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ENVIRONMENTAL PLANNING FOR AN ALASKAN
WATER-ORIENTED RECREATIONAL AREA

by

Jacqueline Doyle LaPerriere

IWR-90

June 1978

Environmental planning for an Alaskan water-oriented recreational area

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Completion Report
OWRT Agreement No. 14-31-0001-4056
Project No. B-026-ALAS

by

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ACKNOWLEDGMENTS

The investigator gratefully acknowledges the assistance of the cooperators, particularly that of personnel of the Sport Fish Division, Alaska Department of Fish and Game at Delta Junction, Fairbanks, and Palmer.

The generous provision of data by Dr. Daniel Smith, currently with R & M Consultants, Inc., is acknowledged. This research effort could not have been successful without the technical assistance of Martha Kandelin Baldridge, Brien McAuliffe, Roger Shum, and Donald Woodruff.

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INTRODUCTION

This research focused initially on delineation of the proper procedures to be applied when the state of Alaska, through the appropriate agencies, selects and develops water-based recreation areas. The Nancy Lakes recreational area was selected as a case study for testing these procedures. This area is located approximately 106 km (66 road miles) northwest of Anchorage along the Parks Highway (61°N,150°W). When the research was begun in July of 1973, this area was determined to be important to the future recreational needs of the residents of the growing municipality of Anchorage as well as to travelers between Fairbanks and Anchorage along the newly opened highway. Today, this area is even more important as the new capital of the state of Alaska will be located approximately 6 km (4 miles) east of Nancy Lakes.

In the summer of 1974, difficulties arose concerning the objectives of the project and the reports to be generated. Therefore, a decision was made to terminate the research at Nancy Lakes. A partial completion report was compiled concerning the work completed to September 1, 1974. This report was distributed to cooperators at the State of Alaska, Department of Natural Resources, Division of Parks; the Sport Fish Division of Alaska Department of Fish and Game, Palmer; and to the Office of Water Resources Research, the predecessor of the Office of Water Research and Technology.

The research has continued, focusing on the Tanana Lakes near Fairbanks, Alaska, (64°N,146°N) with the cooperation of the Sport Fish Division of the Alaska Department of Fish and Game, Fairbanks. These lakes, located within 160 km (100 miles) of Fairbanks, are important to the residents of Fairbanks, as well as to tourists driving to Fairbanks from the 48 continguous states. Many Fairbanks residents have cottages at one of the three largest of these, Harding, Birch, and Quartz Lakes. Several youth groups have summer camps on these lakes; the U. S. Army and the U. S. Air Force are currently sharing an extensive recreation facility at Birch Lake; and the state park at Harding Lake is one of the state's most utilized campgrounds.

The research on this lake group has focused on the variation in productivity between these lakes due to differences in lake morphometry and watershed characteristics, with some attempt to assess recreational impacts on their water quality.

OBJECTIVES

The principal objective of the Nancy Lakes portion of this study was to detail the procedures, methods, alternatives, and considerations necessary for the development of environmental management programs for Alaskan water-oriented recreational areas. The partial completion report concerning this part of the study contains an outline of three documents addressed to these objectives that were incomplete at the time a decision to terminate was made.

The principal objective of the Tanana Lakes portion of the study was to attempt to explain the differences in productivity between several lakes which were apparently formed at the same time by aggradation of the Tanana River (Blackwell, 1965). The hypothesis being tested was that the morphometry of the lakes and of their watersheds influences their relative productivity.

RESEARCH RESULTS

The limnological work at the Nancy Lakes is summarized in Table 1. The morphoedaphic index (MEI) calculated for the smaller lakes is used as a predictor of fish production. It is the ratio between an edaphic (effects due to soil) factor usually measured as total dissolved solids (total residues), and a morphometric parameter, namely mean depth. Unfortunately the smaller lakes, for which we were able to calculate this index, are not fished heavily enough to allow evaluation of fish production; conversely, the large lakes--Nancy, Red Shirt, Butterfly, and Lynx--had not been mapped before our project was terminated. Therefore, the regression between MEI and fish production cannot be tested.

Dissolved oxygen levels were found to be low in the hypolimnion (bottom waters) of Lynx Lake and near the inlets in Nancy Lake. Our data also showed some possibility that dissolved oxygen was low in the

TABLE 1. MORPHOEDAPHIC INDICES FOR SELECTED LAKES OF THE NANCY LAKES AREA

Lake	Color	Total Dissolved Solids (mg/l)	Alkalinity (mg/l as $CaCO_3$)	Mean Depth (m)	Morphoedaphic Index (MEI)*
Nancy	20	81	45.0		
Red Shirt	15	65	42.0		
Butterfly	15	44	17.5		
Lynx	15	95	38.5		
Sheetna	20	48	18.5	5.0	9.6
Heart	35	30	9.0	4.8	6.2
Chicken	5	18	9.0	8.2	2.2
James	20	18	9.0	2.9	6.2
Owl	25	24	5.0	2.7	8.9
Big Noluck	30	18	9.0	4.6	3.9
Milo #1	15	13	5.5	9.3	1.4

*Total Dissolved Solids (mg/l)/mean depth (m) hypolimnion of Butterfly Lake. Several of the smaller lakes that are deep enough to stratify in the summer also gave some evidence of hypolimnetic oxygen depletion.

The morphoedaphic indices for the Tanana Lakes are given in Table 2. While fish yield has not been monitored for these lakes since no commercial fishing takes place on them, studies of the growth of stocked fishes in these lakes have been conducted. One of the sportsfish biologists in charge of these lakes for the Alaska Department of Fish and Game ranks their fish growth potential from highest to lowest as follows: Quartz, Birch, Little Harding, Chisholm, and Harding (M. J. Kramer, 1977, personal communication). He notes that Birch, Chisholm, and Little Harding are hard to separate and rank, that Quartz has perhaps the best growth potential in interior Alaska, and that Harding Lake, while reputed to provide poor sportsfishing, is currently producing silver salmon (*Oncorhynchus kisutch*) as large as 4.5 kgm (10 lbs) in their last year of life.

In a comprehensive review of the concept of the morphoedaphic index, Ryder et al. (1974) compare this index to other models of lake productivity. Schindler (1971), whose model, they found, differs only by scale, hypothesizes a linear relationship exists between several types of measurements of lake productivity and the ratio

$$\frac{A_d + A_o}{V}$$

where:

A_d = area of the terrestrial watershed
A_o = area of the lake surface
V = volume of the lake

Schindler's basic assumption is that the input of the particular nutrients limiting productivity is directly proportional to the size of the entire watershed and inversely proportional to the volume of the lake. He also assumed for his lakes that the main source of this nutrient was precipitation. This latter assumption seemed to apply well to the Tanana Lakes though only a few analyses of the nutrients in precipitation were conducted during our three-year study of Harding Lake.

TABLE 2. MORPHOEDAPHIC INDICES - TANANA LAKES

Lake	Total Dissolved Solids (mg/l)	Alkalinity (mg/l as $CaCO_3$)	Mean Depth (m)	Morphoedaphic Index (MEI)
Harding	34	29	16	2.1
Little Harding	42	36	3.7	11
Chisholm (Lost)	43	24	5.8	7.4
Birch	68	42	5.5	12
Quartz	227	218	3.4	67

Attempts to apply Schindler's hypothesis to the Tanana Lakes were made when it was found that nearly the same relationship between lake color and the ratio A_d/A_o is found for the Tanana Lakes (Figure 1) as for Schindler's lakes, all of which lie on the Canadian Shield in an area near Kenora, Ontario. In fact, Schindler's equation

$$C = 2.74 + 2.90(A_d/A_o)$$

is predictive for the Tanana Takes. Schindler's basic assumption is that, if the soils and vegetation in the various watersheds are similar, then this linear color relationship would be found. Can the logic be turned around to conclude that if the color relationship holds when the soils and vegetation of the watersheds are similar? We have some evidence to say not.

Figures 2 and 3 show that we were unable to confirm Schindler's open hypothesis. Algal growth parameters for the Tanana Lakes are not significantly linearly regressed with the factor $(A_o + A_d)/V$.

In Figure 2, the 1975 data points for Quartz and Chisholm Lakes appear to be outliers. The exclusion of all 1975 data for C-12 fixation may be justified since the batch of C-14 labeled bicarbonate used during this period had an unacceptably high variation in counts per minute with some ampules having twice the activity of the others. With that modification though, we would be left with a fairly meaningless regression on three points.

In any case, the regression with chlorophyll *a* content is also poor (Figure 3) and for those analyses there is no determinant error that can be identified. When summer average total N is plotted versus $(A_o + A_d)/V$ there is also no apparent regression (Figure 4). Quartz Lake and Little Harding Lake are both outliers.

Examination of Figure 5 shows that, in the case of Quartz Lake compared to its sister lakes, MEI and $(A_o + A_d)/V$ are not similar indices that differ only by scale. A probable explanation is that there is some geological formation in the Quartz Lake watershed which is contributing to the high alkalinity of this lake and which is not present in the other watersheds.

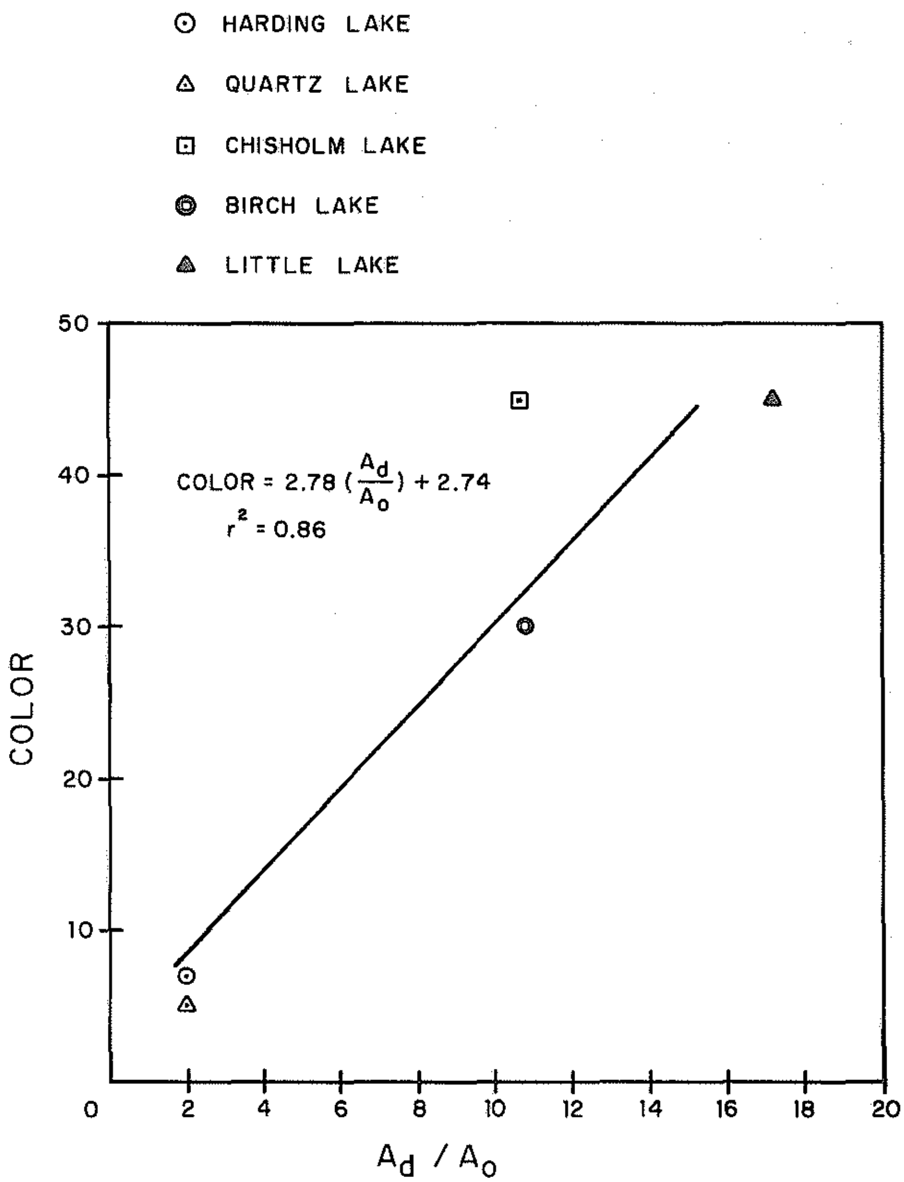

Figure 1: RELATIONSHIP BETWEEN WATER COLOR AND A_d/A_o

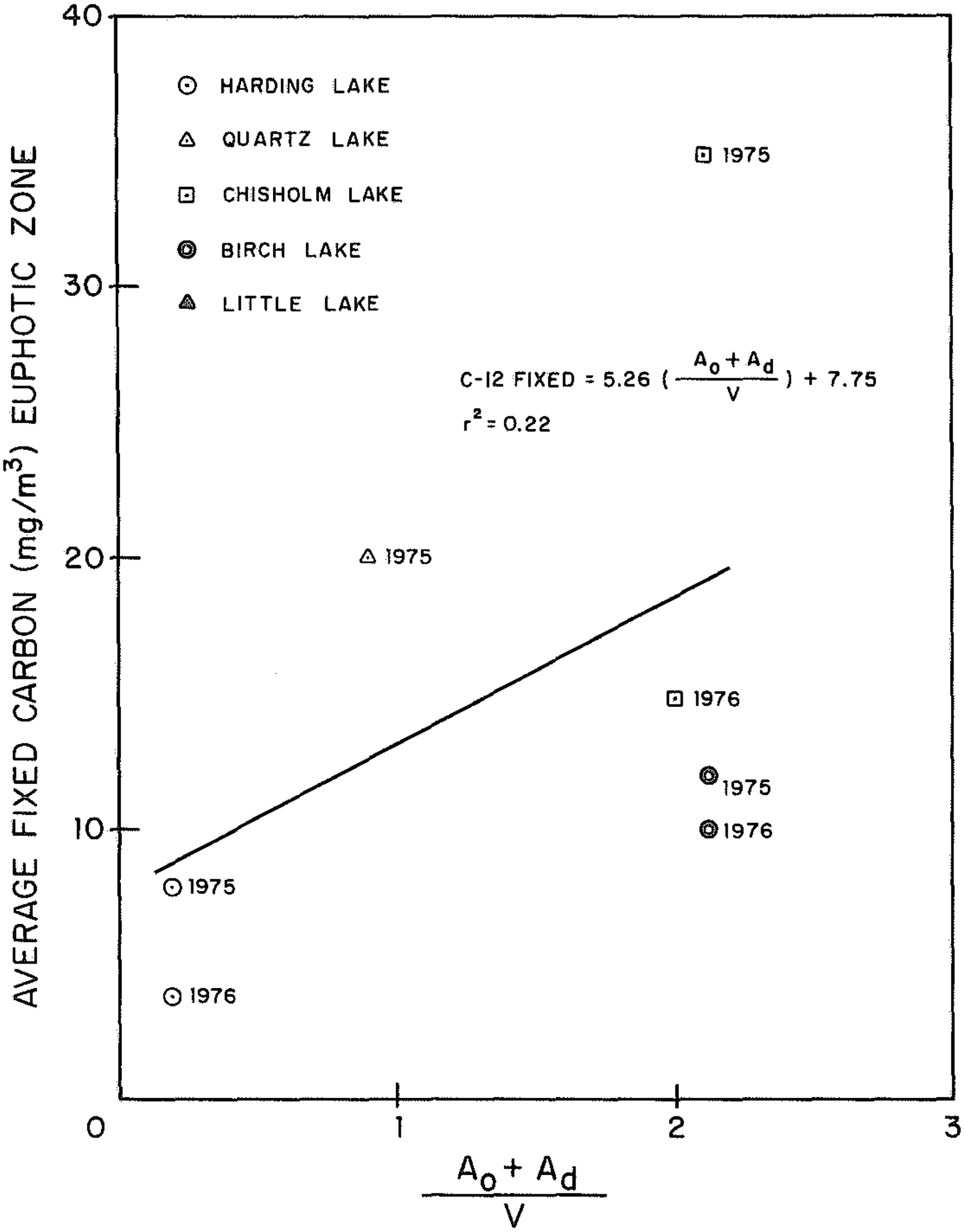

Figure 2: RELATIONSHIP BETWEEN AVERAGE CARBON FIXED IN THE EUPHOTIC ZONE (SUMMER) AND SCHINDLER'S INDEX.

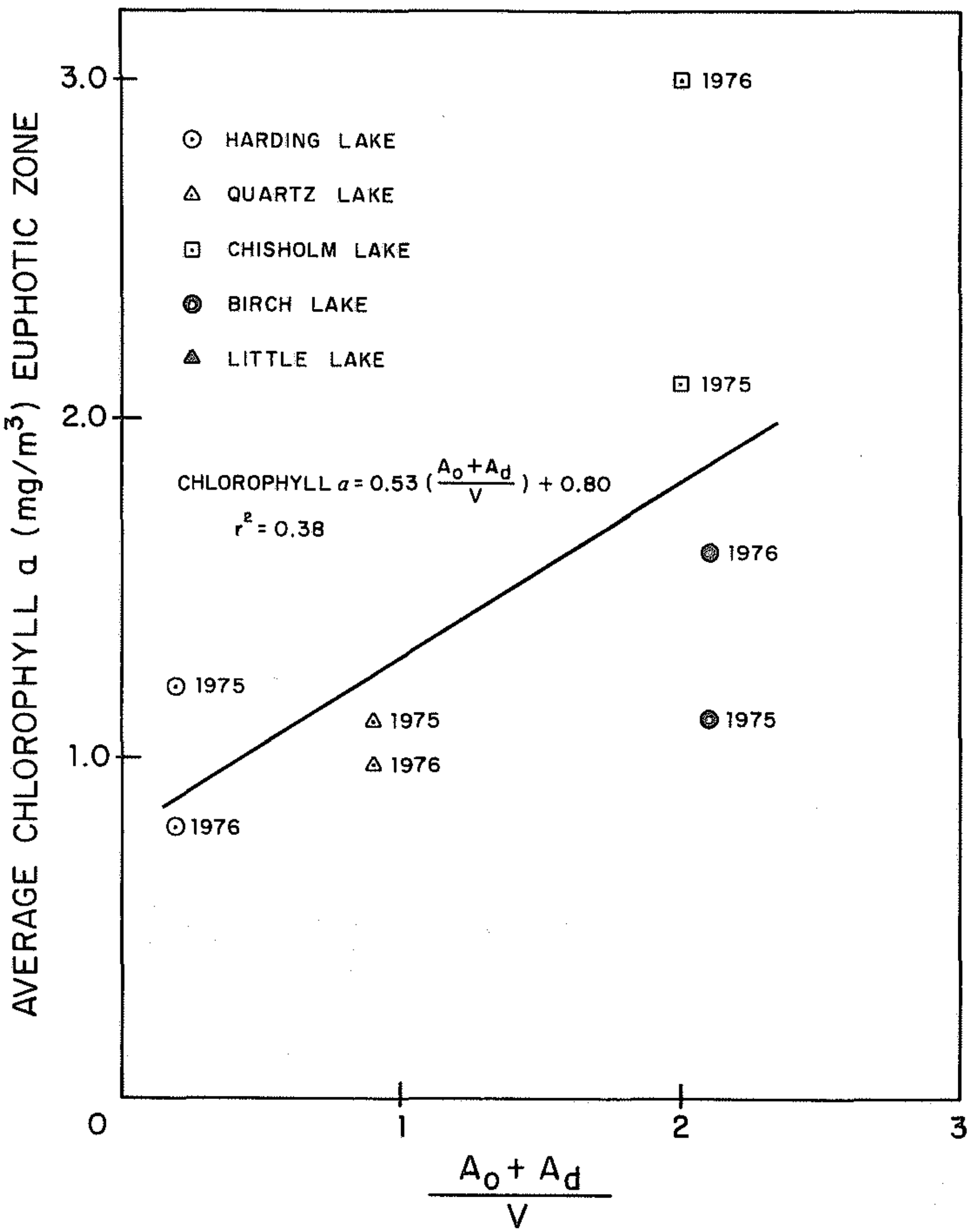

Figure 3: RELATIONSHIP BETWEEN AVERAGE SUMMER CHLOROPHYLL *a* IN THE EUPHOTIC ZONE AND SCHINDLER'S INDEX.

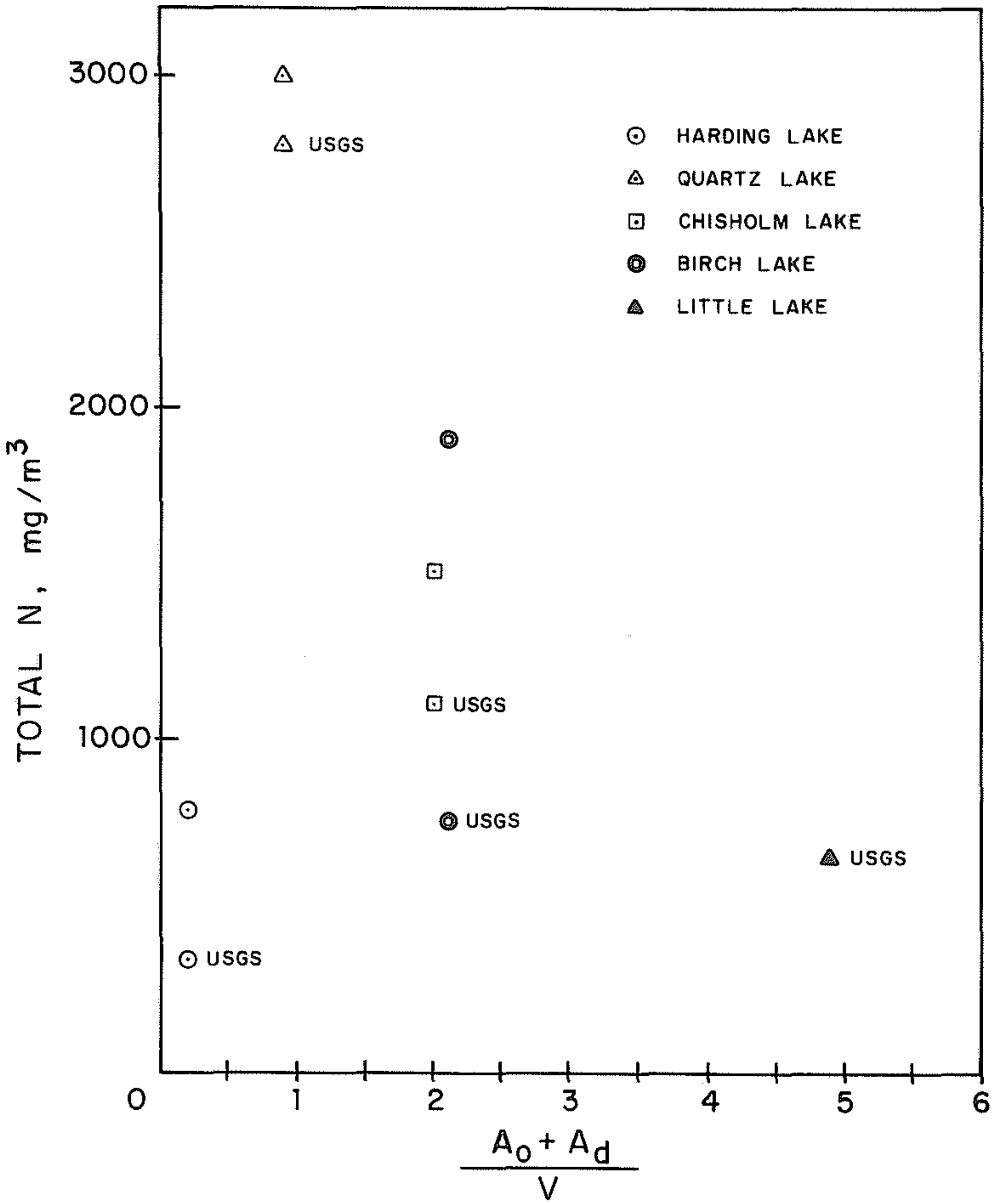

Figure 4: RELATIONSHIP BETWEEN AVERAGE TOTAL N CONCENTRATION (SUMMER, 1976) AND SCHINDLER'S INDEX.

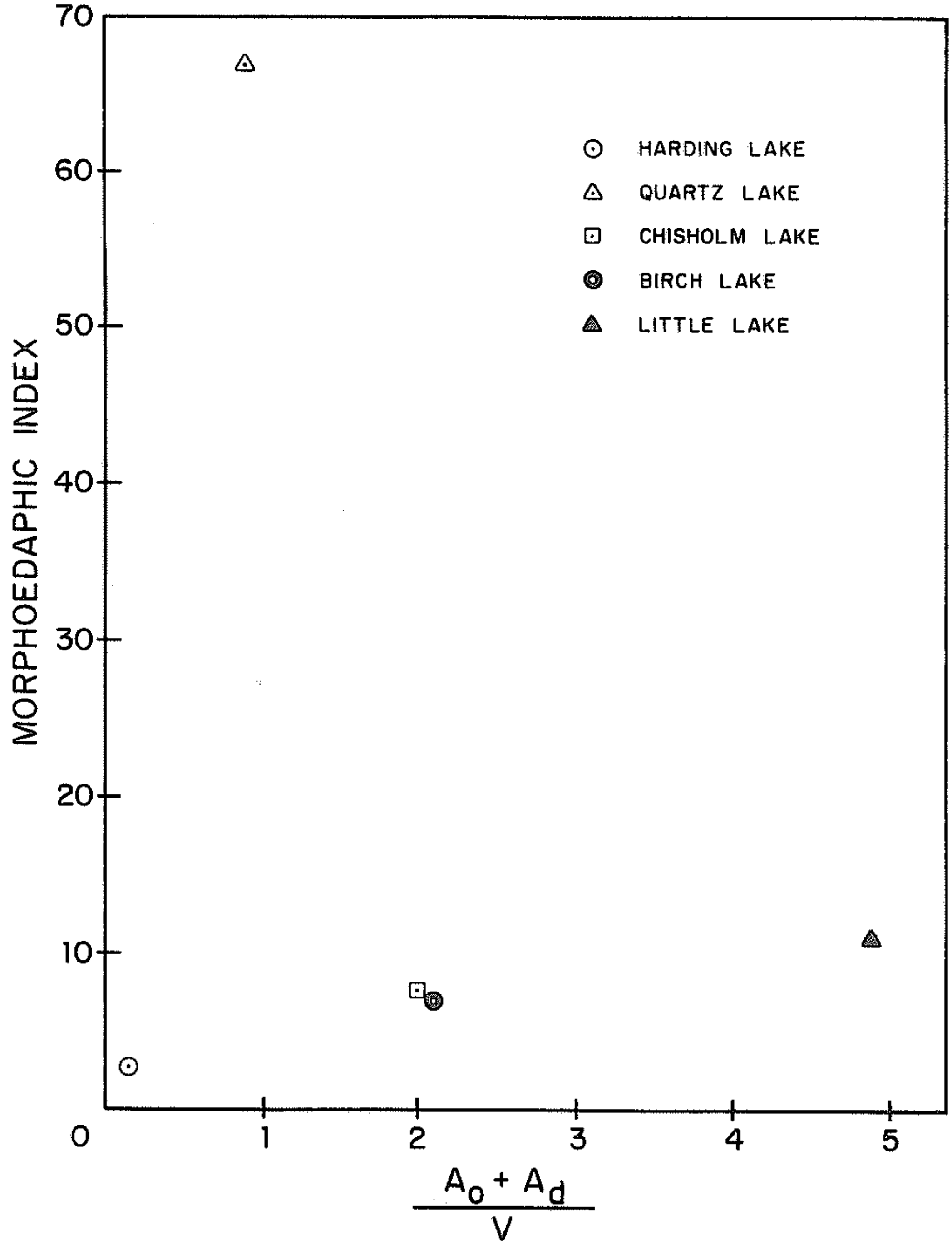

Figure 5: RELATIONSHIP BETWEEN THE MORPHOEDAPHIC INDEX AND SCHINDLER'S INDEX.

Planktonic algal growth parameters also show no apparent relationship with MEI (Figure 6). This is probably due, in this case as well as in the case of Schindler's hypothesis, to the low variation in these parameters between these lakes. It is equally important to note that a relationship between morphoedaphic indices and *total* primary production should be expected. In this study, production of vascular aquatic plants and of benthic algae was not measured. Observations of vascular plants have been made, and it should be noted that Quartz Lake has approximately two thirds of its surface covered with nymphaeid (water lily-type) plants, and there are other vast beds of submerged aquatic plants. Harding Lake, while only one third larger, is much deeper and its beds of aquatic plants cover only approximately 50 ha of the 988-ha lake surface (LaPerriere et al., 1977). There are relatively few nymphaeid plants in Harding Lake, and the water lilies (*Nymphaea* sp.) which were seen in 1966 (LaPerriere and Robertson, 1973) were not observed during the intensive 1973-1975 study of Harding Lake.

Even if benthic algal production were similar in these lakes, which is not likely because of the depth variations, differences in the production of vascular aquatic plants could probably be explained in part by differences in alkalinity, and it is likely that total primary production and MEI are strongly related.

It should be remembered that all of the lakes on which Schindler's open hypothesis was developed lie in granitic basins with attendantly uniformly low alkalinity and that vascular aquatic plants do not grow in these lakes. While we must reject his hypothesis, it is probable that, after conducting extensive studies of total primary production and of fish production, we would find both of these measurements to vary linearly with $(A_o + A_d)/V$ or with MEI for the Tanana Lakes.

In the Tanana Lakes, winter-dissolved oxygen was found to be low in Little Harding and Quartz Lakes in 1975. Summer hypolimnetic oxygen was low in Quartz and Chisholm Lakes that year.

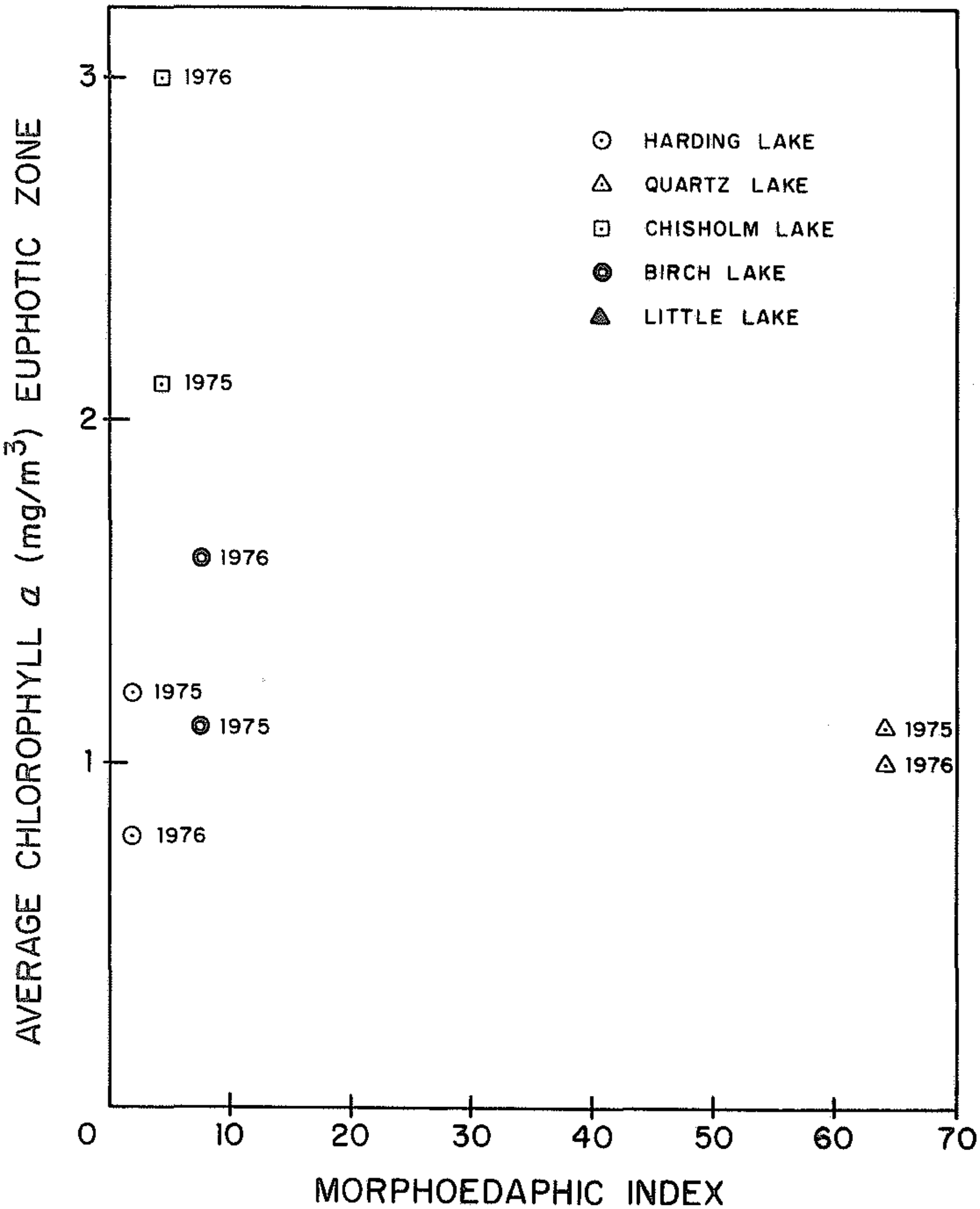

Figure 6: RELATIONSHIP BETWEEN SUMMER AVERAGE CHLOROPHYLL *a* IN THE EUPHOTIC ZONE AND THE MORPHOEDAPHIC INDEX.

DISSEMINATION OF RESEARCH RESULTS

A partial completion report on the Nancy Lakes phase of this project has been completed and distributed to the cooperators and to OWRT. General distribution of that report is not planned.

The Tanana Lakes data will be incorporated with the data from the completed and ongoing studies of Harding Lake, funded by the USEPA (LaPerriere et al., 1977) and the Japanese Ministry of Education, and with data on Birch and Chisholm Lakes collected by USPHS, and a series of journal papers will result.

Upon a request by the State of Alaska, Department of Natural Resources, Division of Parks, and their design contractor, our data on Quartz Lake were examined and recommendations made for the design of a public recreation area. Correspondence concerning this request is contained in appendix.

TRAINING

One student working toward a masters degree in environmental health sciences at the University of Alaska, Fairbanks, and one student working toward the Ph.D. in water resources at Iowa State University of Science and Technology were supported by this funding.

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APPENDIX

Correspondence Concerning Recommendations for the Design of a Recreation Area at Quartz Lake

GROUP THREE DESIGN
LANDSCAPE ARCHITECTURE • LAND USE PLANNING • INTERIOR DESIGN

October 20, 1977

Jaqueline D. LaPerriese
Inst. of Water Resources
University of Alaska
Fairbanks, Alaska

Dear Ms. LaPerriese

We will soon be under contract for the planning and preliminary design of Quartz Lake recreation area near Delta Junction, Alaska. Mr. Harold Woodham, the Area Park Manager, expressed to us that you had prepared a hydrological study which would be helpful in assessing the intensity of development the lake could maintain.

A copy of your study and any personal comments you feel might be helpful for a proper recreational assessment would be welcome. Unfortunately, time for this project is at a minimum and research must be completed shortly. Please forward any information to the above address as soon as possible.

Thank you for your consideration.

Yours truly,

Marcia A. Stevens

Marcia Stevens
Landscape Architect

MS/so

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INSTITUTE OF WATER RESOURCES

UNIVERSITY OF ALASKA
COLLEGE, ALASKA 99701

November 15, 1977

Mr. Neil Johannsen
Chief of Planning
Alaska State Park System
619 Warehouse Drive, Suite 210
Anchorage, Alaska 99501

RE: Quartz Lake near Delta Junction

Dear Mr. Johannsen:

My feelings are that sixty campsites with rock-filled drains will probably not add appreciable phosphorus to the lake. However, toilets and especially camper dump stations for a facility of this size would add a serious amount of phosphorus which could cause nuisance overgrowth of aquatic plants including algae. It is imperative that all sewage be held in vaults and completely removed from the lake basin for disposal. This, I understand, is currently planned for toilet facilities, but it should also be planned for camper dump stations which may be added in the future. Nuisance overgrowths of plants would not only be unpleasant, but may actually cause winterkill of fish. Currently, the lake becomes seriously depleted of oxygen under the winter ice cover, and if more plants were to grow and then decay during winter, this could use up oxygen to levels at which the condition of the fish would suffer or to levels at which the fish could not survive.

I see two management problems that will occur. This lake is known to have a swimmers' itch problem, and even if a swimming beach is not provided campers are likely to swim near the recreational area. It can be predicted that many complaints will result. Perhaps the area can be posted for no swimming with an explanation provided at the central bulletin board.

This lake has extensive weed beds. While these plants may be essential to the relatively high fish production, complaints can be expected. Demands for weed removal can be expected so that outboard motors can be used without the propellers becoming fouled with weed stems. Weed removal, however, could have several unfortunate results. By reducing the amount of protection afforded to young fishes by the weeds, and by reducing the substrate for growth of insects which are eaten by fishes, fish production may be decreased.

Also, removal of rooted plants often favors the growth of algae which can create aesthetically unpleasant conditions, particularly when large floating mats of blue-green algae are produced and blow to the shore and decay. The state will have to be ready to turn a deaf ear to requests for weed removal.

Thank you for your attention to my recommendations.

Sincerely,

Jacqueline D. LaPerriere

Jacqueline D. LaPerriere
Instructor of Water Resources

mh

cc: Burdett B. Lent, Group Three Design
George VanWyhe, Alaska Department of Fish and Game

GROUP THREE DESIGN
LANDSCAPE ARCHITECTURE • LAND USE PLANNING • INTERIOR DESIGN

November 25, 1977

Jacqueline D. LaPerriere
Inst. of Water Resourses
University of Alaska
Fairbanks, AK

Re: Quartz Lake State Recreation Area

Dear Ms. LaPerriere,

We received your letter of November 15, 1977, and would like to thank you for your recommendations in the development of Quartz Lake State Recreation Area. We will definately take them into consideration in our final master plan for the State. Completion and printing of the plan should be ready by the end of January 1978. We will send you a copy at that time.

Thank you again for your time and valuable comments.

Yours truly,

Burdett B. Lent

Burdett B. Lent, Partner, ASLA, A.S.P.O.
Landscape Architect

BBL/so

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