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**AQUATIC PLANT CONTROL RESEARCH PROGRAM**

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# PLAN OF STUDY FOR DETERMINING ECONOMIC VALUES OF AQUATIC PLANT MANAGEMENT


by

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Control of aquatic plants by the US Army Corps of Engineers (CE) provides a rauge of beuefits that are valued by the public. It is important to conaider the economic costs and benefits of aquatic plant control in making decisions on the allocation of funds, for determining the appropriate level or degree of control for plant infestations, and for evaluating economic trade-offs of one control effort or technology over another. Many of the economic benefits and costs of aquatic plant control efforts have not been well identified, quantified, or valued. This report sets out a Plan of Study for determining the economic value of aquatic plant control. The objective of the effort will be to identify market and nonmarket valuation methods that can be used by the CE.

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The Plan of Study includes four phases: literature review; determination of impacts and public perceptions of aquatic plant management; valuation methods for aquatic plant control; and field testing and development of field guidance. Completion of these four phases is scheduled during Fiscal Years 1990-1993. The product of the study will be a User's Manual for Valuation of Aquatic Plant Control.

# PREFACE

This study was conducted as a part of the US Army Corps of Engineers Aquatic Plant Control Research Program (APCRP). Funds for the study were provided by the Headquarters, US Army Corps of Engineers (HQUSACE), under Department of the Army Appropriation No. 96X3122, Construction General. The APCRP is managed by the US Army Engineer Waterways Experiment Station (WES) under the Environmental Resources Research and Assistance Programs, Mr. J. Lewis Decell, Manager. Technical Monitor for the study was Mr. James W. Wolcott, HQUSACE.

Principal investigator for this study was Mr. Jim E. Henderson, EL. The report was reviewed by Dr. Eric Thunberg of the University of Florida. Ms. Jessica S. Ruff of the WES Information Technology Laboratory edited the report.

The study was performed under the general supervision of Dr. John Harrison, Chief, EL, and Dr. C. J. Kirby, Chief, Environmental Resources Division, and under the direct supervision of Mr. H. Roger Hamilton, Chief, Resource Analysis Group.

Commander and Director of WES was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

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CONTENTS

# PLAN OF STUDY FOR DETERMINING ECONOMIC VALUES OF AQUATIC PLANT MANAGEMENT

## PART I: INTRODUCTION

1. Decisions on the management of natural resources require a number of pieces of information. Increasingly, the economic value of natural resource management to the public is being considered in making decisions with regard to management of those resources. This paper sets out a Plan of Study for determining the economic value of aquatic plant programs. The product of this effort will be a User's Manual that provides economic anslysis methods for equatic plant control. The User's Manual will set out a methodology that can be used by Districts to evaluate the economic benefits and costs of aquatic plant control efforts.

2. Economic analysis involves the identification or explication of human choices. Humans mske a variety of decisions in determining the most desirable, efficient, and effective way to accomplish personal or societal objectives. Applied to public programs, economic analyais is used to ensure that public programs are implemented to make the best use of public revenues and achieve the gosls and objectives of the programs. Because there are always more program needs than there is funding or tax base to meet the goals, economic analysis is used to compare the merits or benefits of funding one project over another.

3. Economic analysis is used in public programs to evaluate the effectiveness of program efforts in terms of public economic benefits or National Economic Development, and to compare alternative programs or competing uses of public funds. Information on the economic aspects of aquatic plant control can provide for more informed decisions on aquatic plant control at the local level, by State and local cost-sharing partners, by District and Division personnel, and at the national level. From an agency standpoint, decisions have to be made on the basis of the overall benefits and costs to society. This requires that an understanding of societal benefits and costs be used. The benefits of an open waterway in terms of recreation, aesthetics, and habitat are benefits to include along with the project purpose benefits of commercial navigation, flood control, and water supply. Additionally, public

response to the cleared waterway will induce secondary effects such as changes in land use, recreation use patterns, and improvement of aesthetic quality.

4. An economic analysis of aquatic plant programs can provide additional information for decisionmaking. Decisions can be made with an understanding of public perceptions of different technologies and willingness-to-pay for varying levels of control or management. Information on all the benefits and costs associated with aquatic plant control will lead to better allocation of scarce resources. In evaluating different projects in competition for funding, it will be possible to compare the benefits and costs associated with each proposed project. This comparison can lead to allocation of funding commensurate with the level of the perceived problem and benefits of a project.

5. The benefit and willingness-to-pay information can be used to determine:

a. The value of the program, from a local, District, state, or national perspective.

b. The comprehensive valuation of all benefits and costs associated with aquatic plant control.

c. The economic trade-offs of different control technologies.

## PART II: PLAN OF STUDY

6. This study effort is composed of four phases, over a 4-year period, as outlined below. The study will be carried out with cooperation of District personnel responsible for aquatic plant control, Corps and other resource economists, and US Army Engineer Waterways Experiment Station (WES) personnel. All phases will be performed by WES and supporting contractor(s), with District review and input. Phase II will involve utilizing ongoing District studies to determine public perceptions and values on aquatic plant problems and control strategies. Table 1 shows the scheduling of the four phases; Table 2 outlines the user products and milestones for their accomplishment.

### Phase I - Literature Review

7. The purpose of the Literature Review is to assimilate existing information on valuation of aquatic plant management. The costs of implementation of control programs and the economic benefits produced by control efforts can provide critical input in making decisions on aquatic plant programs. Literature will be reviewed to identify information relevant to economic valuation of costs and benefits. Documentation on control strategies, research, testing, and experience in the field has produced reliable estimates of costs for implementing a management plan. This cost information has generally been limited to labor, equipment, and management expenditures. Indirect, secondary, and opportunity costs have not usually been included in the evaluations.

8. The economic benefits produced by control efforts are evaluated using methods that have become accepted and standardized within Federal and State agencies. The project purposes that aquatic plant management supports, e.g., navigation or water supply, have specific economic criteria and evaluation procedures to determine their value. This part of the literature review will, for each project purpose, identify the economic criteria used in project evaluation, e.g., reduction in damages for flood control. The economic evaluation procedures will be examined to determine such things as availability of data, sources of data, and acquisition of the data in the course of a normal aquatic plant planning effort.

Table 1

Schedule of Plan of Study Activities

| Activity | FY 90 | FY 91 | FY 92 | FY 93 |
|---|---|---|---|---|
| Phase I | | | | |
| Literature review | -------- | | | |
| Phase II | | | | |
| Task 1 - Impacts of aquatic plant control | ---------- | | | |
| Task 2 - Public perceptions | ---------- | ---------- | | |
| Phase III | | | | |
| Valuation methods | | ---------- | | |
| Phase IV | | | | |
| Field tests and guidance preparation | | ---------- | ---------- | ---------- |

Table 2

Products and Milestones

| Item | Date |
|---|---|
| Literature review | Jun 90 |
| Miscellaneous Paper - Impacts of Aquatic Plants and Aquatic Plant Control Efforts | Sep 91 |
| Miscellaneous Paper - Public Perceptions of Aquatic Plant Problems and Aquatic Plant Control Efforts | Jun 92 |
| Technical Report - Valuation Methods for Aquatic Plant Control | Sep 92 |
| User's Manual for Valuation of Aquatic Plant Control | Sep 93 |

9. A number of the benefits of aquatic plant control, e.g., recreation, are not well identified, documented, or quantified in the aquatic plant literature. Valuation of these benefits has not generally been included in aquatic plant planning efforts. Other such data gaps will likely be identified. The literature review will provide a baseline understanding of "Where do we stand?" with regard to how the costs and benefits of plant control are presently being accounted. The evaluation of the costs and benefit information will be summarized in a Literature Review Synthesis.

10. The sources used for the literature review will include the standard literature databases available, the Aquatic Plant Information Retrieval System, available Aquatic Plant Control Reconnaissance and Feasibility studies and General Design Memoranda, and economic evaluation documentation. A summary of the aquatic plant control literature will be developed. The documents examined during the literature review will be abstracted and included in the Literature Review Synthesis.

## Phase II - Impacts and Public Perceptions of Aquatic Plant Management

11. Management of aquatic plants is undertaken so that specific activities, e.g., navigation, can occur without being impeded or diminished by the plant biomass. Removal of aquatic plants or management of plants at nonproblem levels makes possible navigation or other project uses such as recreation. Plant management may allow construction of public use facilities, such as boat docks, or residences on land adjacent to the waterway, or induce other land use changes because of the plant-free water. If the decision is made not to provide for navigation, then more will be lost than just the navigation capability. Recreation may be displaced to some other part of the waterway or lake, to another lake, or may be foregone altogether. The point is that management of aquatic plants can result in a myriad of secondary or indirect effects both in the water and on the land.

12. To value aquatic plant efforts, it is necessary to determine the benefits and costs of all of the services provided by or resulting from control efforts. The primary project purposes for requiring plant control, e.g. navigation or flood control, may not turn out to be the greatest or most highly valued of the services by the public. Similarly, with a decision not

to fund a plant control project there are indirect costs in terms of such things as displacement of recreation use, loss of access to lake areas, fish and wildlife habitat losses, loss of flood control benefits, and diminished quality of recreation experience.

Task 1 - Impacts of
aquatic plant management

13. Plant infestations, resulting in loss of project benefits for navigation or water supply, also cause loss of recreation capacity and degradation of project aesthetics, and can cause decreases in the value of adjacent property, from loss of use of the lake. Similarly, control of aquatic plants ensures navigation and other project benefits, provides for access to the water and improved aesthetics, and may induce changes in land use. Currently, evaluation of aquatic plant control has focused totally on the effects of control efforts on aquatic plants, without considering the range of impacts and effects caused by the plants and control efforts. Therefore, the objective of Task 1 of Phase II is to identify all effects, impacts, and changes attendant to aquatic plant problems and management.

14. The effects of aquatic plant programs will be assessed using a number of methods. The human response to changes in natural resources will be determined through discussions with resource managers and State and local personnel responsible for implementing aquatic plant control efforts. District, State, or private documentation or data will be examined to identify changes in land use, recreational use, and resource management, e.g., closing of boat ramps, and other impacts caused by aquatic plant problems and control efforts.

Task 2 - Public perceptions
of aquatic plant management

15. The impacts of aquatic plant control identified in Task 1 are qualitative and will vary with the project. Valuation, however, requires site- or project-specific information on the willingness-to-pay for use of a particular waterway. Public perceptions of the impacts of aquatic plants and control efforts and the public's willingness-to-pay for plant control benefits must be accounted for in valuation of equatic plant programs. Task 2 thus involves determining public perceptions of plants and plant problems, and identifying public preferences and perceptions for different management technologies.

16. Through research and experience with various control technologies, it is possible to manage aquatic plants at varying levels (for instance, at

various biomass densities). Understanding the public perceptions of exactly what constitutes a problem or problem level is important. It is also important to determine the public perception as to what plant levels or management measures constitute a solution, or an acceptable level. Public perceptions of desirable plant densities may be determined by use patterns (e.g., fishing versus swimming), aesthetics, and intangible values. Because the public holds different preferences for the various plant levels, the public willingness-to-pay may vary with the different plant levels.

17. Public input on desirability of different control levels is elicited through responses to the different plant conditions. Depictions of different levels of aquatic plant conditions can be developed using photographs of project conditions. Visual simulations can be used to show the public how the levels of infestation appear. Visual representations likely have the most effectiveness for emergent species. More important than the visual appearance of a particular level of infestation is the effect that a particular plant level has on the activities of the waterway user.

18. Preferences for different plant levels based on user preferences are elicited from different scenarios describing plant conditions and how use is affected by the different plant levels. The scenarios used to elicit willingness-to-pay can describe, for instance, that a fisherman would not be able to get to a fourth of the fishing areas at a project due to aquatic plants, that boat motors would become clogged with plants at a certain frequency, that critical fish habitat would be replaced by aquatic plants, or that the catch of fish would be reduced by a certain percentage.

19. To determine willingness-to-pay for different levels of control, questionnaires describing (narrative form) or depicting (photo form) the different plant control levels are prepared. In either form, a scenario is presented for the different levels of control, describing the extent or presence of the aquatic plant infestation. The respondent is asked to provide the dollar amount he or she is willing to pay to preserve or to obtain the described level of plant control.

20. Preferences for different control technologies by the public affect the willingness-to-pay for control efforts. Public perceptions of the implementation and the long- and short-term impacts, e.g., the closing of recreation areas for herbicide treatment, affect the public support and, in some cases, the cooperation by the general public and those local agencies

responsible for cost-sharing. Public perceptions of control technologies are acquired by a number of means involving questionnaires. Respondents indicate preference, acceptability, and willingness-to-pay for different technologies. Questionnaires can be designed to determine the extent of understanding of the control technologies by the public.

21. To determine public perceptions and preferences for different control technologies for planning and decisionmaking requires public surveys using statistical sampling designs. For specific waterways or lakes, public perception surveys will be administered to a sample of the users of the project. The sample would be stratified to include respondents from each of the user groups, including recreationists, navigation personnel, and local residents. Less rigorous sampling designs, while not providing the statistical level of reliability, can still give an indication of public perceptions and preferences for control technologies. Where recreation use or other surveys are already being undertaken, a limited number of questions on aquatic plant control can readily be added. Public meetings in conjunction with Reconnaissance or Feasibility studies or General Design Memoranda may easily be used to obtain public input on the different technologies (though public meeting attendees do not represent a statistical sample).

22. The Phase II documentation of impacts of aquatic plant management and the public perception information is brought together in the form of a Valuation Framework. The purpose of the Valuation Framework is to clearly identify all the benefits and costs and to state which benefits and costs will be included in the valuation analysis. Secondary or indirect benefits and costs may be readily identified, but quantification or valuation may be beyond the present state of the art. It is important to be able to identify all benefits and costs, even if quantification is not possible. The impact and effects information shows the benefits and costs of aquatic plant problems and the effects of control efforts. This information can be used to establish the accounting stance, that is, what public and perhaps private costs and benefits will be considered. The Valuation Framework thus establishes the extent of the economic analysis by identifying the benefits and costs to be considered.

## Phase III - Valuation Methods for Aquatic Plant Control

23. Phase III involves identifying market and nonmarket valuation methods for the benefits and costs identified in the Valuation Framework of Phase II. Emphasis will be on methods that are conceptually valid and that have the greatest potential for use in District decisionmaking. Aquatic plant control results in economic changes in both market (e.g., land values) and nonmarket (e.g., recreation) goods and services; thus, both market and nonmarket valuation methods will be evaluated.

24. Examination of market and nonmarket valuation methods for use in aquatic plant control decisions will look at the suitability of the methods in terms of (a) appropriateness for use in decisionmaking and planning in aquatic plant efforts and (b) appropriateness for the water and land resources affected by aquatic plant problems and management. This evaluation of methods will be accomplished by District representatives, resource economists, and personnel experienced in the valuation of natural resources and management programs.

25. Market and nonmarket valuation methods used for other natural resources or natural resource services may not be suitable for aquatic plant work because of characteristics of aquatic plants or aquatic plant control. Although the resources and natural resource attributes may be similar, use of a specific technique for aquatic plant valuation may require adaptation or extreme care. For instance, use of a method to determine wetland residential development benefits may not be appropriate for aquatic plants. The wetland benefit method is for the valuation of naturally occurring characteristics, e.g., water access. Use of this approach in aquatic plant control requires care because the valuation would be of a man-induced condition, that is, exotic plants.

### Market valuation methods

26. The market valuation of natural resources is usually limited to increases in project benefits such as navigation, water supply, and flood control. The impact of natural resources on market values of such things as real estate is often evidenced in controversies (such as those involving wetland development). Obviously, the natural resource characteristics (water

frontage, direct access to water, etc.) make the wetland development site of a higher value, as evidenced by the market price of the lots.

27. Recently, efforts have been made to incorporate or measure the value attributable to natural resources that is a component of the market value of land developments. A market-based method called the Hedonic Price Approach has been used to determine the value that natural resource characteristics contribute to land sale prices. This approach uses actual land transfer and sale information (such as lot size, water frontage, and access to water) to identify the willingness-to-pay for these characteristics. This type analysis enables valuation of the natural resource characteristics based on market data.

28. The Hedonic Price Approach was used to develop a regression analysis of a subdivision developed in a coastal wetland in Virginia (Batie and Mabbs-Zeno 1985). Using the characteristics of the different lots and the sale price of the lots, a regression equation was developed to show the influence or contribution of the different characteristics to the sale price. This analysis determined, for instance, that consumers were willing to pay $4,180 for a lot on a canal but $7,410 for a lot on open water. Lots adjacent to wetlands are valued at $1,120 less than lots not adjacent to wetlands. Other market analysis methods, such as econometric land market analyses (Luken 1976), have been used to place a value on residential development in wetlands. Land market analyses utilize projected demand for land and land market characteristics to value development benefits. These land development valuation methods and other market methods will be examined for suitability in aquatic plant valuation.

Nonmarket valuation methods

29. Recreation is the only nonmarket value that is usually included in water resources valuations, due to the extensive water-based recreation opportunities available at rivers and lakes. Recreation benefits are measured by willingness-to-pay for the recreation services (Headquarters, Department of the Army 1982). The methods used to estimate willingnesa-to-pay for recreation are (a) Unit Day Value, an administrative or judgment-based method that assigns a dollar value or dollar range to recreation activities or facilities; (b) Travel Cost Method, which uses the cost of travel and time of the recreationist as a proxy for willingness-to-pay; and (c) Contingent Valuation Method

(CVM), which establishes a hypothetical market for recreation and elicits a direct measure of willingness-to-pay for alternative recreation experiences.

30. Use of one method over another is dependent on characteristics of the resource, availability of data, and type of recreation use. Unit Day Values use professional judgments, rather than site-specific data, to assign a willingness-to-pay value from professionally derived values. The Travel Cost Method is applicable for resources that draw recreationists from varying distances. The inverse relationship between level of use and distance traveled is used as a surrogate for willingness-to-pay for use of the resource. The CVM provides a bidding mechanism whereby recreationists state their willingness-to-pay for use of the resource or for potential resource conditions, e.g., decreased fishing opportunity, without dependence on travel characteristics. The CVM approach has applicability for highly popular or unique recreation opportunities, and for situations where natural conditions are changing, e.g. loss of fish habitat from aquatic plants, or other situations where hypothetical or projected, rather than existing, conditions must be assessed.

31. To date, the only study to value recreation benefits related to aquatic plant control is a CVM fishing study conducted at Orange and Lochloosa Lakes, Florida (Milon, Yingling, and Reynolds 1986). However, CVM has been used to value recreation benefits for wetland and other recreation resources.* Little work has been done to evaluate such benefits as existence or conservation benefits due to their intangible nature and lack of past consideration in agency decisionmaking. However, because the public expressed an interest in conservation through protection or conservation legislation for specific resources, efforts are being directed toward estimating willingness-to-pay for these preservation services. Bergstrom, Dillman, and Stoll (1985) determined the values for preservation of prime farmland in South Carolina; Bowker and Stoll (in press) have examined such values for whooping cranes; and Walah, Loomis, and Gillman (1984) examined preservation values for wilderness areas. These studies have identified the attributes of the resource that are important, and then elicited willingness-to-pay values for changes to the resources.

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* John P. Titre et al. 1988. "Valuing Wetland Recreational Activities on the Louisiana Coast: Final Report," prepared for US Army Engineer District, New Orleans, New Orleans, LA.

Evaluation and recommendations

32. Potential market and nonmarket valuation methods will be examined by resource economists, District personnel, WES, and other agency economists to determine which methods meet the criteria for use in aquatic plant valuation. Primary responsibility for evaluation of methods lies with WES and its contractors. At the initiation of the evaluation effort, input will be solicited to formulate evaluation criteria and procedures. Input for this effort will come from District personnel, Corps resource economists, and other agency economists. These personnel can serve as an informal technical review panel for the evaluation of methods. Particular methods or parts of methods may require adaptation or modification for application to aquatic plant valuations. The conclusions from Phase III will be presented in a report identifying the methods or adaptations to methods that should be used in aquatic plant valuation. This report will demonstrate how the valuation methods sre used to determine economic values for the services identified in the Valuation Framework.

## Phase IV - Field Testing and Development of Field Guidance

33. A User's Manual on the valuation of aquatic plant management will be developed through field testing and examination of the valuation methods. It is important, though not critical, that the field testing be in ongoing studies, rather than case studies specifically for testing purposes. This is so the methods can be tested using typical or normal data, time, and other limitations. Ongoing District, State, or Corps of Engineers analyses will be used to test the valuation methods. Planning studies or cost-sharing agreements for which Phase II public perception information was developed can be used for field testing, or other available studies may be used.

34. Evaluation of the field tests will be undertaken by District personnel and other agency resource economists. The evaluations will determine how well the valuation methods meet the requirements for economic information in the specific study. The evaluation will examine such things as the ease of data collection and the degree of understanding of the valuation information and the usefulness of the information in decisionmaking. Any deficiencies or

problems in the way the methods are implemented will be identified in the evaluation of field tests.

35. The User's Manual will explain how to use economic valuation methods for aquatic plant management. Changes to the methods, as identified by the field test evaluation, will be made. A Draft Manual will be prepared for review. This document will incorporate the revisions to the methods based on field tests, guidance on implementation of the methods, and guidance on the use of public preference and economic information in decisionmaking for aquatic plant programs. The Manual will be revised based on the review, published, and distributed.

## PART III: SUMMARY

36. The Plan of Study outlined herein will result in a methodology that can be used to determine the economic benefits and costs of aquatic plant control efforts. Development of the methodology will require coordination between WES and District personnel to determine all the impacts of aquatic plant infestations, the economic benefits from management, and the costs of management efforts. The methodology will provide a way to evaluate economic benefits of a project and to compare benefits and costs of different projects. This economic information provides highly useful information for all levels of decisionmaking for aquatic plant management.

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