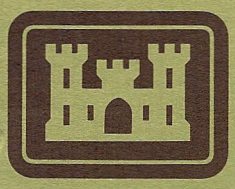

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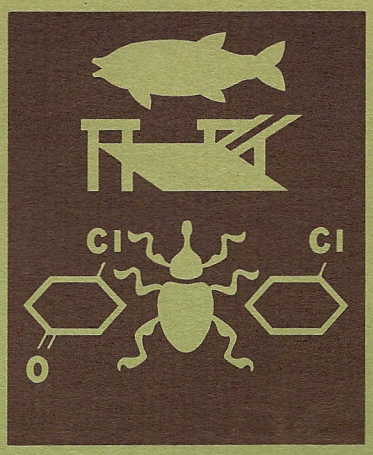

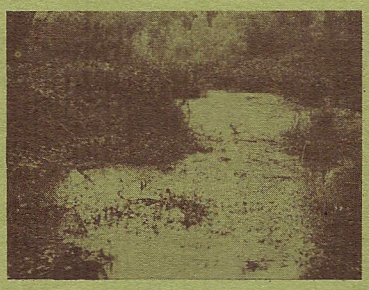

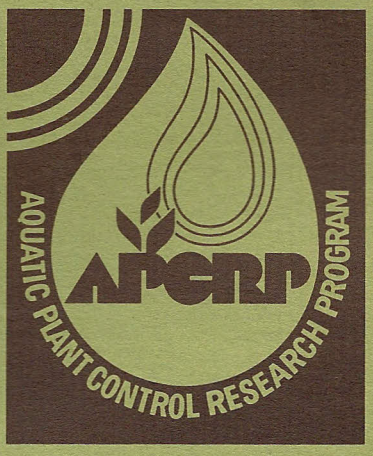

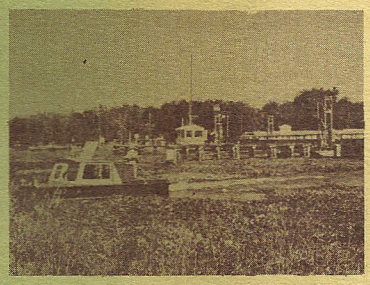

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AQUATIC PLANT CONTROL RESEARCH PROGRAM

Information Exchange Bulletin

A POSITIONING SYSTEM FOR FIELD STUDIES IN AQUATIC HABITATS

BY K. JACK KILLGORE AND BARRY S. PAYNE

INTRODUCTION

Researchers performing field studies of lakes and rivers are hampered by the difficulty of accurately positioning boats over the same sampling site(s) during multiple visits to the same waterbody. Marker buoys used to designate sample sites are frequently lost or moved between visits. From a boat on the water, one can triangulate to two permanent shore locations using an optical range reader or portable electronic positioning systems. However, these methods can be limited by distance or cost.

The Agricultural Navigator* (AGNAV) is a relatively inexpensive, commercially available electronic positioning system designed to be used to apply farm pesticides and fertilizers in straight, parallel, and evenly spaced paths. The AGNAV system measures distances up to a mile and thus is appropriate for most aquatic research studies.

The Aquatic Plant Control Research Program (APCRP) of the Waterways Experiment Station (WES) modified the AGNAV for field positioning of equipment used in aquatic plant control research. The AGNAV positioning system has been used successfully to:

- Map the distribution of aquatic plant colonies in a waterbody relative to shoreline features.
- Relocate plots and sampling sites for aquatic plant control research studies requiring multiple visits to the same study area.

* Patent and manufacturing rights held by Electronic Agricultural Products, 1313 Production Rd., Ft. Wayne, Ind. 46808.

OPERATION OF AGNAV SYSTEM

Equipment

The AGNAV system consists of a mobile unit and two repeaters (A and B) (Figure 1). For aquatic use, the mobile unit is placed in a boat and the repeaters are located at separate shoreline positions. The mobile unit consists of a computer-transmitter-receiver (c-t-r) with an antenna, range reader, control panel, and direction indicator display unit. The mobile unit runs on external AC power supply while the repeaters are powered

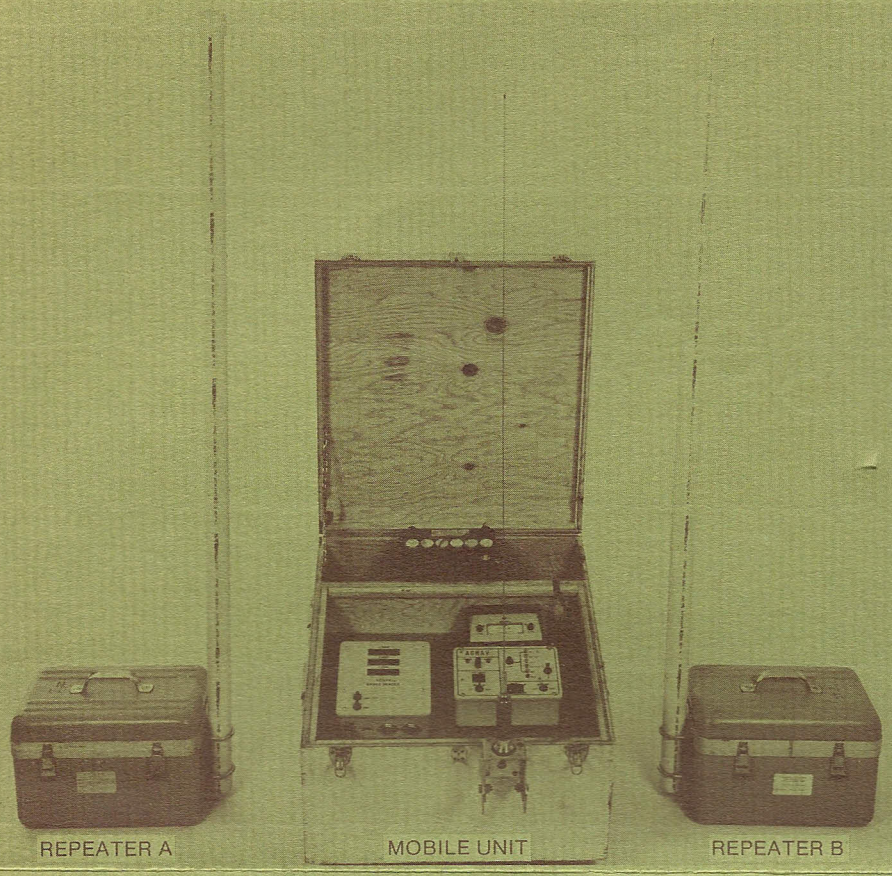

Figure 1. Components of the AGNAV System

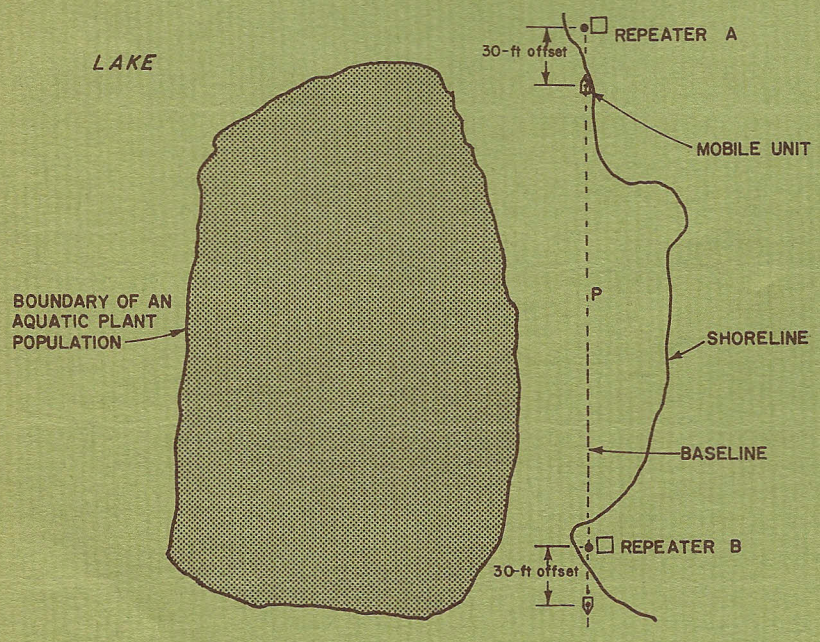

Figure 2. Establishing the baseline

by internal 12-volt gel cell batteries. The c-t-r transmits a short (.002 sec) burst of high-frequency radio signals 100 times each second. Both repeaters receive each signal burst, which activates the repeater transmitter. Repeater A stores the c-t-r transmission for .0025 sec and repeater B stores it for .005 sec before they retransmit the signal back to the c-t-r. By sequentially delaying the repeater transmissions, the c-t-r is given time to activate its receiver and also to distinguish the transmissions of the two repeaters. The c-t-r counts the number of 1/4 wavelengths transmitted by each repeater and computes and displays a number on the range reader. The number or AGNAV unit corresponds to the total number of 1/4 wavelengths between the c-t-r and a single repeater. One AGNAV unit for 154.6 MHz transmissions equals 9.584 in. The range reader displays the AGNAV unit distances from the mobile unit to repeater A, the mobile unit to repeater B, and repeaters A to B (A, B, and P respectively as displayed on range reader).*

Establishing a baseline

In order for the range reader to display the AGNAV A and B units, first the baseline distance between the two repeaters (P) must be determined. This is the most difficult step in operating the AGNAV.

The AGNAV computer calculations require a 30-ft offset from the mobile unit antenna to each repeater. First, the mobile unit antenna is positioned 30 ft from repeater A on a straight line between the two repeaters (Figure 2). This distance is programmed into the c-t-r. The mobile unit

* In any triangle, if the locations of two vertices (the A and B repeaters) and the lengths of all three sides are known (distance A, B, and P), the location of the third vertex can be determined.

antenna is then placed 30 ft past repeater B on a straight line passing through the locations of repeaters A and B. This distance is programmed into the c-t-r to complete the baseline establishment procedure.

If the boat containing the mobile unit antenna cannot be positioned at the 30-ft offset positions during establishment of the baseline, a coaxial cable can be connected between the c-t-r and the antenna, and the antenna hand-carried to the 30-ft offset location. The length of the coaxial cable must be in multiples of 1/2 wavelengths of the AGNAV operating frequency according to the following equation:

$$\lambda_{1/2} = 1/2(C/F)(VF)3.28 \times 10^{-6}$$

where

$\lambda_{1/2}$ = length of half-wave matching section (ft)
C = velocity of electromagnetic wave (M/S)
F = frequency of the AGNAV transmission (MHz)
VF = velocity factor of the coaxial cable

Limitations

The AGNAV system is limited by distance but not so much that its usefulness in aquatic research studies is often restricted. The maximum distance between repeaters A and B is 2500 ft. The mobile unit can be positioned up to 5000 ft from either repeater. Distances measured using the AGNAV under ideal conditions can vary by 0.8 of the wavelength (9.584 in. with AGNAV operating at 154.6 MHz).

If the transmission of the radio waves are interrupted during the AGNAV operation, incorrect distance measurements will occur. Trees, brush, and hilly terrain near the repeaters can interfere with the transmission or receiving of radio waves during baseline establishment or determining distance from the mobile unit to the repeaters. AGNAV distance errors occur if the repeaters are not repositioned exactly at the original shoreline sites or when the 30-ft offset of the mobile unit antenna is not determined precisely after the repeaters are placed during baseline establishment.

DATA COLLECTION

The morphology of a shoreline and an aquatic plant colony can be delineated by moving the mobile unit along their boundaries and recording the AGNAV A and B distances at successive points along the boundaries (Figure 3). More irregular boundaries require collection of additional AGNAV coordinates for accurate mapping. By repositioning repeaters A and B at their original sites during successive sampling periods, changes in the areal extent of the aquatic plant colony can be determined.

Establishment of experimental plots and sample sites can be facilitated by using a simple computer that can be carried with the mobile unit of the AGNAV system. The WES has used a system consisting of a pocket-size programmable calculator, a thermal printer, direct-to-alternating current inverter, and magnetic cards containing programs that facilitate plot and sampling site establishment (Figure 4).

One program has been developed that identifies corners and areas of rectangular or square experimental plots (Figure 5). To establish square or rectangular plots in an aquatic plant colony, two corners positioned diagonally from each other are selected (P1 and P2) and marked with floats, and the AGNAV A and B distances are entered in the calculator. The calculator computes the locations of the two unknown corners and the dimensions and the area of the plot, all of which are then printed on the thermal paper. The plot area is determined by the location of the diagonal corners (P1 and P2) and can range from less than 1 acre to 320 acres. The plot can be relocated easily if buoys are lost or are moved by positioning the repeaters at their original locations and moving the mobile unit until the AGNAV values for each corner are located.

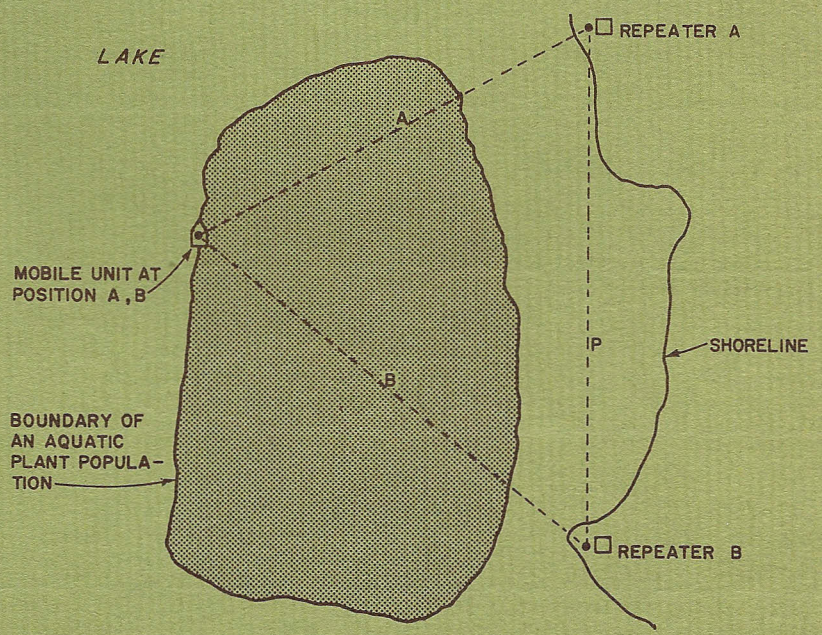

Figure 3. Delineating the boundary of an aquatic plant population

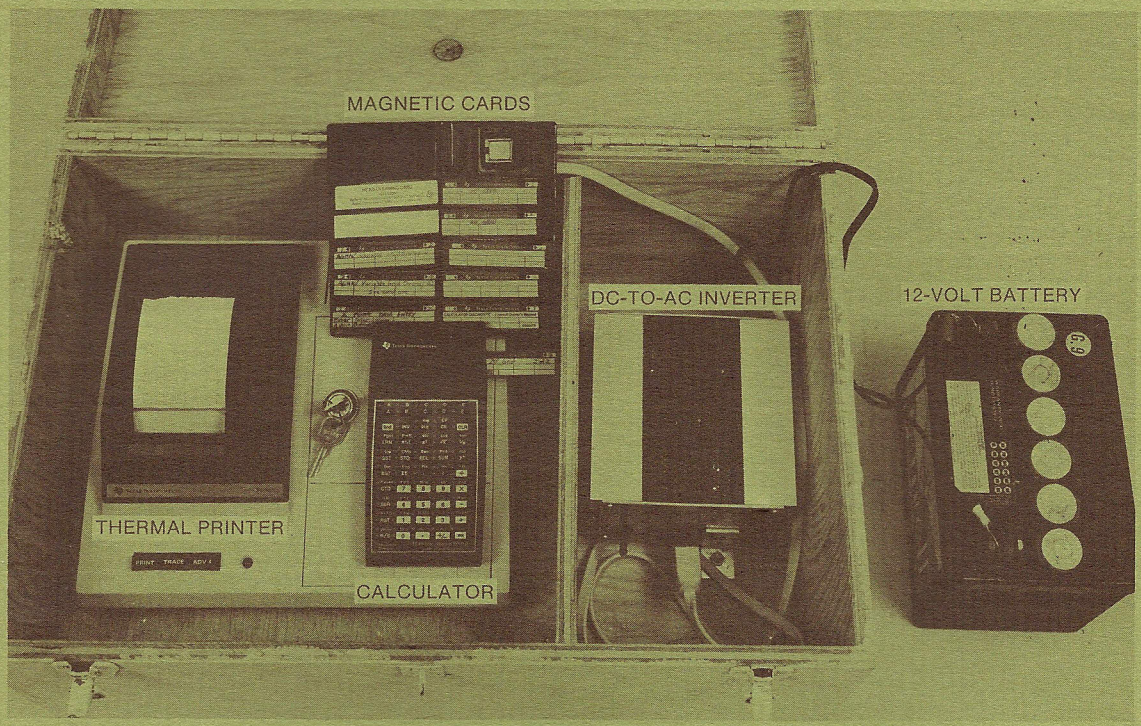

Figure 4. Programmable calculator and printer setup for field use

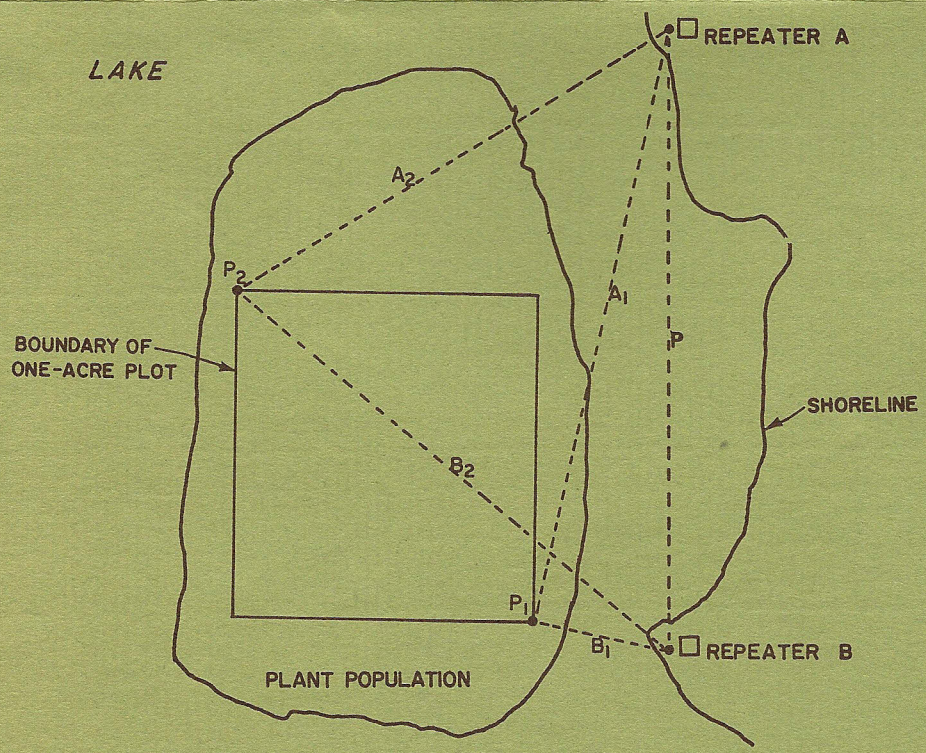

Figure 5. Establishing 1-acre treatment plot

Another program has been developed for the system that expedites random sampling within square or rectangular plots. The WES has used a calculator program that superimposes a grid over the plot. The dimensions of an individual grid square are determined by the operator of the program. Each grid square is numbered. The program randomly selects grids by number, and the AGNAV A and B values for the center of these grids are printed on thermal paper. Thus, the randomly selected grids then can be located using the AGNAV's positioning system (Figure 6).

The AGNAV positioning system is ideal for repetitive, systematic sampling within a plot. To systematically sample, the mobile unit is positioned at the desired sampling site and the AGNAV A and B distances are recorded. This unique site can be found during any subsequent sampling period if the original positions of repeaters A and B were marked.

(Continued on page 9)

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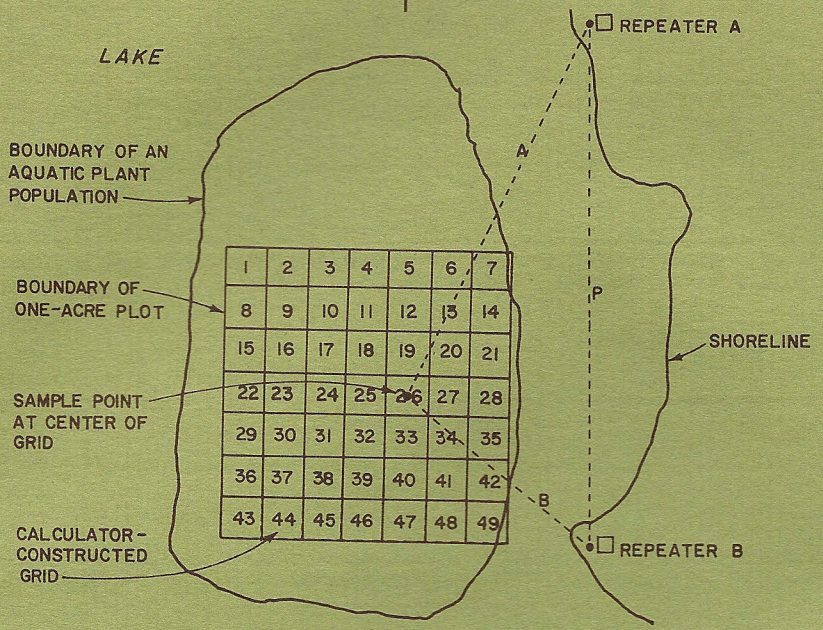


Figure 6. Establishing sampling points for random sampling approach

Positioning System

(Continued from pg 4)

The AGNAV system used with a fathometer can rapidly provide accurate indicator data on the efficacy of treatments (e.g., chemical, mechanical) aimed at controlling the growth of submerged aquatic plants. The fathometer used with AGNAV was an echo depth sounder that provided a permanent record of water depth, bottom topography, and height of submerged aquatic plant colonies.

Once a plot has been designated, straight-line transects are positioned over the plot using the AGNAV transect positioning system. Each transect is positioned perpendicular to the baseline and directed in a straight line using the AGNAV direction-indicator display unit. While traveling over each transect, event marks are put on the fathometer paper at appropriate intervals and an AGNAV location corresponding to each event mark is recorded. By always positioning repeaters A and B in the same locations, plant height throughout the plot can be determined along the same transects at various times after the initial sampling period. Fathometer tracings for each plot on each sampling date can be interpreted at each event mark for water depth and plant height and average plant height and water depth within a plot can be obtained. Percent change in average plant height can be determined by comparing the plant heights within a plot on different dates. Thus, changes in aquatic plant height can be measured rapidly and accurately and used as an indicator of treatment efficacy.

DATA DISPLAY

A terminal and an interactive digital plotter or similar automated systems can be used to display and provide hard-copy graphics of study areas (Figure 7). The AGNAV A and B distances for the boundary of the aquatic plant colony and shoreline, plots, sampling points, and fathometer event marks can be entered into a computer file. A program has been developed to retrieve these data and display the locations of sampling stations with respect to the shoreline, plot, and aquatic plant colony. Then, hard-copy graphics of study areas can be produced at various scales as desired.

NOTE: The contents of this article are not be be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

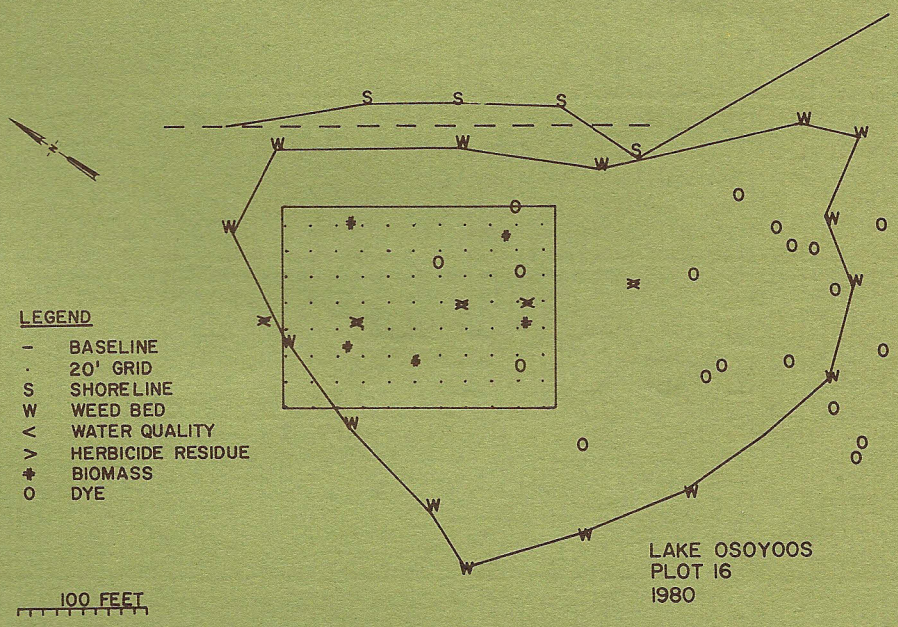


Figure 7. Hard-copy display of study plot in Lake Osoyoos, Washington

ANNUAL MEETING NOTICE

The 17th Annual Meeting of the Aquatic Plant Control Research Program is scheduled for 16-19 November 1982 in Sacramento, California. The agenda topics will include overviews of aquatic plant problems, research needs, progress on current work, and plans for the future.

Corps Divisions/Districts will identify the aquatic plant problems in the respective areas and present the status of their control programs. Other agenda items include presentations on biological, chemical, and mechanical control; plant ecology; and problem identification and assessment.

The FY 84 Civil Works Research and Development Aquatic Plant Program Review will be held following the Annual Meeting.

Point of contact for the meeting is Mr. W. N. Rushing (601/634-3542 commercial or 542-3542 FTS).

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
PO BOX 631
VICKSBURG, MISSISSIPPI 39180

REPLY TO ATTENTION OF WESEV

19 August 1982

Letter to all District and Division Commanders:

We are holding the 17th Annual Meeting of the Aquatic Plant Control Research Program at the Mansion Inn, Sacramento, California, 16-19 November 1982. Please note that this year's meeting begins on Tuesday rather than on Monday as in previous years. The agenda topics will follow the same general format as last year with overviews of aquatic plant problems, research needs, progress on current work, and plans for the future. We have reserved a block of rooms at the Mansion Inn, Sacramento. If you plan to attend, please send your check or credit card number for one night's lodging in the inclosed prepaid envelope (Incl 1) before 1 November. The room rate is $36.00 per night, single or double occupancy. During registration, we will collect $20.00 to cover the cost of a reception and coffee breaks. Please note that this is not a registration fee and is not reimbursable to Federal employees.

Each year at this meeting the Corps Divisions/Districts present the status of aquatic plant problems and control programs in their respective areas. We solicit your participation in presenting a short status report. Please advise us by 25 October if you or a representative of your office will participate and/or make a presentation. If you plan a presentation, please provide a short written summary before or during the meeting for inclusion in the published proceedings.

As an integral part of the meeting, we will hold the FY 84 Civil Works Research and Development Aquatic Plant Program Review at 8:30 a.m., Friday, 19 November. We encourage representatives of your office to attend.

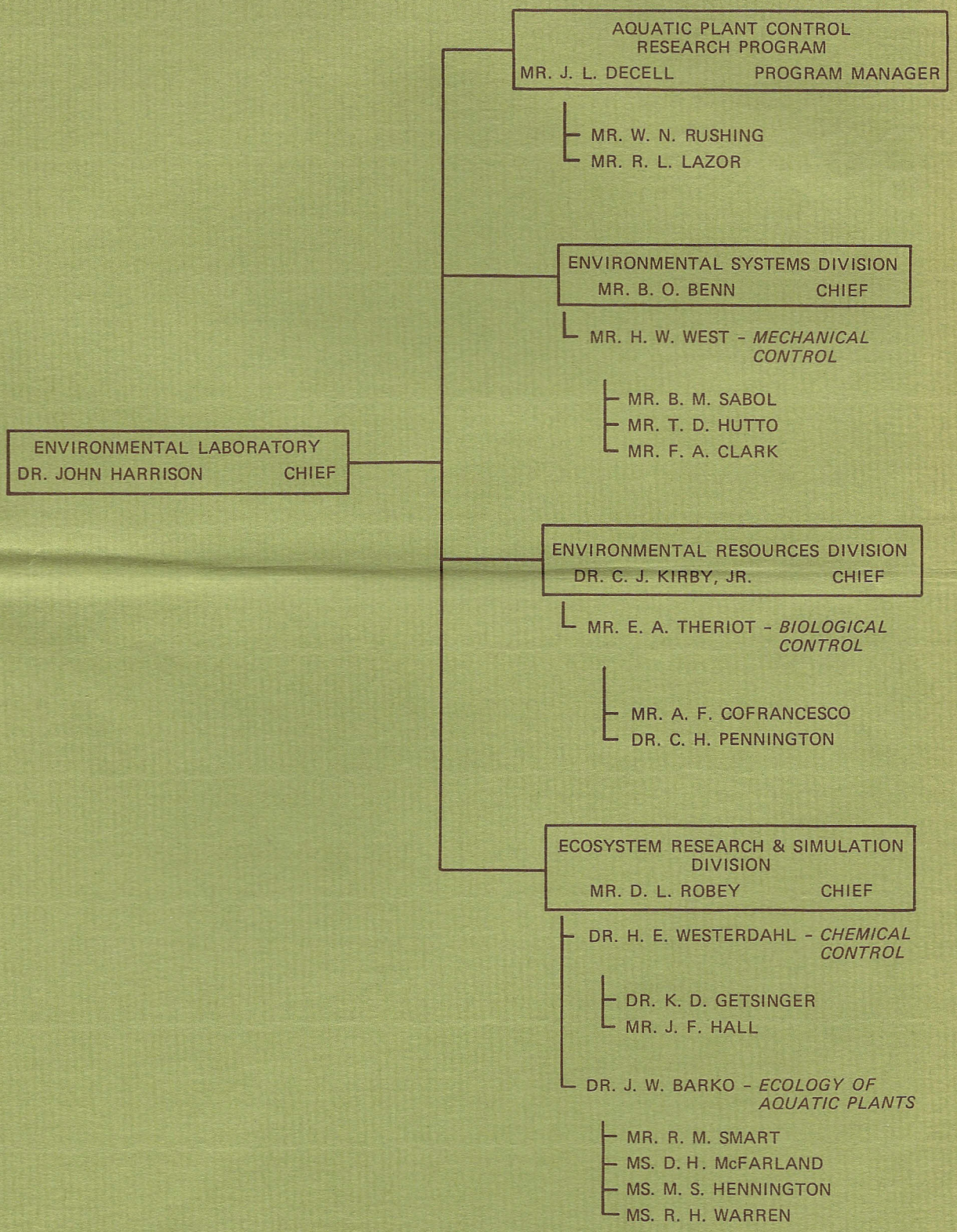
If you have any questions concerning the meeting, please contact Mr. W. N. Rushing, 601-634-3542 (FTS 542-3542).

Sincerely,

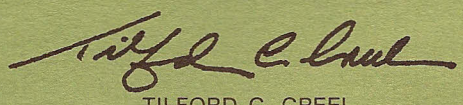
1 Incl
As stated

TILFORD C. CREEL
Colonel, Corps of Engineers
Commander and Director

ORGANIZATION OF AQUATIC PLANT CONTROL RESEARCH PROGRAM, PRINCIPAL INVESTIGATORS AND AREAS OF RESPONSIBILITIES



This bulletin is published in accordance with Army Regulation 310-2. It has been prepared and distributed as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Aquatic Plant Control Research Program (APCRP) can be rapidly and widely disseminated to Corps District and Division offices as well as other Federal agencies, State agencies, universities, research institutes, corporations, and individuals. Contributions are solicited and will be considered for publication so long as they are relevant to the management of aquatic plants as set forth in the objectives of the APCRP, which are, in general, to provide tools and techniques for the control of problem aquatic plant infestations in the Nation's waterways. These management methods must be effective, economical, and environmentally compatible. This bulletin will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: J. L. Decell, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180, or call 601-634-3494.



TILFORD C. CREEL
Colonel, Corps of Engineers
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