EVALUATION OF LAKE RESTORATION METHODS: PROJECT SELECTION

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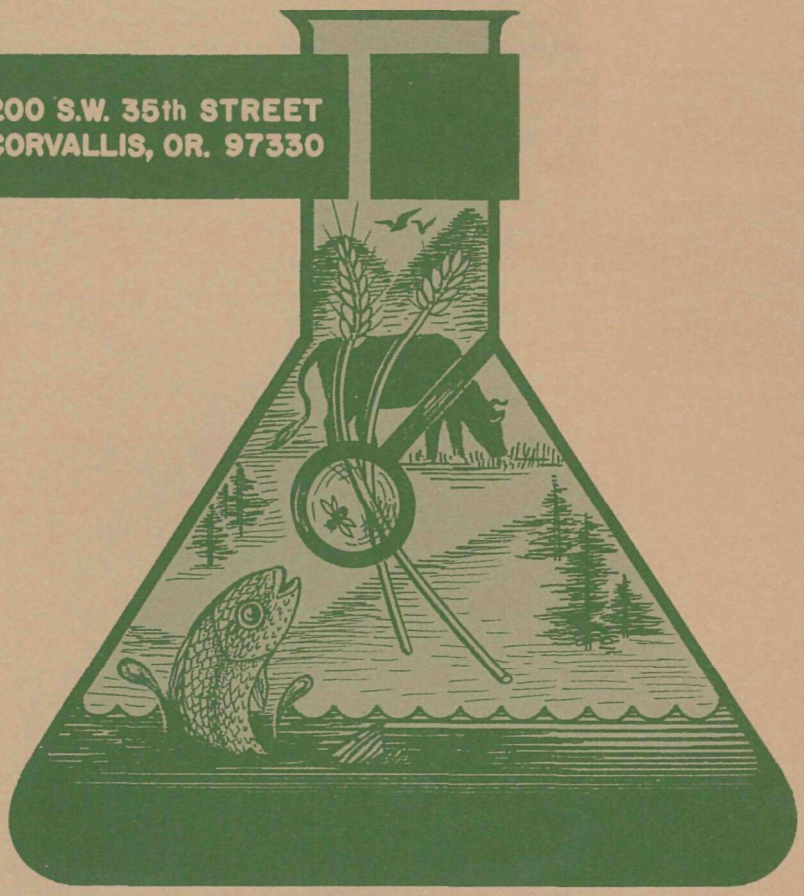
Criteria and Assessment Branch

CERL-034

Corvallis
Environmental
Research
Laboratory

200 S.W. 35th STREET
CORVALLIS, OR. 97330



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INTRODUCTION

Implementation of P.L. 92-500, Sections 314/104(h), (the Clean Lakes program) is part of a major Federal, State and Local effort to clean up the Nation's polluted lakes. Under this program, State and Local governments are encouraged to classify lakes according to their trophic status, identify problems contributing to a poor trophic status, and then to design a project which will control the problem sources to restore or protect water quality of the lakes. Federal grants for these projects (Demonstration Grants) are awarded through the states and funded on a 50:50 matching basis to those projects which qualify. Guidance for the preparation of demonstration grant applications under the "Clean Lakes Program" is outlined in a recent EPA publication (EPA, 1976).

Most of the lake restoration techniques being employed under the "Clean Lakes Program" are relatively untested and thus experimental in nature. Therefore, it will be beneficial to evaluate demonstration projects which are funded. These evaluations will be administered by the Corvallis Environmental Research Laboratory (CERL) and funded as research grants. Application for these evaluation funds may be made according to guidelines issued by CERL (Maloney, 1976). The objectives of the evaluation projects will be 1) to determine the effectiveness of various techniques to improve the quality (usefulness) of a specific lake and 2) to compare the relative effectiveness of these techniques in different lakes. Some lakes will be evaluated in terms of sociological and economic aspects as well as limnologically. Funding constraints prohibit detailed evaluations of all demonstration projects; thus a representative sample will be selected from those which are funded. The goals of this paper are 1) to describe an experimental design rationale, and 2) to describe a process by which candidate lakes were selected for in-depth assessments.

An experimental design was formulated to categorize lake restoration techniques according to the primary mode of treatment (source control, in-lake control, and problem treatment). This provided a "lake restoration classification" scheme. Then based on the needs of the experimental design and the constraint of limiting the number of fundable projects (approximately 20), a rating system for selecting candidate lakes was devised, and a selection was made. The rationale that went into the experimental design and the lake selection are described in the following section.

CATEGORIZATION OF LAKE RESTORATION TECHNIQUES

Relating Lake Response to Manipulations

A variety of techniques have been developed for restoring lake systems or preventing their degradation (Peterson et al., 1974; Dunst et al., 1974) (Table 1). These can be broadly grouped into three categories based on a nutrient-loading concept: input or source control, in-lake controls, and problem treatment techniques. The first category applies to inputs of materials such as water, sediments, nutrients, heavy metals, toxicants, and litter and refuse. The second category includes 1) morphological effects such as dredging or deepening caused by raising of the outlet structure; 2) changes in mixing patterns; 3) interruption of nutrient or metals cycling. The third category tends toward the treatment of symptoms rather than sources and will likely require continuous treatment.

Source Controls

Source controls include treatment of inflows by sedimentation ponds or basins, chemical treatments to remove nutrients or heavy metals, and the construction of wetlands so that "biological filtration" of materials carried in streams, runoff, groundwater inflows or point sources (e.g., wastewaters and stormwater) occurs. Diversion of inflow is a common alternative to treatment but requires either makeup water or consequent increase of residence time and/or decrease in volume. Watershed activities can be modified and hence materials input modified by the application of land use restrictions, best land use practices, non-point source control or treatment, and stream management. Control of activities adjacent to the lake shore (riparian) are similar in intent to watershed management but may have more direct influence on lake dynamics. Product modification or regulation (detergent phosphorus bans, pesticide bans, industrial product or process bans and/or fines) is an applicable lake restoration technique but is usually separated in time and space from the effects being observed and is not considered herein. Also, treatment plant effluent controls are considered to be covered under other sections of the Law. Thus, although advanced waste treatment of such effluents might be a part of an overall plan for lake restoration, that segment of the project would not be funded under the Clean Lakes program.

Table 1. Classification of Lake Restoration Techniques

I. Source Controls
   A. Treatment of inflows
   B. Diversion of inflows
   C. Watershed management (land uses, practices, nonpoint source control, regulations and/or treatments).
   D. Lake riparian regulation or modification
   E. Product modification or regulation

II. In-Lake Controls
   A. Dredging
   B. Volume changes other than by dredging or compaction of sediments
   C. Nutrient inactivation
   D. Dilution/Flushing
   E. Flow adjustment
   F. Sediment exposure and dessication
   G. Lake bottom sealing
   H. In-lake sediment leaching
   I. Shoreline modification
   J. Riparian treatment of lake water
   K. Selective discharge

III. Problem Treatment (directed at biological consequences of lake condition)
   A. Physical techniques (harvesting, water level fluctuations, habitat manipulations)
   B. Chemical (algicides, herbicides, piscicides)
   C. Biological (predator-prey manipulations, pathological reactions).
   D. Mixing (aeration, mechanical pumps, lake bottom modification)
   E. Aeration (add DO; e.g. hypolimnetic aeration)

In-Lake Controls

Some in-lake manipulations are directed primarily at the physical characteristics of lakes (depth, volume, circulatory patterns) while others are directed primarily at materials cycling (nutrient regeneration, organo-metal complex release), but some manipulations affect both categories at the same time. For example, dredging affects lake morphology by deepening the lake, but it also involves removal of nutrient rich organic sediments and aquatic weeds in the dredging of littoral areas. Volume changes typically result from changes in outlet structures, but changes in inflow or outflow could also result in volume changes, especially for reservoirs.

Nutrient inactivation precipitates water column nutrients to the sediment phase. Some "sealing" of the sediments can result from the application of precipitants. Dilution with high quality water and subsequent flushing of material through the lake system can be effective in reducing in lake problems. Flow adjustments are a special subcase of dilution/flushing and result from changes in lake volume which in turn require makeup flows to maintain satisfactory lake residence time or lake volume for downstream or riparian uses.

Measures directed at sediments as a source (at least seasonally) of recycled materials to the water column include sediment exposure and dessication, lake bottom sealing, and leaching of sediments *in situ*. Exposure and dessication may be a prelude to dredging; i.e. drying of sediments after drawdown followed by bulldozing has similar effects to dredging, since volume changes and removal of sediments and associated materials occur.

Shoreline modification includes riprap, breakwaters, and diking of bays which are intended to prevent shoreline erosion or to minimize the shoreline sinuosity effects on lake surface area, e.g. littoral productivity, evaporation surfaces, "dead volumes" (do not mix with lake), etc. This technique does not include riparian control activities.

Treatment of lake water, directed at a specific water mass, can be a reasonable alternative to total lake treatment for inactivation (precipitation) of specific materials. Similarly, selective discharge is directed at a specific water mass (e.g. hypolimnetic discharge to downstream users).

It is possible that the cost-effectiveness of most of these in-lake manipulations can be improved by selective application to parts of the lake system. For example, dredging can be applied to littoral or pelagic sediments depending on the lake problem and the purposes of the manipulations; nutrient inactivation can be applied to hypolimnetic waters only, so that chemical costs are minimized.

Problem Treatment

These controls are palliative but may be useful as stopgap measures in cases where cost precludes more fundamental changes or as part of a more extensive treatment. They can be divided into physical, chemical, and biological techniques on the basis of how they are applied to the lake system. In most cases the use of palliative methods is restricted for lake restoration under the PL 92-500 Matching Grants program (Section 314). In most instances application for funds to harvest aquatic plants, treat with algicides or herbicides, or to aerate would be acceptable only as part of a more comprehensive plan (multi-manipulation). Mixing by aeration or pumps may improve lakes which have poor water quality caused by the development of anaerobic conditions typically resulting from vertical or horizontal stagnation. Addition of oxygen, usually by hypolimnetic aeration, can also ameliorate the effects of anaerobic conditions, i.e. nutrient regeneration from sediments.

EXPERIMENTAL DESIGN OF LAKE RESTORATION EVALUATIONS PHASE

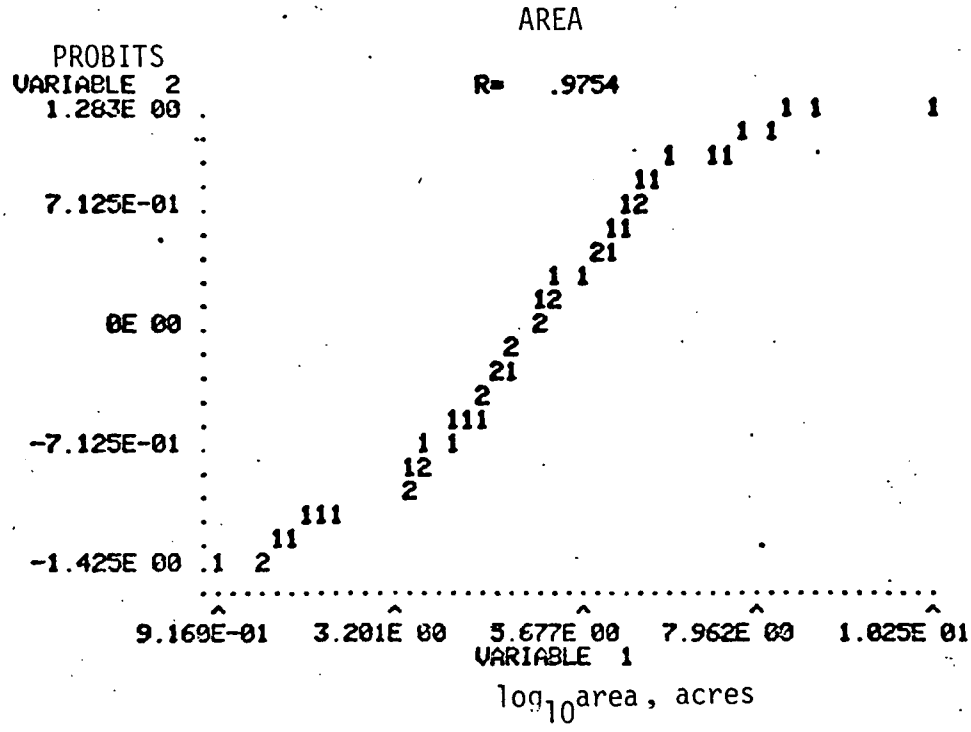
Funded Projects

As of September, 1976, 49 proposals concerning 57 lakes had been funded (awarded or pending award) by the USEPA as well as 4 specific evaluation projects for 5 of the demonstration lakes. For those proposals containing data on the lakes involved, a log-probability graph of area and volume shows that a wide variety of morphological types have been included in the set of funded projects (Figure 1).

The number of approaches shown in Table 2 indicates the variety of problems and unique characteristrics of the various lakes and their basins. The particular approach selected for each demonstration reflects the availability of local resources, understanding of the limnology of the specific lake system, and the specific uses intended for the lake.

A minimal amount of limnological data will be collected on all of these demonstration projects (Table 3) as part of the demonstration. These data will provide some measures of the before and after effects of lake restoration, but in order to understand the actual cause and effect relationship (i.e. to achieve the two objectives stated in the Introduction), additional data and analyses are required.

Ideally, one should analyze a set of lake systems having only one type of manipulation. However, local agencies are concerned primarily with achieving a measurable degree of restoration, not evaluating the efficacy of a given manipulation. Thus, funded demonstration grants cover a broad spectrum of manipulations and combinations of manipulations (Tables 2 and 4) with an average of 2.3 techniques per lake. Those lakes receiving only single manipulations are shown in Table 5. Since the objective of the evaluation program is to provide an overall assessment of various lake restoration techniques, an evaluation of only the 12 lakes with single manipulations would be insufficient. Thus it is desirable to evaluate a number of lakes with multi-manipulation projects as well as some of the single manipulations.



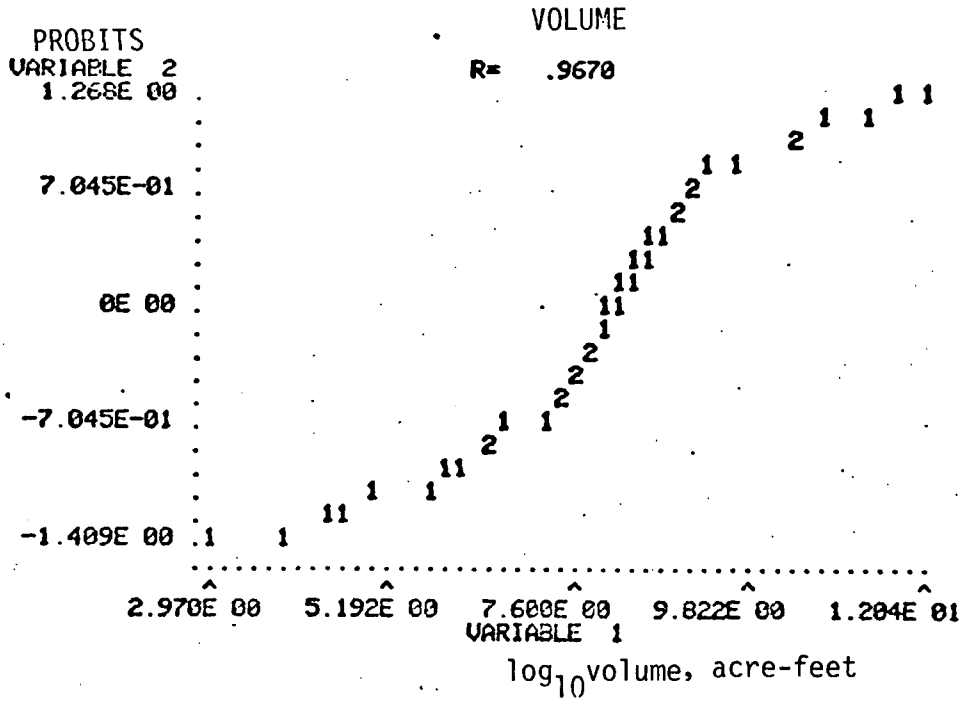


FIGURE 1. Log-normal distribution of funded lakes in the lake restoration program based on morphological features.

Table 2. Funded (awarded or pending award) demonstration projects have a wide variety of manipulation types (as designated in Table 1)

Project, state	Name of Lake(s)	Region	(Number)	Manipulation Type*
Demarissocata, ME	Little Pond	I	(1)	III C
Wellesley, MA	Morses Pond		(2)	IIC, IIA, IIIA, IC, ID
Cochituate, MA	Upper Pond		(3a)	IA, IIIA
	Middle Pond		(3b)	IA, IIIA
	Lower Pond		(3c)	IA, IIIA
Boston, MA	Charles River Basin		(4)	IIID, IB
Brocton, MA	Ellis Brett Pond		(5a)	IA, IIA
	30 Acre Pond		(5b)	IA, IIA
Scotia, NY	Collins Park	II	(1)	IIA, II-I
Islip, NY	Ronkonkoma		(2)	IA (ID, II-I)
Buffalo, NY	Delaware		(3a)	IB, IID, IIF(IIB), IC
	North Bay		(3b)	IB, IID, IIF, IC, IIA
East Greenbush, NY	Hampton Manor		(4)	IIF (IIA)
Albany, NY	Washington Park		(5)	IIF (IIA)
Albany, NY	Buckingham		(6)	IIF (IIA)
Schenectady, NY	Steinmetz		(7)	IIF(IIA), IB
Charlottesville, VA	Rivanna	III	(1)	IIID, IA (ID), IB
Baltimore, Md	Loch Raven		(2)	IIID, IC
Tallahassee, FL	Apopka	IV	(1)	IIF, IC
Tallahassee, FL	Jackson		(2)	IA(IIIA)
Albert Lea, MN	Fountain Lake	V	(1)	IA, IC
Chain of Lakes, MN	Lake of the Isles		(2a)	IB
	Harriett		(2b)	IC
Wheatland, WI	Lilly		(3)	IIA, IIC
Eau Claire, WI	Half Moon		(4)	IB, IIE, IIID
Waupaca, WI	Mirror		(5a)	IB, IIC, IIID
	Shadow		(5b)	IB, IIC
Wheatland, WI	Little Muskego		(6)	IIA
Maple Run, MN	Hyland		(7)	IID, IIF, IA, IIID
Waseca, MN	Clear		(8)	IB, IIIA
Fort Wayne, IN	Skinner		(9)	IB, IIIA, IIC, IC
Marionette, WI	Noquebay		(10)	IIA, IIIA, IB
Arden Hills, MN	Long		(11)	IIA, IA(IIIA), IC
Minn-St. Paul, MN	Phalen		(12)	IB, IIE
Blair, WI	Henry		(13)	II A, IC, ID
Madison, WI	White Clay		(14)	IC
Mason, MI	Lansing		(15)	IIA, IIG
Bloomington, MN	Penn		(16)	IIA, IIE, ID, IIIC, IIID
Pauls Valley, OK	Paul's Valley	VI	(1)	IC
Lenox, IA	Lenox Lake	VII	(1)	IIA
Oelwein, IA	Oelwein		(2)	IIA, IA
Brookings, SD	Cochrane	VIII	(1)	IA
Watertown, SD	Kampeska		(2)	II-I
Brookings, SD	Oakwood Lake 1		(3a)	II-I (IC)
	Oakwood Lake 2		(3b)	II-I (IC)
Viborg, SD	Swan		(4)	IC, ID, II-I
Lafayette, CA	Lafayette	IX	(1)	IIC, IIIE
Oakland, CA	Temescal		(2)	IIA, IIF, IIG, IIID, IIK, IIB, IIC, IA
Marion, CA	Stafford		(3)	IIA, II-I, IC
Port Orchard, WA	Long	X	(1)	IC, IA, IIIA, IIC IIF
Vancouver, WA	Vancouver		(2)	IIA, IID
Beaverton, OR	Commonwealth		(3)	IID, IIA, II-I, IIC
Spokane, WA	Liberty		(4)	IIF(IIA), IIC, IA, II-I
Medical, WA	Medical		(5)	IIC
Moses, WA	Moses		(6)	IID
Everett, WA	Spada		(7a)	IC, II-I
	Chaplain		(7b)	IC

*Treatments in parentheses are an integral part of a major treatment.

Table 3. Monitoring Requirements Attached to Each Lake Restoration Demonstration Grant to Provide Minimum Limnological Evaluations (EPA, 1976)

After the initial ten percent (10%) advance payment of EPA grant funds, future grant payments will be contingent upon monthly monitoring at appropriate test sites of the following parameters

1. Ammonia and Nitrate Nitrogen
2. Kjeldahl Nitrogen
3. Total and Dissolved Phosphorus
4. Temperature
5. Transparency (Secchi Disk)
6. Dissolved Oxygen
7. Chlorophyll a
8. pH
9. Alkalinity

Table 4. Compilation of project lakes according to manipulation type of Table 1

Type of Treatment	Lakes in treatment type (key from Table 2, Region-Number)	Total in type
IA	I-3a I-3b I-3c I-5a I-5b II-2 III-1 IV-2 V-1 V-7 V-11 VII-2 VIII-1 IX-2 X-1 X-4	16
IB	I-4 II-3a II-3b II-7 III-1 V-2a V-4 V-5a V-5b V-8 V-9 V-10 V-12	13
IC	I-2 II-3a II-3b III-2 IV-1 V-1 V-2b V-9 V-11 V-13 V-14 VI-1 VIII-4 IX-3 X-1 X-7a X-7b	17
ID	I-2 V-13 V-16 VIII-4	4
Total of Source Controls		50
IIA	I-2 I-5a I-5b II-1 II-3b V-3 V-6 V-10 V-11 V-13 V-15 V-16 VII-1 VII-2 IX-2 IX-3 X-2 X-3	18
IIB	IX-2	1
IIC	I-2 V-3 V-5a V-5b V-9 IX-1 IX-2 X-1 X-3 X-4 X-5	11
IID	II-3a II-3b V-7 X-2 X-3 X-6	6
IIE	V-4 V-12 V-16	3
IIF	II-3a II-3b II-4 II-5 II-6 II-7 IV-1 V-7 IX-2 X-1 X-4	11
IIG	V-15 IX-2	2
IIH		0
II-I	II-1 VIII-2 VIII-3a VIII-3b VIII-4 IX-3 X-3 X-4 X-7a	9
IIJ		0
IIK	IX-2	1
Total of in-lake controls		62
IIIA	I-2 I-3a I-3b I-3c V-8 V-9 V-10 X-1	8
IIIB		0
IIIC	I-1 V-16	2
IIID	I-4 III-1 III-2 V-4 V-5a V-7 V-16 IX-2	8
IIIE	IX-1	1
Total of Problem Treatments		19
Total of all manipulations		131

Table 5. Lakes receiving only one manipulation

Treatment	Lakes (data from Tables 2 and 4)	Total in type
IA	VIII-1	1
IB	V-2a	1
IC	V-2b V-14 VI-1 X-7b	4
ID		
IIA	V-6 VII-1	2
IIB		
IIC	X-5	1
IID	X-6	1
IIE		
IIF		
IIG		
IIH		
II-I	VIII-2	1
IIJ		
IIK		
IIIA	I-1	1
IIIB		
IIIC		
IIID		
IIIE		
	Total	12

By classifying the demonstrations into the three "lake restoration classifications," it is possible to group the many manipulations into a limited number of similar types and thus to approach the set of lakes in the manner of an experimental design. The basis for the design depends on three assumptions: 1) treating manipulations in terms of their effect is a valid approach, 2) unlike lakes can be standardized using a mass-balance modeling approach (Vollenweider, 1975; Dillon and Rigler, 1974; Larsen et al 1975), or a "Lake Quality Index" approach (Shapiro, 1975; Brezonik, 1976); and 3) the relative quantitative impacts of the manipulation can be determined.

Assuming that the foregoing approach is valid for the set of lakes and manipulations that have been funded, the data in Table 4 were handled as a standard factorial design (Table 6). It can be seen that at least two manipulation types (source controls, in-lake controls), and the combination of these two types provide a large sample size; 35 projects and 41 lakes. This design will be used to develop a set of candidate lakes suitable for detailed evaluation.

Table 6. An experimental design for funded demonstration projects as of September, 1976*

	I Source Controls	II In-Lake Controls	III Problem Treatment
I. Source Controls	II-2, IV-2, V-1, V-2(2), V-14, VI-1, VIII-1, X-7(2)	I-5(2), II-3(2), II-7 IV-1, V-4, V-5(2), V-11, V-12, V-13, VII-2, VIII-4, IX-3, X-4	I-3(3), I-4, III-1 III-2, V-8
	8 Projects,10 Lakes	13 Projects, 16 Lakes	5 Projects, 7 Lakes
II. In-Lake Controls		II-1, II-4, II-5, II-6, V-3, V-6, V-15, VII-1, VIII-2, VIII-3(2), X-2, X-3, X-5, X-6	IX-1
		14 Projects, 15 Lakes	1 Project, 1 Lake
III. Problem Treatment			I-1
			1 Project, 1 Lake
I,II.Source & In-Lake Controls			I-2, V-7, V-9, V-10 V-16, IX-2, X-1
			7 Projects, 7 Lakes

*Number in parenthesis is number of lakes in project.

SELECTION OF LAKES FOR DETAILED EVALUATION

All lake restoration projects funded (awarded or pending award) as of September 1976 were rated and ranked in priority order. Numerical ratings were assigned according to 1) the quality of the baseline data available, 2) the length of time and frequency of baseline data collection, 3) the probability of measurable short term response, 4) the potential for quantification of the changes of phosphorus loading on a short and long term basis and 5) the number of manipulations proposed (Table 7).

1) Quality of baseline data refers to the type of measurements which have been made on the lake and to what degree these data might be useful in assessing the changes in lake quality as a result of the proposed restoration. In general the information most useful would include Secchi disk transparency; temperature; dissolved oxygen; algal speciation and/or chlorophyll a levels; macrophyte distribution, speciation, and density; benthos and fish data; bacterial levels and sediment nutrient concentrations. All will assist the researcher in evaluating the effects of the lake restoration manipulation. However, central to these evaluations is the overriding need to develop accurate data on input-output nutrient loading and in-lake nutrient concentrations. Phosphorus is the one thread of commonality woven throughout the variety of restoration projects being proposed.

2) Length of time and frequency of data collection are important to an evaluation of lake quality change because these data represent a baseline from which to measure changes. This baseline ideally should cover a year or more in time and should have been gathered with adequate frequency to depict the condition of the lake over a reasonable period of time (e.g. an annual cycle). This is of particular importance during the "growing season" or during the period when the nuisance problem is most prevalent. A great amount of data may have been collected on some lakes over a short period of time or sporadically over a long period of time. While both types of data are valuable in some respects, they are of limited use to the researcher attempting to assess trends of change in the lake due to a restoration manipulation.

Table 7. Lake Ranking Parameters and Combining Formula To Select Candidate Lakes For Full-Scale Evaluations

I Relative Quality of Baseline Data = X_1

Measured Parameters pts	Minimal (2)	Poor (4)	Fair (6)	Good (8)	Excellent (10)
Secchi Disk	x	x	x	x	x
Temperature	x	x	x	x	x
Dissolved Oxygen	x	x	x	x	x
Nutrients (lake)		x	x	x	x
Nutrients (Inlet-Outlet)			x	x	x
Algae or Chloro.			x	x	x
Macrophytes				x	x
Sediment Measurements				x	x
Benthos & Fish					x
Bacteria					x

II Time Frame of Baseline Observations = X_2

Time (yrs)	points
<0.5 or sporadic	1-3
0.5-1.0	4-7
≥1.0	8-10

III Prediction of Time Required to Demonstrate Measurable Change = X_3

Time (yrs)	points
>2	0
1-2	5
<1	10

IV Estimated Potential for Measurable Change in Phosphorus Content of the Lake (Less than 2 years) = X_4

Percent Reduction of Phosphorus in the Lake	points
60-100	10
40-60	8
30-40	6
20-30	4
10-20	2
0-10	0

V Estimated Potential for Measurable Change in Phosphorus Content of the Lake (Greater than 2 years) = X_5

Percent Reduction of Phosphorus in the Lake	points
60-100	10
40-60	8
30-40	6
20-30	4
10-20	2
0-10	0

VI Complexity of Manipulations in the Proposed Treatment Technique = k

Number of Manipulations Proposed	Weighting factor (k)
1	1.0
2	0.7
3	0.4
4	0.1
≥5	0.05

Formula for Combining Lake Ranking Parameter: $Y = 1/3\ (2X_1 + X_2) + 2X_3 + k(X_4 + X_5)$.

where Y = weighted points (50 max)

3) Probability of measurable short term response refers to the time frame within which it is estimated that a lake will show significant response (change in lake quality) as a result of the lake restoration technique applied. This is a factor based on literature and the experience of CERL staffers familiar with lake restoration techniques. In order to be practical, it was decided that a positive, measurable change must occur within two years of the lake restoration.

4) The potential for quantification of the changes of phosphorus loading on a short and long term basis represents an attempt to assess all the projects in terms of a single variable. Phosphorus was used since it is the most common limiting nutrient and usually the primary target of lake restoration. In cases where changes in phosphorus loading as a result of manipulation might be measured with ease, relative to other lakes, those lakes would receive a higher rating in this category.

5) The number of manipulations in a multi-manipulation treatment technique becomes important in evaluating effectiveness of the lake restoration project. As the number of manipulations increases, it becomes more difficult to attribute success or failure of a project proportionally to each of the manipulations. This becomes an even more complex problem when one attempts to meet the second objective of the evaluation--comparison of the relative effectiveness of various techniques in different lakes. Therefore, as the number of manipulations on a given lake increases, the usefulness of the demonstration in terms of evaluating a specific treatment technique decreases, and it is rated lower.

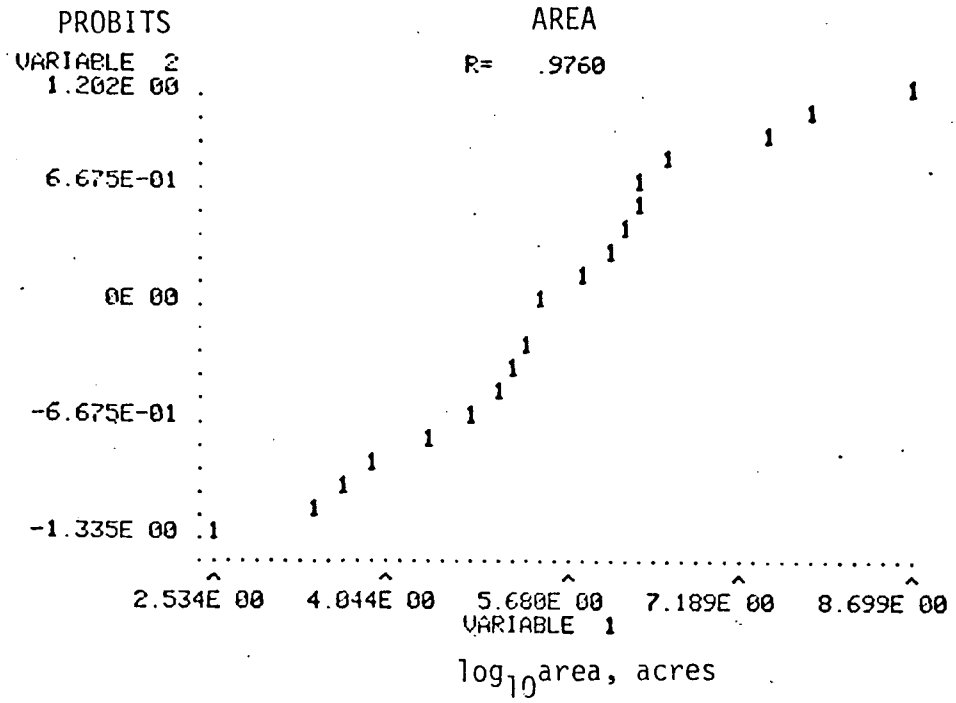
Ranking the lake projects by this system resulted in a priority list of lakes falling into the three basic categories of the experimental design (Source Controls, In-lake Controls, and Problem Treatment). The highest ranking projects on the list were grouped according to the experimental design. Unfortunately, there were too many projects of some types (notably source control and dredging) in given blocks of the experimental design. Therefore, some projects in these blocks were eliminated and the next highest ranking project added until the desirable

mix of projects consistent with the experimental design was achieved. The resultant list of 18* candidate evaluation projects is shown in Table 8. The same lakes are shown in Table 9 to indicate their position within the experimental design. Figure 2 shows that the subset of candidate lake projects is representative of the entire set of funded projects in terms of their area and volume (compare to Figure 1).

*18 projects were considered optional at this date to allow for additions of desirable projects at a later date to reach the goal of approximately 20 evaluations.

Table 8. Candidate Evaluation Projects

REGION	LAKE	STATE	AREA (acres)	VOLUME (acre-feet)
II	Collins Park	New York	54	432
II	Ronkonkoma	New York	225	2700
III	Loch Raven	Maryland	1895	45000
V	Long Lake	Minnesota	184	2208
V	White Clay	Wisconsin	240	3200
V	Mirror/Shadow	Wisconsin	13/42	326/741
V	Little Muskego	Wisconsin	506	7170
V	Lilly	Wisconsin	88	415
V	Fountain	Minnesota	555	3330
V	Lansing	Michigan	450	2486
V	Clear	Minnesota	611	10682
VII	Lenox	Iowa	33	99
IX	Lafayette	California	125	3700
X	Long Lake	Washington	339	2180
X	Liberty	Washington	781	16750
X	Medical	Washington	167	5060
X	Moses	Washington	6800	126000
X	Vancouver	Washington	2600	5200



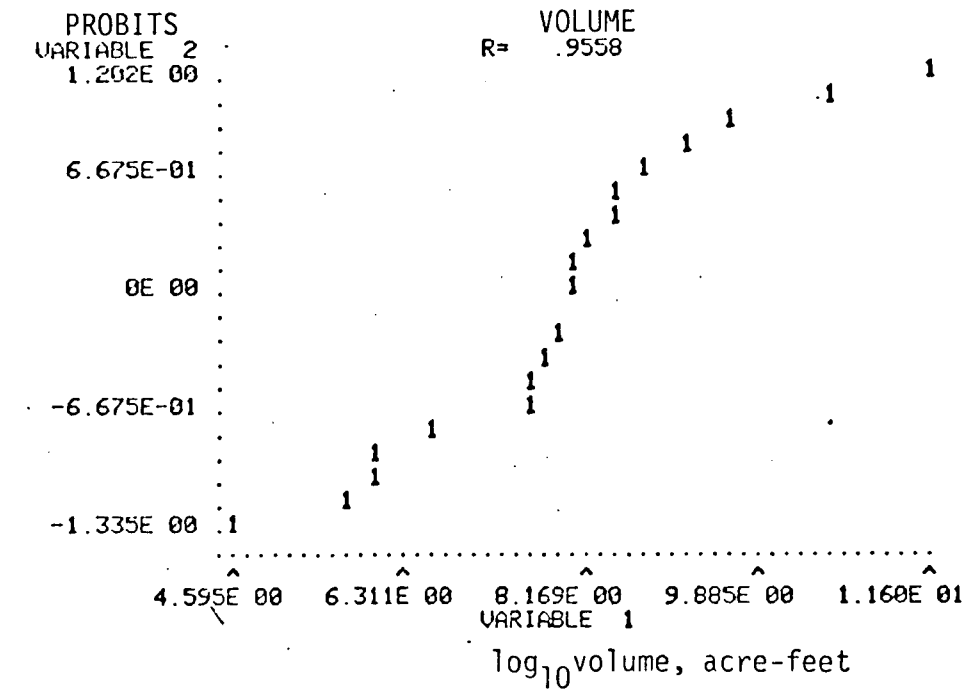


FIGURE 2. Log-normal distribution of area and volume of candidate restoration evaluation lakes.

Table 9. Experimental Design of Candidate Lake Restoration Evaluation Projects

	SOURCE	INLAKE			OTHER
		DREDGING	NUT.INACT.	DIL/FLUSH	
SOURCE	Fountain, Mn Ronkonkoma NY Clear MN White Clay WI* Loch Raven MD**	Long MN	Mirror/ Shadow WI* Liberty WA		
DREDGING		Lansing MI Muskego WI Collins* Park NY Lenox, IA	Lilly WI*	Vancouver WA	
INLAKE NUT. INACT.			Medical WA Lafayette CA**		
DIL/ FLUSH				Moses WA	
OTHER					Long (Kitsap Co) WA (draw-down, dredge, nut. Inact, NPS)*

*Funded
**Aeration also

SUMMARY AND FUTURE DIRECTIONS

An experimental design was prepared to guide the process of selecting lakes for evaluation by grouping demonstration projects according to similar effects. Lake restoration demonstration projects were rated for their suitability for detailed evaluation. The projects were then ranked, and candidates for evaluation were selected in accordance with the experimental design. Thus predominant and apparently practicable restoration techniques will be evaluated in terms of their effects on single lakes and on their comparative effects on different lakes.

The next steps in the evaluation program are to develop a means for comparing different lakes on a limnological basis (e.g. a lake quality index or a mass balance modeling approach) and development of utility functions which relate beneficial uses to specific lake quality parameters. Discussions of these steps will be presented along with data needs, analytical approaches, and expected results in subsequent papers.

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