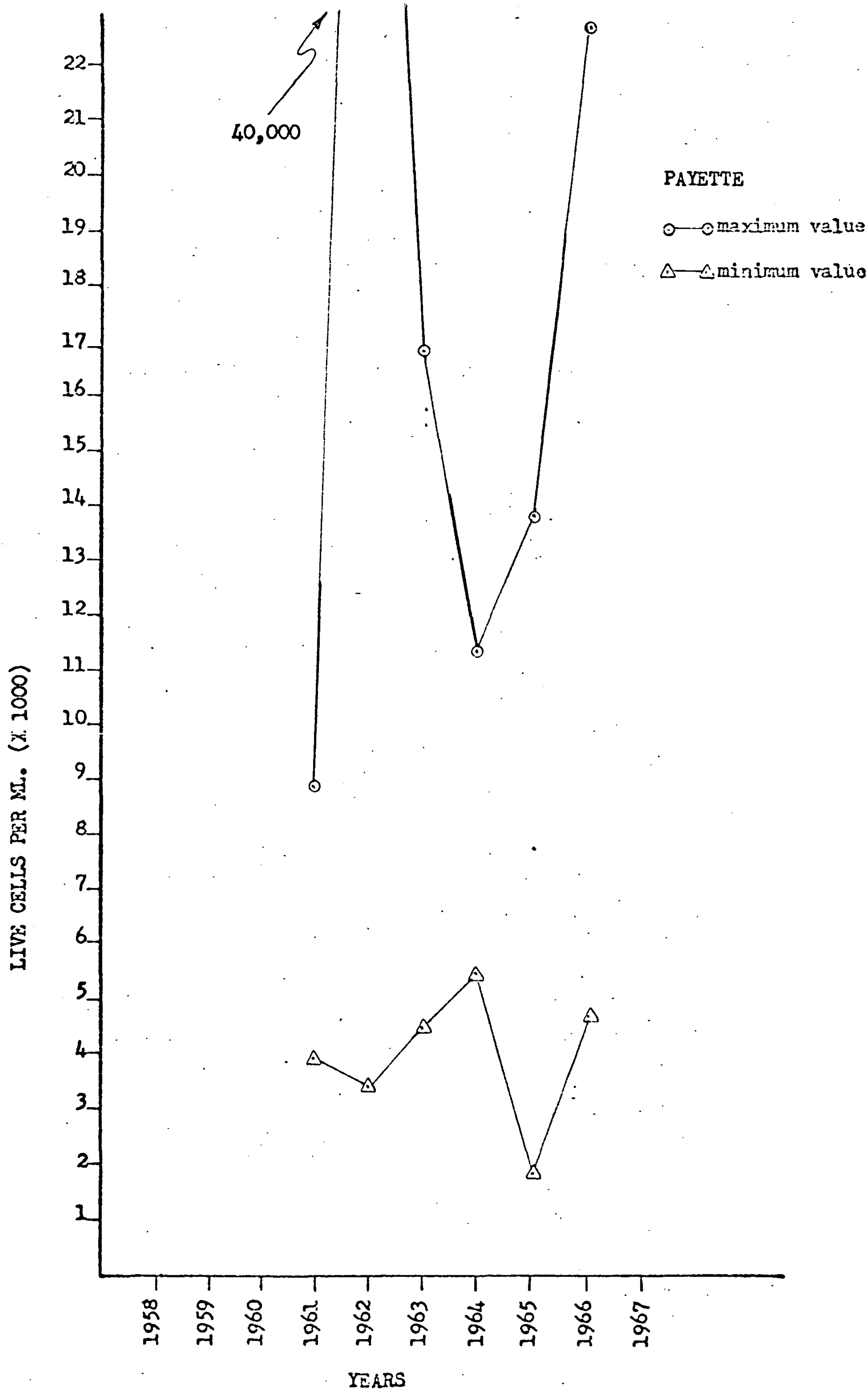
1965
1966
1967
YEARS



PAYETTE
maximum value
minimum value
40,000
LIVE CELLS PER ML. (X 1000)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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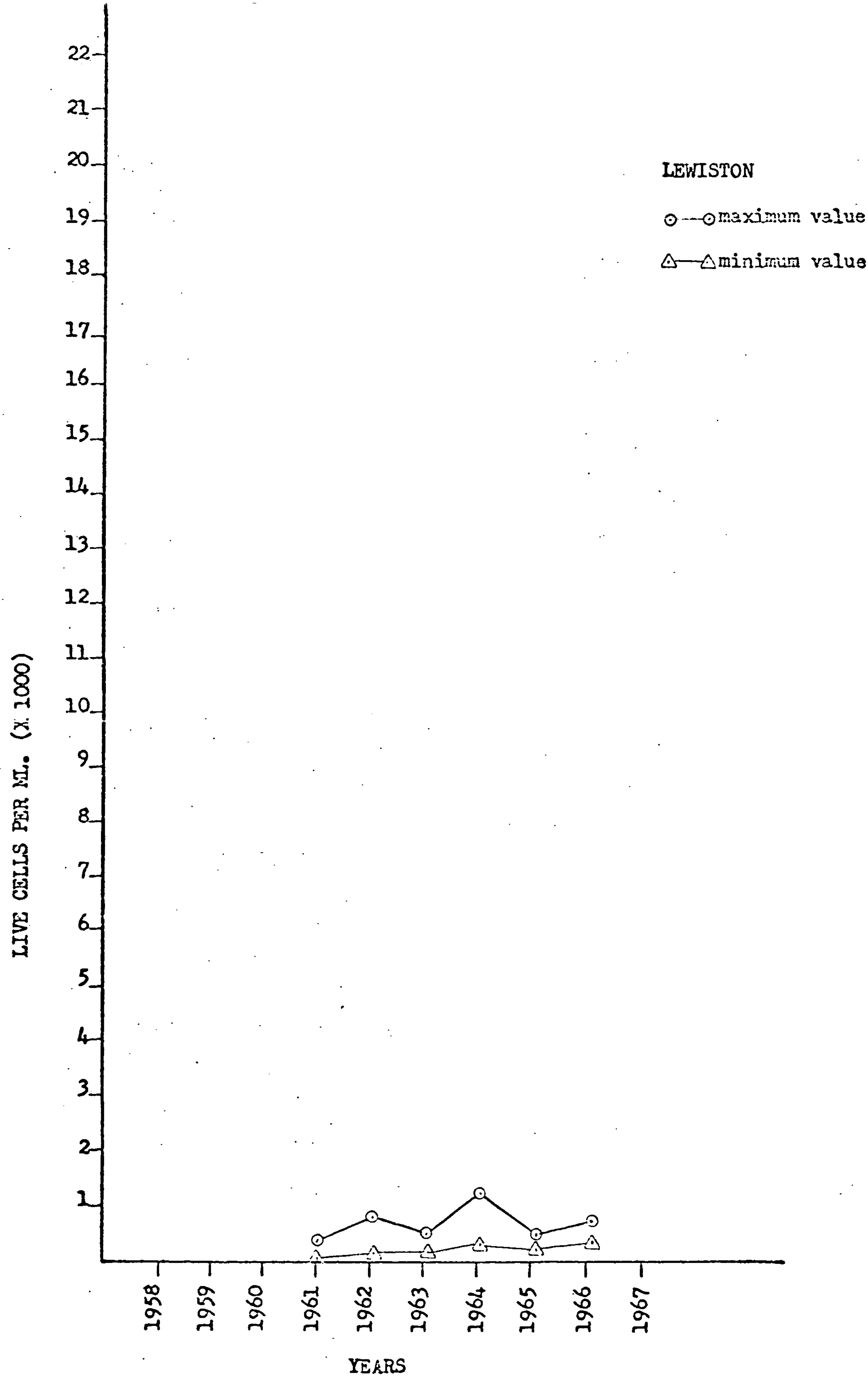
1967
YEARS


LEWISTON
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
21
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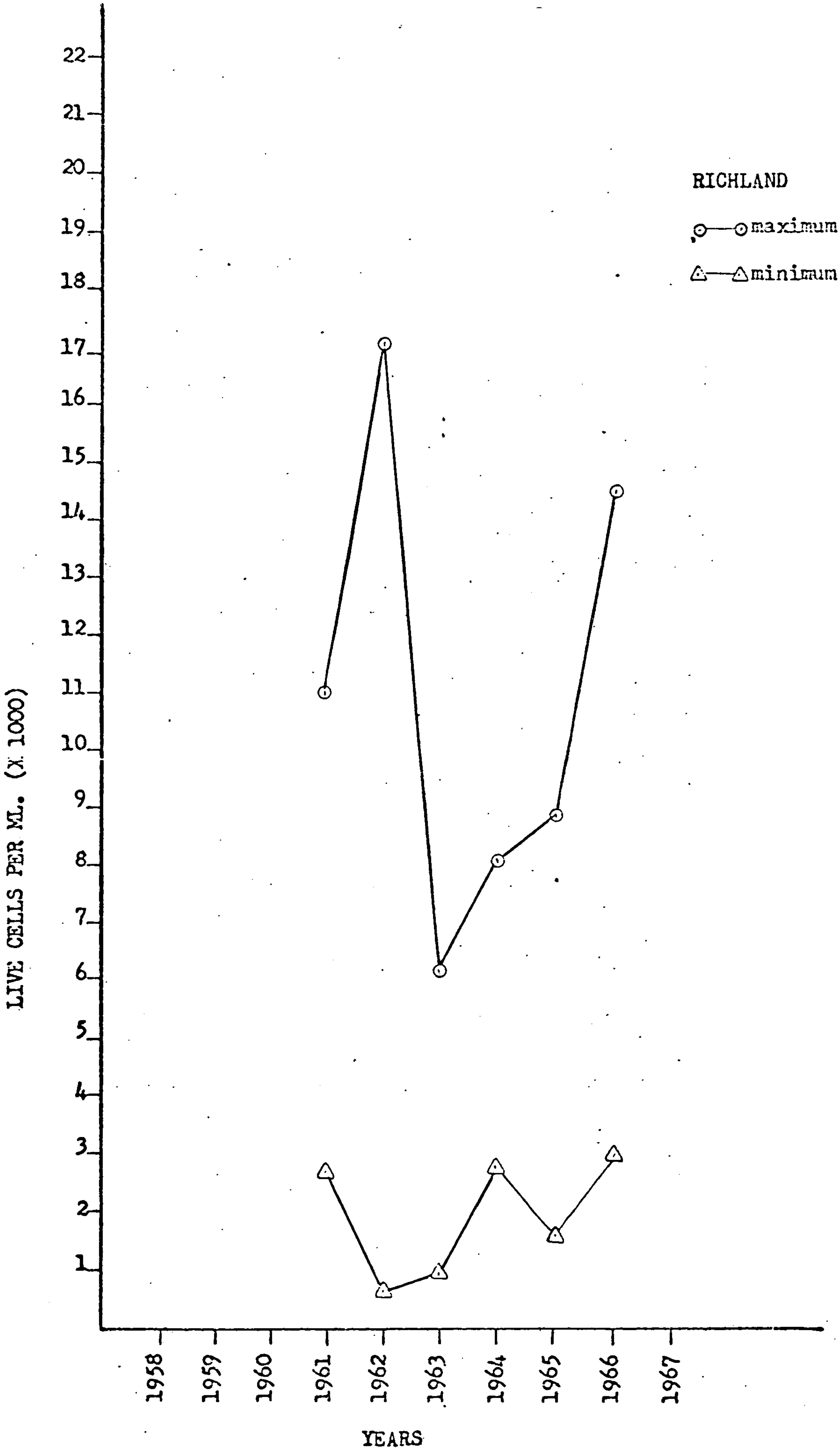
YEARS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LIVE CELLS PER ML. (X 1000)
RICHLAND
maximum value
minimum value
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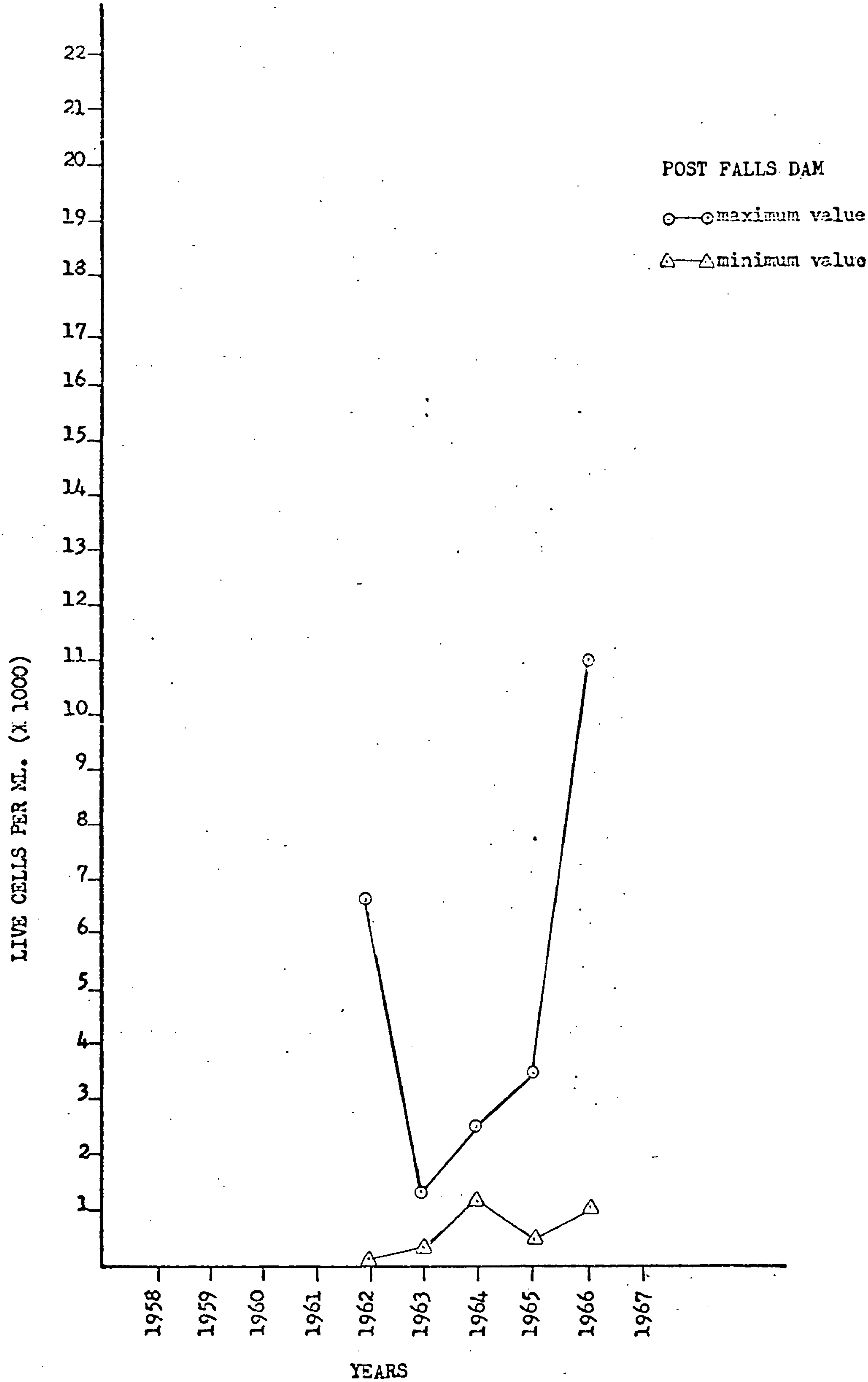
1967
YEARS



POST FALLS DAM
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
22
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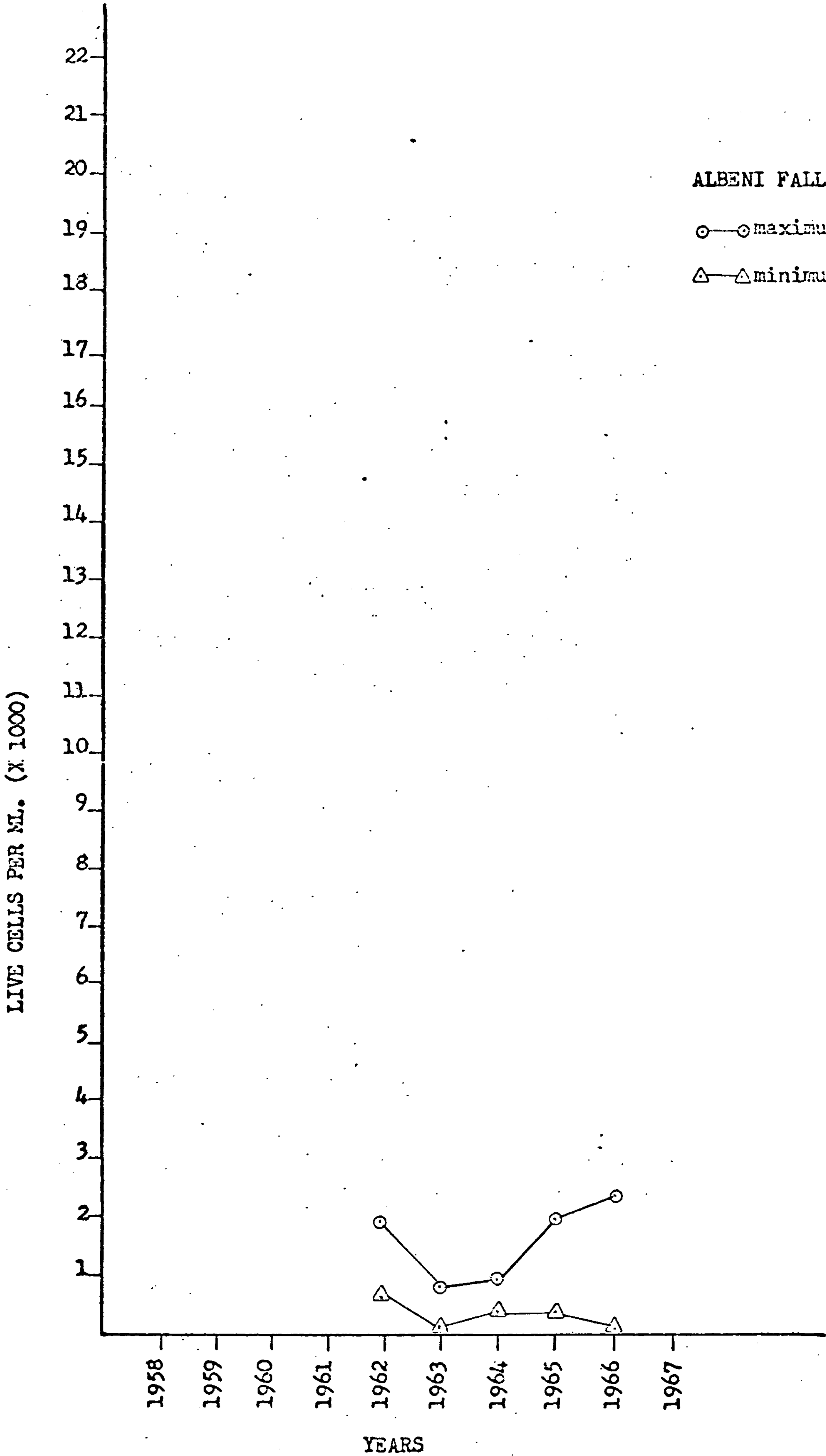
YEARS



ALBENI FALLS DAM
maximum value
minimum value
LIVE CELLS PER ML. (X 1000)
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12
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YEARS