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ENVIRONMENTAL IMPACT RESEARCH PROGRAM

INSTRUCTION REPORT EL-84-1

FEB 1 8 1998

A LOW-COST TRANSPLANTING TECHNIQUE FOR SHOALGRASS (*HALODULE WRIGHTII*) AND MANATEE GRASS (*SYRINGODIUM FILIFORME*)

by

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September 1984

Final Report

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Under Environmental Impact Research Program
Work Unit 31632

Monitored by Environmental Laboratory
US Army Engineer Waterways Experiment Station
PO Box 631, Vicksburg, Mississippi 39180-0631

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PREFACE

This report was sponsored by the Office, Chief of Engineers (OCE), U. S. Army, as a part of the Environmental Impact Research Program (EIRP) Work Unit 31632 entitled Coastal Erosion Control Techniques Using Plants, which was assigned to the U. S. Army Coastal Engineering Research Center (CERC). The Center, originally located at Fort Belvoir, Va., moved to the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., on 1 July 1983. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker of COE and Mr. David B. Mathis, Water Resources Support Center.

The study and preparation of a draft final report were accomplished during the time period October 1, 1982 to October 1, 1983; preparation of the reproducible copy was done during February, 1984.

The report was prepared by Mr. Mark S. Fonseca, Department of Environmental Sciences, University of Virginia, and Mr. W. Judson Kenworthy, Ms. Kathleen M. Cheap, Ms. Carolyn A. Currin, and Dr. Gordon W. Thayer of the Beaufort Laboratory, Southeast Fisheries Center, National Marine Fisheries Service.

The authors express appreciation to D. Robertson, M. Robertson, and C. Foltz for assistance in the field exercises, and to H. Gordy for graphics.

Mr. Paul L. Knutson was technical monitor for this report, under the general supervision of Mr. E. J. Pullen, Chief, Coastal Ecology Branch, and Mr. R. P. Savage, Chief, Research Division. Dr. Roger T. Saucier, WES, was the Program Manager of EIRP.

Technical Director of CERC at Fort Belvoir during the study and preparation of the draft final report was Dr. Robert W. Whalin. Commander and Director of WES during preparation of the reproducible copy was COL Tilford C. Creel, CE; Technical Director was Mr. F. R. Brown.

This report should be cited as follows:

Fonseca, M. S., Kenworthy, W. J., Cheap, K. M., Currin, C. A., and Thayer, G. W. 1984. "A Low-Cost Transplanting Technique for Shoalgrass (*Halodule wrightii*) and Manatee Grass (*Syringodium filiforme*)," Instruction Report EL-84-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss., prepared by National Marine Fisheries Service under contract to Environmental Laboratory.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	4046.873	square metres
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
square feet	0.09290304	square metres

A LOW-COST TRANSPLANTING TECHNIQUE FOR SHOALGRASS (*Halodule wrightii*) AND MANATEE GRASS (*Syringodium filiforme*)

Introduction

1. A cooperative research program between the Beaufort Laboratory of the Southeast Fisheries Center, National Marine Fisheries Service, and the U. S. Army Coastal Engineering Research Center (CERC) has developed low-cost transplanting techniques for the subtropical seagrass species shoalgrass (*Halodule wrightii*) and manatee grass (*Syringodium filiforme*). Research is continuing into establishment of turtlegrass (*Thalassia testudinum*), which does not readily develop adequate bottom cover using transplants of mature vegetative parts, as described here for shoalgrass and manatee grass.

2. The transplanting techniques presented are effective for restoring areas damaged by coastal engineering activities and update a previous report by Phillips (1980). A similar technique was developed for temperate species (Fonseca, Kenworthy, and Thayer 1982) and should be used in concert with upcoming technical reports that describe environmental requirements for some seagrass species and sediment stabilization properties of others.

Harvesting and Storing Plants

Identifying preferred harvest sites

3. Seagrass transplants should be obtained from healthy, well-established meadows large enough to minimize the impact of plant

removal. When no reasonable alternative to loss of seagrass habitat exists, areas to be destroyed should also be considered as possible harvest sites for onsite compensation of that loss. Research has demonstrated that eelgrass (*Zostera marina*) transplants collected from high-current areas are found at higher densities than at low-current areas and sometimes exhibit higher growth rates than transplants from low-current areas (Fonseca et al. 1979). These attributes can improve collection efficiency and rates of seagrass bed development (Fonseca, Kenworthy, and Thayer 1981). Our experience suggests that these characteristics may also be true for shoalgrass and manatee grass collected from moderate- and high-current areas. Moderate- to high-current areas are defined as those areas in which water surface current velocity ranges between 0.8 and 1.6 ft/sec.*

4. Sufficient numbers of apical meristems, or growing tips, are necessary for successful transplants. These are illustrated in Figure 1, and collectors should be familiar with their appearance. Upon identifying a potential harvest site, random subsamples of at least 10 planting units (a group of shoots with anchoring device, see page 8) should be made from transplant stock collected from several different locations in the harvest site. The number of apical meristems per planting unit should be recorded. It is recommended that there be a mean ratio of apical meristems to planting units of 1.0, although successful plantings have been established with a mean ratio as low as 0.4. Aerial runners, which always have apical meristems, are sometimes available as an alternative to rhizomes which must be dug up in transplanting these species (techniques are described in later sections). "Aerial runners" is a misnomer for what are actually rhizomes

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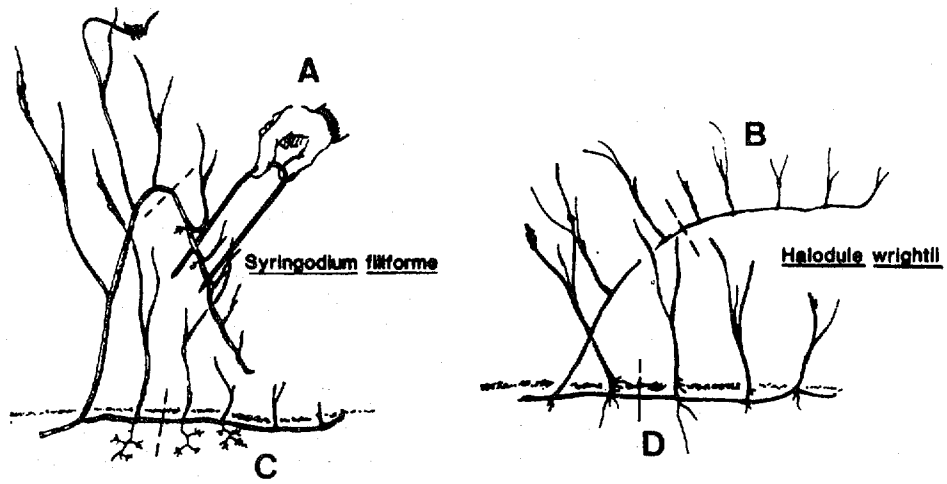
* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 4.

growing out of the sediment exhibiting a stoloniferous-like form. The distribution of aerial runners is not known to be controlled by current regime; therefore, current is not a harvesting site criterion when using this method.



a. Syringodium filiforme *b. Halodule wrightii*

Figure 1. Aerial runners (A and B) and rhizomes (C and D) with apical meristems. Section A illustrates the anchor's placement on a planting unit. The dashed lines indicate the point of detachment when harvesting planting unit.

Harvest technique

5. Two techniques that may be employed in the harvest of shoalgrass and manatee grass are (a) the collection of aerial runners and (b) the removal of "sods" or mats of seagrass from the sediment.

6. Aerial runners containing at least 6 shoots and the apical meristem are removed from the plant by hand. The dashed lines in Figure 1 (A and B) illustrate the point at which aerial runners should be detached.

7. Harvesting sods is most readily accomplished with a dive knife or shovel inserted 6-8 in. into the substrate. A sod of seagrass is cut out and carefully removed from the sediment to avoid damaging the plants and to preserve the root-rhizome mat. Sod harvest necessitates some disruption of the donor meadows. Sods should be cut in small, shovel-sized sections from the meadow as widely dispersed as possible to facilitate regrowth into the shovel hole. The harvested seagrass mat should be gently rinsed free of sediment. Individual planting units from this material will resemble the rhizomes in Figure 1 (C and D).

Storage guidelines

8. Aerial runners and mats of seagrass should be stored in ambient seawater and processed into planting units within 36 hr. If possible, the water in closed storage containers (plastic trashcans work well) should be aerated; otherwise, replace the water frequently. For outdoor storage the planting material can be retained in coarse mesh bags (typical nylon dive bags work well) and hung overboard from a boat or pier. For prolonged storage of 2-3 weeks, floating pens with open tops (for light) are suggested. Setting the mats of seagrass into shallow, flowing seawater tables works well and provides an ideal area for sorting and preparing planting units. These submerged plants do not tolerate any exposure to direct sun when out of the water; they should always be kept in ambient seawater.

Preparing Planting Units

9. A planting unit (PU) consists of a section of aerial runner that has at least 6 shoots and the apical meristem. Properly harvested aerial runners will need no sorting prior to transplanting. If the plant material was harvested by the sod method, planting units consisting of at least 3

healthy rhizomes bearing a minimum of 5 intact shoots will need to be sorted from the mat.

10. Anchors must be used to secure the plant to the sediment. Anchors can be made from pieces of sturdy wire approximately 8 in. in length and bent into U-shaped pins. Bent sections of coat hangers or commercially available erosion control fabric pins work well. Figure 1A illustrates placement of the anchors over the transplant stock.

11. Additional preparation may be necessary, depending upon the current velocity at the transplant site. In moderate-to high-current areas, planting units are attached to anchors by twist ties. The anchor should be attached to a sturdy portion of the runner(s) or rhizome(s). In low-current areas it is not necessary to attach planting units to anchors; the appropriate number of anchors and transplant stock need only be brought to the transplant site.

Planting Method

12. Proper handling and spacing of planting units is essential for a successful transplant. Planting units should be kept covered with seawater at all times and handled carefully to reduce breakage and transplant shock.

13. Transplanting can be done in shallow water areas (up to about 2 ft deep) by wading workers or by SCUBA divers in deeper areas. Planting grids with the proper spacing should be established using a weighted line marked in the calculated spacing units or by other measuring devices.

14. Planting units need to be secured to the sediment surface but not buried. The U-shaped anchors are placed over the rhizome or runner of

the planting unit and then pushed into the sediments until the planting unit is held firmly against the bottom and will not be removed by current or wave action (Figure 2). Greatest efficiency is obtained when personnel work in teams, with one worker holding the planting unit in position while the other worker places the anchor to secure it. When planting units are already attached to anchors, one worker plants while another individual provides a continuous supply of planting units.

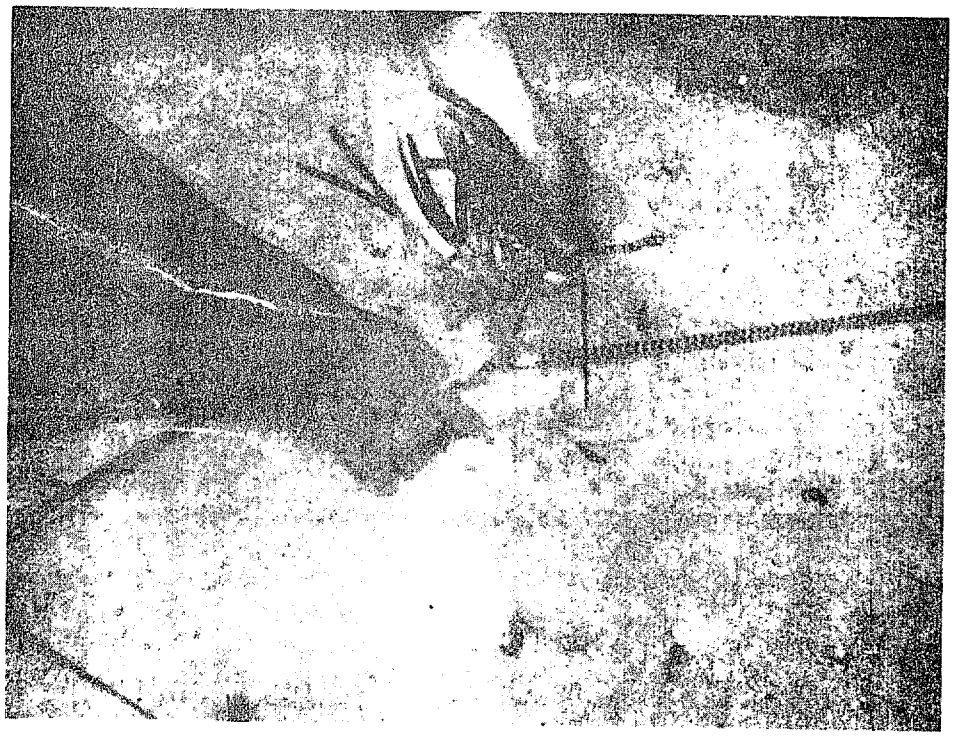


Figure 2. Planting method described in text showing planting unit, anchor, and weighted line marked in spacing units. Planting unit is inserted next to the marked line

Plant Material Requirements

15. To determine the required number of planting units and spacing between them for a transplant area, first determine which species will be used, the desired number of days for transplant stock to cover the area, and the size of the transplant area in square feet. Based on the species used and the desired number of days to coverage, determine the Y value from the table below. For example, if shoalgrass is to be used and the value for days to coverage is 125, then Y = 7.5406.

Days to Coverage	Y Value (ft^2)	
	Shoalgrass (H.w.)	Manatee grass (S.f.)
50	0.7543	0.2765
75	1.6248	0.4250
100	3.5002	0.6521
125	7.5406	0.9996
150	16.2444	1.5333
175	34.9969	2.3381
200	75.3975	3.5852

16. The Y values given above were derived from the formula:

$$Y = ae^{rt} \qquad (1)$$

where

a = Time 0 area (ft^2)
(H.w. = 0.1625; S.f. = 0.1173)

e = base of the system of natural logarithms

= $(1+t)^{1/t}$ as t goes to 0 = 2.7182818

r = Instantaneous growth coefficient
(H.w. = 0.0307, S.f. = 0.0171)

t = Days to coverge.

17. To calculate the number of planting units needed for a transplant site use the following formula:

$$\text{Number of PUs} = \frac{\text{Area of transplant in square feet}}{Y} \qquad (2)$$

To calculate the spacing between PUs in the planting grid, use the following formula:

$$\text{Distance between PUs in feet} = \sqrt{\frac{\text{Area of transplant in square feet}}{\text{Number of PUs}}} \qquad (3)$$

18. As another example, assume a transplant area of 3 acres is to be planted with manatee grass. The transplants should cover the area in 150 days. Convert acres to square feet as follows:

$$3 \text{ acres} \times 43{,}500 \text{ ft}^2/\text{acre} = 130{,}500 \text{ ft}^2$$

The Y value for manatee grass at 150 days is 1.5333; hence:

$$\text{Number of PUs} = \frac{130{,}500}{1.5333} = 85{,}111$$

$$\text{Distance between PUs} = \sqrt{\frac{130{,}500}{85{,}111}} = 1.24 \text{ ft}$$

19. The authors would like to point out that of the two species, shoalgrass had a higher growth rate when transplanted. If stock availability and site environmental conditions do not suggest a particular species, the choice of a faster-growing species will reduce total man-hours required for the transplant. Planting both species together would, however, allow for a natural selection of the best species for the site. The selection of a longer time period to coverage will also result in fewer total man-hours required.

20. Figure 3 and 4 illustrate the development of a shoalgrass planting unit from transplant to 160 days' growth.

Labor Requirements

21. Labor rates for the three phases of planting are discussed below.

22. Harvesting and preparation of planting units.

a. Aerial runners.

(1) Shoalgrass - 500 aerial runners or planting units per man-hour.

(2) Manatee grass - 325 aerial runners or planting units per man-hour.

b. Sods.

For either species, 18,000 shoots or 3,000 planting units per man-hour.

23. Anchor Attachment. If planting units are to be attached to anchors, labor rate is 100 PUs per man-hour.

24. Planting.

a. Planting rate for wading, non-SCUBA assisted workers is about 150 PUs per man-hour in most habitats.

b. Planting rate for SCUBA-assisted workers is about 175 PUs per man-hour. (Note: although SCUBA-assisted workers are at least 15 percent faster than non-SCUBA assisted workers, wage difference has always resulted in non-SCUBA workers being most economical when conditions permit.)

Figure 3. Newly planted shoalgrass stock

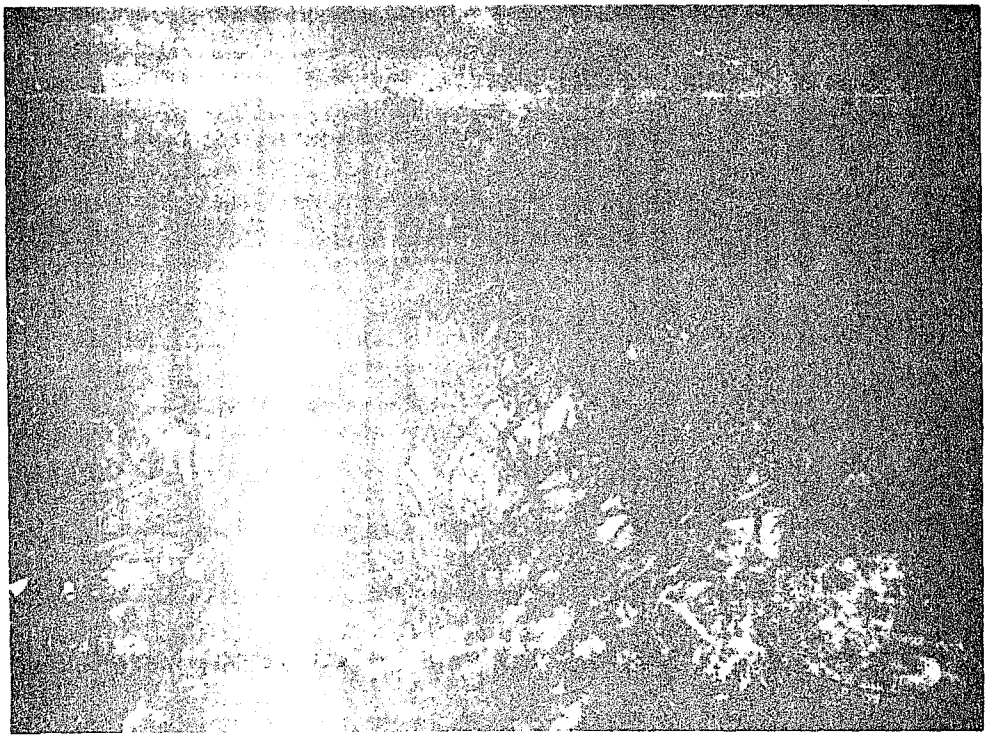


Figure 4. Shoalgrass transplant after 160 days of growth

25. Total Man-Hours. As an example, determine total man-hours required to harvest, prepare, and plant 25,000 PUs of shoalgrass from sod samples. Planting units were attached to anchors and wading workers were used.

	Man-hours
Harvest (25,000 PUs ÷ 3,000 PUs/man-hour)	8.3
Attaching anchors (25,000 PUs ÷ 100 PUs/man-hour)	250.0
Planting (25,000 PUs ÷ 150 PUs/man-hour)	166.7
TOTAL	425.0

26. This estimate includes only onsite work; it does not include travel, gear preparation, or additional requirements for safety of workers and equipment.

Summary

27. The planting techniques recommended in this report make use of mature vegetative plant material that can be acquired with (sod) or without (aerial runners) impact to the donor site. Based on the estimated man-hour requirements for each collection technique reported herein, a cost-benefit analysis with regard for the impact to the donor site could be completed.

28. Cost estimates must account for the attachment of anchors in moderate- to high-current areas, as well as consideration of shallow water versus SCUBA-assisted planting.

29. Material requirements are estimated by accounting for the species selected, the species growth rate, and the area to be covered. Formulas are provided for simplified computation of spacing of planting units to achieve coverage within the desired time period.

30. The table for computation of Y values was developed from the results of several experimental pilot plantings in which the transplants were carefully monitored for 160 days and the growth rates and area covered were recorded.

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: Instruction Report EL-84-1

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): A LOW-COST TRANSPLANTING TECHNIQUE FOR SHOALGRASS (*HALODULE WRIGHTII*) AND MANATEE GRASS (*SYRINGODIUM FILIFORME*)

5. TYPE OF REPORT & PERIOD COVERED: Final report

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): M. S. Fonseca, W. J. Kenworthy, K. M. Cheap, C. A. Currin, and G. W. Thayer

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS: University of Virginia, Department of Environmental Sciences, Charlottesville, Va. 22903; National Marine Fisheries Service, Southeast Fisheries Center, Beaufort Laboratory, Beaufort, N. C. 28516

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Environmental Impact Research Program, Work Unit 31632

11. CONTROLLING OFFICE NAME AND ADDRESS: DEPARTMENT OF THE ARMY, US Army Corps of Engineers, Washington, DC 20314-1000

12. REPORT DATE: September 1984

13. NUMBER OF PAGES: 16

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): US Army Engineer Waterways Experiment Station, Environmental Laboratory, PO Box 631, Vicksburg, Mississippi 39180-0631

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report):

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report):

18. SUPPLEMENTARY NOTES:

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22161.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number):

Cost evaluation
Currents
Manatee grass
Seagrass
Sediment stabilization
Shoalgrass
Transplanting techniques

20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

A simplified, low-cost transplanting technique has been developed for seagrasses, *Halodule wrightii* and *Syringodium filiforme*, for use in high- and low-current regimes. The method makes use of mature, vegetative shoots, free of sediment and anchored to the substrate. The technique accounts for selection of planting stock, species growth rate, and depth of planting site for estimating the design, labor, and material requirements of a transplant. Examples are provided to illustrate use of the tables and formulas for computing the necessary requirements.

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