137 FERC ¶ 62,258
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Appalachian Power Company Project No. 739-022

ORDER ISSUING NEW LICENSE

(December 27, 2011)

Article 409. *Habitat Management.* The Habitat Management Plan is approved and made part of this license and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the Habitat Management Plan, filed June 29, 2009.

Appalachian Power Company
Claytor Project
FERC No. 739

Habitat Management Plan

June 2009

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SUMMARY

The Claytor Project (No. 739) is licensed to Appalachian Power Company (Appalachian) and is a conventional hydroelectric project located on the New River in Pulaski County, Virginia.

The purpose of this Habitat Management Plan (Plan) is to identify measures for protecting, enhancing and creating habitat within Project lands and waters and to outline how this will be accomplished over the term of the new license. The goal of this Plan is to maintain the ability to construct private access to the Project waters and allow for shoreline stabilization while protecting and enhancing the habitat along the shoreline.

The Habitat Management Plan is being submitted to the Federal Energy Regulatory Commission (FERC) as part of the license application and reflects the measures that Appalachian will be responsible for as the licensee. There will be times when it makes sense to develop a cooperative agreement between Appalachian and other parties to manage a resource in a mutually beneficial way. These types of agreements will be outside of relicensing and may reflect additional measures that are above those required by this management plan.

1.0 INTRODUCTION

This Habitat Management Plan has been prepared to identify measures to protect, enhance and create littoral habitat within Project lands and waters and to outline how this will be accomplished over the term of the new license. The goal of this plan is to maintain the ability to allow for the construction of private access to the Project waters and allow for shoreline stabilization while protecting and enhancing the habitat along the shoreline within the project boundary. This Plan, which has been prepared in consultation with agencies and stakeholders, will be filed as part of the license application.

1.1. CLAYTOR PROJECT LANDS AND WATERS

The Claytor Project is located on the New River in Pulaski County, Virginia. The Claytor Project has four generating units, with a combined generating capacity of 75 MW. The reservoir behind Claytor dam has a surface area of 4,360 acres at an operating pool elevation of 1846 feet National Geodetic Vertical Datum 1929 (NGVD) and 100 miles of shoreline.

The Project boundary for the Claytor Project is generally the 1850' contour NGVD. During normal operations of the Project, the reservoir can fluctuate up to 2 feet over a week.

Habitat within the project boundary comes from a variety of sources including overhanging trees, woody debris, wetlands, aquatic vegetation, and other submerged structures. As development continues around the shorelines, this habitat can be altered and/or removed. The Shoreline Management Plan (SMP) that is being developed as part of the relicensing efforts, addresses the removal of vegetation on land between the water and the project boundary and has provisions to protect wetlands and woody debris sites as defined in the plan. The SMP will also address other types of habitat that is removed from shoreline clearing for docks or the installation of riprap.

In 2007, Appalachian retained Normandeau Associates (Normandeau) to conduct a Wetland, Riparian, Littoral, Woody Debris and Bald Eagle Habitat Study as part of Appalachian's relicensing efforts for the Project. In addition, Normandeau also conducted a Native and Exotic Aquatic Vegetation Study. The Habitat study reports provide information on lake shore activities and their potential effect on fish and fish habitat that utilize the littoral zone. As part of the consultation process for relicensing, it was determined that a Habitat Management Plan should be prepared to address current and future habitat needs under the term of the new license. This includes the mitigation for habitat that is altered and/or removed by shoreline construction and implementation of projects to enhance habitat in areas that have limited existing habitat.

1.2. PURPOSE OF HABITAT MANAGEMENT PLAN

The purpose of this Habitat Management Plan is to identify measures for protecting, enhancing and creating habitat within Project lands and waters and to outline how this will be accomplished over the term of the new license. The goal of this plan is to maintain the ability to allow for the construction of private access to the Project waters and allow for shoreline stabilization while protecting and enhancing the habitat along the shoreline.

2.0 HABITAT ENHANCEMENT AND PROTECTION

The purpose of this section of the Plan is to outline how habitat will be protected and enhanced over the term of the next license. Enhancement projects must comply with all applicable local, state and federal regulations. The applicant must obtain all necessary governmental permits or approvals, a FERC order (if applicable) and written authorization from Appalachian prior to beginning any activity/construction within the Project boundary.

2.1 PROTECTION UNDER THE SHORELINE MANAGEMENT PLAN OR OTHER MANAGEMENT PLAN

The Claytor Shoreline Management Plan (SMP) contains provisions for protecting habitat such as wetlands, woody cover, bald eagle habitat, streams and areas identified by the Virginia Natural Heritage Program as important natural communities. Native aquatic vegetation and potential Fringed Mountain Snail habitat are addressed under separate management plans as described below.

2.1.1 Wetland Habitat as defined in the SMP

The shoreline adjacent to wetland habitat is classified as Conservation / Environmental and includes the following types of wetland habitat:

Conservation / Environmental Zone:

- Palustrine forested wetlands
- Palustrine shrub-scrub wetlands
- Palustrine emergent wetlands

Development within the Conservation / Environmental Zones is prohibited unless a variance from the FERC is obtained as described in the SMP.

2.1.2 Woody Cover

The shoreline adjacent to woody cover habitat is classified as follows:

Impact Minimization Zone:

- Downed trees (natural or cut)

- Brush piles
- Woody debris

Development within an IMZ is limited, but possible, based on a review of the related plans, including mitigation for any impacts to resources. This development requires review and approval by the resource agencies.

2.1.3 Natural Heritage Areas

The shoreline adjacent to areas identified by the Virginia Natural Heritage Program are classified as follows:

Conservation / Environmental Zone:

- Areas identified by the Virginia Natural Heritage Program as important natural communities.

Development within the Conservation / Environmental Zones is prohibited unless a variance is obtained from the FERC as described in the SMP.

2.1.4 Shoreline Vegetation

Vegetation within the Project boundary must be preserved if present. Ground disturbing activities in this area must be minimal in order to maintain the function of the buffer and comply with the conditions of the Shoreline Management Plan.

In the event that vegetation is removed from within the Project boundary without a permit, the responsible individual may be required to replace vegetative materials within the Project boundary.

2.1.5 Aquatic Vegetation

The management of existing aquatic vegetation is addressed in Appalachian's Aquatic Vegetation Management Plan. The introduction of native, aquatic vegetation where this type of habitat is lacking is covered in Section 2.3 of this Habitat Management Plan.

2.1.6 Bald Eagle Habitat

As part of Appalachian's relicensing efforts, Bald Eagle habitat and nest surveys were conducted within 3,300 feet of the Claytor Lake shoreline (1846' contour) by Dr. Bryan Watts of the Center for Conservation Biology at the College of William and Mary, Williamsburg, VA in 2007. All lands were

then evaluated with respect to suitability for Bald Eagle nesting and foraging habitat.

There are a significant number of forested areas surrounding Claytor Lake that have the potential to support both eagle nesting and foraging. However, based on size of the impoundment and the degree of development that has taken place, the lake could realistically support no more than two breeding pairs (Watts, 2007).

During the survey, 44 areas comprising a total of 1610.4 hectares (ha) (3,979 acres) were delineated. The potential of these areas to provide nesting and foraging were rated as limited, moderate, good or very good. Of the areas surveyed, 33 areas (1,326.3 ha total)(3,276 acres) are located along shoreline that is within the Project boundary in which Appalachian has authority. Of the 33 sites adjoining the project boundary, there are 10 sites (Sites 1, 6, 8, 9, 10, 17, 18, 34, 43, 44) comprising of a total of 548.3 ha (1,354 acres) with both good nesting and good foraging potential. There is one site (Site 40 – 110.8 ha)(274 acres) with both very good nesting and very good foraging potential.

The remaining 11 sites (Sites 22 – 33) comprised of 284.1 ha (701 acres) are located upstream and outside of the Claytor Project boundary on the New River. Appalachian does not have authority to control activities taking place along the river at these sites.

A. Existing Nests:

During the 2007 survey, only one active Bald Eagle nest was discovered. It is located near Claytor Dam. This nest is located on property owned by Appalachian and is within the project boundary. It is located within 150 feet of the shoreline. Currently this property is leased to an individual that occupies a dwelling that is located within 750 feet from the nest. There is also an existing, unimproved construction roadway and a 138 kV powerline located within 750 feet of the nest. The above mentioned roadway is gated and the gate is locked at all times.

In order to protect existing nesting sites, Appalachian will implement the following restrictions for new and existing nests located on Appalachian-owned property and property within the project boundary:

a. A primary management zone will be established around existing occupied nests. This zone will be an area between 330 feet and 660 feet in radius around the occupied nest based on consultation with the VDGIF regarding potential activities in

the area. This zone will be posted and any current leases, if applicable, will be modified to prohibit the following activities:

i. Land clearing, clear cutting, mining, and other habitat modification activities (except dam, right-of-way, substation, and road maintenance during the non-nesting season);
ii. Development of new residential, recreational, agricultural, commercial, or industrial structures, power lines, roads, trails, or any other construction activities (except maintenance or upgrading of the existing 138 kV line during the non-nesting season);
iii. Use of chemicals toxic to wildlife.

b. The following activities will not occur within the primary management zone during the breeding/nesting season (December 15 – July 15), unless the nest is determined to be unoccupied in a particular year based on consultation with VDGIF or the proposed activity does not create a concern based on consultation with VDGIF.

i. Maintenance to existing buildings, substation, lines, and roads except in emergencies;
ii. Use of motorized vehicles and heavy equipment except in emergencies;

c. Abandoned Nest Determination: Appalachian will request a determination of nest abandonment from VDGIF and USFWS if the nest is unoccupied (and any portion of the nest is present) after five consecutive nesting seasons. Until a formal determination is made, the requirements of this section will remain in effect.

d. Nest/Nest Tree Removal: The eagle nest and the tree/structure in which it is located shall not be removed as long as any portion of the nest remains in the tree/structure without a permit from the USFWS and VDGIF.

e. Routine Operations and Maintenance of the Existing Project Spillways, Generating Facilities and Transmission/Distribution Facilities: The above listed requirements do not require modifications to project operations or maintenance activities related to the existing Project spillways, generating facilities, substations, or transmission/distribution lines. All efforts will be taken to protect the nesting sites should any routine operation and maintenance activities be required to these existing facilities.

B. Potential Habitat:

There were 11 sites (total 659.1 ha) adjacent to the project boundary that were identified as good or very good nesting and good or very good foraging potential for the Bald Eagle during the 2007 survey. These areas include both Appalachian-owned properties and private properties.

Appalachian has a responsibility under its license to enhance and protect the scenic, recreation, and environmental values of the Project. While Appalachian does not have control over activities that take place outside the project boundary, it does control the disturbance of habitat and the construction activities taking place within the project boundary.

a. Shoreline Classification:

The shoreline along the 11 sites that were identified as good or very good nesting and good or very good foraging potential for the Bald Eagle during the 2007 survey will be classified as Impact Minimization Zones under Claytor's Shoreline Management Plan. Under the IMZ classification, a permit for disturbance or construction within the project boundary can not be issued without prior consultation with the resource agencies. For shoreline identified as IMZ due to its potential Bald Eagle habitat, the resource agencies to be consulted will include the USFWS, VDGIF, and Virginia Department of Conservation and Recreation (VDCR).

b. Consultation Process for IMZ areas due to Potential Bald Eagle Habitat:

In order to obtain a permit for the construction of docking facilities / piers, shoreline stabilization, dredging, vegetation removal or other land disturbing activities within the project boundary along shoreline classified as IMZ for potential Bald Eagle habitat, a survey will be required to be completed to identify Bald Eagle activity within a zone of 330 feet around the proposed activity. This survey will be the responsibility of the person seeking the permit for the activity and must be completed by a person or agency with experience identifying the presence of Bald Eagles.

This survey will be forwarded to the USFWS, VDGIF, VDCR and AEP Environmental Services for review, comments and/or recommendations for mitigation. If there are no objections to the proposed activity and the applicant is agreeable to the recommended mitigation proposed by the agencies, Appalachian will issue a permit for the proposed activity. The permit will include any required mitigation.

C. New Bald Eagle Nests:

If Appalachian becomes aware of a new active bald eagle nest within the 330 foot zone from the project boundary on property not owned by Appalachian (outside the project boundary), then Appalachian will seek an amendment to the Shoreline Management Plan to reclassify the shoreline as IMZ and the requirements in Section B of this plan will be implemented.

If Appalachian becomes aware of a new active bald eagle nest on property owned by Appalachian, then the requirements in Section A. of this plan will be implemented.

Appalachian will notify the USFWS, VDGIF and VDCR of any new bald eagle nests that it becomes aware of in the vicinity of the Claytor Project.

Watts, B.D. 2007. An assessment of the bald eagle population along Claytor Lake, Virginia. Center for Conservation Biology Technical Report Series, CCBTR-07-12. College of William and Mary, Williamsburg, VA. 13p.

USFWS. May 2007. National Bald Eagle Management Guidelines.

2.1.7 Fringed Mountain Snail Habitat

The management of possible suitable Fringed Mountain Snail habitat is addressed in Appalachian's Fringed Mountain Snail Management Plan.

2.1.8 Streams

The shoreline adjacent to streams entering the Project has been classified as Conservation / Environmental. Development within the Conservation / Environmental Zones is prohibited unless a variance is obtained from the FERC as described in the SMP. Virginia Department of Environmental Quality and/or U.S. Army Corps of Engineers regulate activities in streams as well.

2.2 MITIGATION FOR THE LOSS OF HABITAT DUE TO SHORELINE DISTURBANCE

Disturbance along the shoreline for the construction of a boat dock or the installation of shoreline stabilization can result in the removal of important habitat along the shoreline and the littoral zone. Trees and woody debris along the shoreline, especially trees that overhang or protrude into the water, provide important habitat that is utilized by a variety of aquatic, semi-aquatic, and terrestrial organisms.

2.2.1 Dock Construction

The SMP requires mitigation for lost habitat due to the construction of a dock. At the time of dock construction, it will be required that bundles of woody debris and/or cedar trees or other approved material be anchored and contained within the area under the stationary portion of the dock. Guidelines for bundling and anchoring woody debris and/or cedar trees are located in Appendix A of this Plan. If it is deemed that the site is not suitable for habitat replacement (e.g. the water is too shallow or too deep, it creates navigational issues, etc.), then off-site mitigation may be considered. Appalachian will consult with VDGIF if off-site mitigation is recommended.

2.2.2 Shoreline Stabilization

The SMP requires mitigation for lost habitat due to the clearing of shoreline and installation of riprap to replace the function of the woody debris. At the time of shoreline disturbance, it will be required that bundles of woody debris and/or cedar trees or other approved material be anchored at sufficient depths adjacent to the disturbed shoreline. Guidelines for bundling and anchoring woody debris and/or cedar trees are located in Appendix A of this Plan. If it is deemed that the site is not suitable for habitat replacement (e.g.

the water is too shallow or too deep, it creates navigational issues, etc.), then off-site mitigation may be considered. Recommended mitigation will depend on existing habitat at the site prior to disturbance. Appalachian will consult with VDGIF if off-site mitigation is recommended.

Mitigation will be determined on a case by case basis after coordinating with the appropriate resource agencies. Virginia Department of Environmental Quality and/or U.S. Army Corps of Engineers determines appropriate mitigation actions for impacts to surface waters under their jurisdiction.

2.2.3 Vegetation Removal

The SMP requires mitigation for lost habitat due to the removal of vegetation along the shoreline that is extending over into the water. This will include any dead vegetation that is overhanging into the water. At the time of vegetation removal, any vegetation extending out into the water will need to be replaced with alternative habitat. Guidelines for alternative habitats are located in Appendix A of this Plan. If it is deemed that the site is not suitable for habitat replacement (e.g. the water is too shallow or too deep, it creates navigational issues, etc.), then off-site mitigation may be considered. Appalachian will consult with VDGIF if off-site mitigation is recommended.

Mitigation will be determined on a case by case basis after coordinating with the appropriate resource agencies. Virginia Department of Environmental Quality and/or U.S. Army Corps of Engineers determines appropriate mitigation actions for impacts to surface waters under their jurisdiction.

2.2.4 Mitigation in an Impact Minimization Zone

Shoreline classified as an Impact Minimization Zone due to habitat features (i.e. woody cover, etc.) can not be developed without agency review and approval. The first preference will be to design around these habitat features so as to not disturb them. If this is not an option, the landowner will need to develop a mitigation plan in consultation with the various resource agencies to mitigate for the loss of habitat for consideration. If it is deemed that the site is not suitable for habitat replacement (e.g. the water is too shallow or too deep, it creates navigation issues, etc.), then off-site mitigation may be considered. There may be times when the habitat can not be adequately replaced and the disturbance of the shoreline within the Project boundary will not be allowed.

Mitigation will be determined on a case by case basis after coordinating with the appropriate resource agencies. Virginia Department of Environmental Quality and/or U.S. Army Corps of Engineers determines appropriate mitigation actions for impacts to surface waters under their jurisdiction.

2.2.5 Failure to Comply

Failure to comply with the requirements for mitigation may result in either 1) revocation of the dock or shoreline stabilization permit, 2) installation of habitat by Appalachian and/or other authority at the property owner's cost or (3) owner contributing to a fund that will be used for off-site mitigation. These items are listed by preference.

2.3 ENHANCEMENT IN AREAS OF LIMITED HABITAT

Habitat at the Project is of key importance to the fish, birds, reptiles and other animals that live at the lake. This section of the plan provides a process for enhancing and/or creating additional habitat in areas where there is limited or poor habitat. This overall plan will be adaptive in nature and modified as necessary based on the previous year's experiences and will incorporate new techniques as they are identified.

Encroachments onto surface waters for enhancement activities may require permits from local, state or federal resource agencies.

An Aquatic Vegetation / Debris / Habitat / Shoreline Management Plan Technical Review Committee (Technical Review Committee) will be established with representation from Appalachian, Virginia Department of Game and Inland Fisheries, Virginia Department of Conservation and Recreation, Virginia Department of Environmental Quality, Friends of Claytor Lake and one at-large member with experience in habitat enhancement. The purpose of the Technical Review Committee will be to plan habitat enhancement projects at the Project and to review enhancement / mitigation projects submitted by individuals or community groups.

A list of areas and the type of habitat to be added is included in Appendix B of this plan. These areas may include land adjacent to public access sites, islands, and areas adjacent to undeveloped shoreline (including Appalachian- owned properties) on Claytor Lake. Sites identified to date include shoreline at the Claytor Lake State Park, VDGIF's public boat ramp access sites, Pulaski County's Harry DeHaven Park, Appalachian-owned islands, Appalachian's picnic area, and other Appalachian-owned properties including the two sites set aside for future public use. A map of potential enhancement sites is located in Appendix C. Areas adjacent to private shoreline will also be considered for enhancement projects upon developing appropriate agreements with the adjacent land owners. Each site will be assessed for the type of habitat that should be created. Habitat to be considered will include both

natural and man-made fish attraction structures, vegetative plantings, and native (non-aggressive) aquatic vegetation. Appendix A contains guidelines for constructing the various types of habitats. These guidelines will be revised as necessary based on experience that is gained each year. The sites have been prioritized and a schedule developed for implementing the measures. These sites will be revised as necessary based on experience that is gained each year and upon consultation with the Technical Committee. This schedule is located in Appendix B. These areas will also be considered as areas where the off-site mitigation that is required under Section 2.2 can be located if approved by the Technical Review Committee.

A demonstration project that has the dual benefits of habitat and erosion control will be developed for a site on Claytor Lake. Appalachian, in consultation with the Technical Review Committee and the Erosion/Sedimentation Technical Committee, will develop detailed plans for the demonstration project. The plans will be provided to the Technical Review Committee for review and comment. Following the consultation, the detailed plans will be filed with the Commission for review and approval along with final estimated costs and final schedule. The estimated cost to Appalachian for the demonstration project will be $25,000.

Information will be provided to the lake community containing ideas on how to enhance habitat adjacent to their properties. Partnering with interested communities, clubs and associations to construct enhancement projects will be encouraged. Information on how to locate the enhancement sites will also be provided to the community in the form of brochures and a website.

A fund will be set up to support habitat enhancement projects for Claytor Lake. Appalachian will contribute $5,000 per year (adjusted by appropriate Consumer Price Index) to this fund and the funds may be accumulated over several years for larger projects. This money will be used for habitat enhancement projects on the lake as determined in consultation with the Technical Review Committee. Additional funds may come from the state, counties, grants, mitigation payments, or partnering groups.

3.0 MONITORING AND CONSULTATION MEASURES

The purpose of this section of the Plan is to outline how the plan will be monitored and the process for consultation with the state agencies and other interested stakeholders.

3.1 Monitoring

Mitigation measures under Section 2.2 will be verified by Appalachian when the completed dock, riprap or vegetation removal project is inspected. Follow-up inspections of random projects may also be performed to ensure the measures stay in place. For projects required under Section 2.2.4, GIS data will be collected and the mitigation measures will be inspected periodically to ensure the measures remain in place.

GIS data for all enhancement projects under Section 2.3 will be collected and the areas included on a map. This information will be made available publicly to the fishing community. These sites will be inspected annually to qualitatively assess their success and ensure they are functioning as designed. The criteria to assess the structures will include ensuring that they are in place, are in relatively the same condition as when installed and they remain secure. Following the fifth year of plan implementation, Appalachian will consult with VDGIF in order to assess habitat enhancement areas for comparison with areas without the enhancements. This is currently being done at another Project by electro-shocking both types of areas (shoreline with enhancements in place vs. shoreline without enhancements) for comparison. It may also be done by underwater viewing equipment or other fish-sensing equipment. The results of this exercise will be provided in the five-year report to FERC to determine success of the enhancements.

3.2 Consultation

An overall plan for enhancement projects will be developed in consultation with the Technical Review Committee. Encroachments onto surface waters for enhancement activities may require permits from local, state or federal resource agencies. The table in Appendix B will be developed as part of this consultation process. The plan outlines locations, types of habitat, and parties to be consulted in the enhancement projects as some sites are located adjacent to their facilities. This plan will be periodically revised as experience is gained. The Technical Review Committee will meet at least once per year to review the overall plan and recommend changes as needed. IMZ mitigation plans will be circulated to members of the Technical Review Committee for review and comment. (Note: The agencies that are already required under the Shoreline Management Plan's requirements will still be involved in the IMZ review process.) Additional meetings will be held on an as-needed basis.

3.3 Reporting

The enhancement plan that is developed as part of the Habitat Management Plan will be reviewed annually by the Technical Review Committee and revised as needed by Appalachian. Appalachian will prepare an annual report outlining the enhancement work that has been completed. It will include a) monitoring information associated with Section 3.1 above; b) a summary of the enhancement projects that have been completed including details on the habitat types; c) education measures that have been implemented; and d) any recommendations for changes to the Habitat Plan. A five year report will be compiled for submission to the Federal Energy Regulatory Commission. Included in this report will be support documents indicating consultation with the Technical Review Committee, a summary of the annual report findings as described above, an assessment of the success of the enhancements and any changes in the Habitat Plan that will require Commission approval.

4.0 Education

The Technical Review Committee will identify measures to be implemented to share information with the lake community related to the importance of habitat, measures that individuals can undertake to improve habitat along their shoreline, and opportunities to partner on habitat enhancement projects.

5.0 Coordination with Other Management Plans

The Erosion Monitoring Plan includes the requirement to develop a demonstration project that incorporates both erosion control and habitat along shoreline of the lake. Appalachian, in consultation with the Technical Committees, will develop detailed plans for the demonstration project. The plans will be provided to the Technical Review Committees for review and comment. Following the consultation, the detailed plans will be filed with the Commission for review and approval, along with final estimated costs and final schedule.

A copy of the annual Debris report will also be provided to the Technical Review Committee for their information. This will provide information to the committee regarding potential debris accumulation areas so these areas can be assessed for habitat potential.

Appendix A – Mitigation Guidelines and Specifications

The following information is provided as guidelines for constructing Habitat Enhancement Projects under the Habitat Management Plan. Since this plan is adaptive in nature, these guidelines will be modified as necessary to take into consideration experience from previous year's projects and new techniques as they are identified. Contact Appalachian for the most current guidelines.

Note: If this type of enhancement is being proposed for purposes other than mitigation required under an Appalachian approved dock, shoreline stabilization or vegetation removal permit, then additional approval will need to be obtained from Appalachian before the enhancement is installed.

Cover:

Natural:

1) Submerged Trees
2) Felling

Artificial:

1) Plastic Structures
2) Wooden Structures

Riprap Structures:

Plantings: Native Vegetation (Water willow)

Source Documents:

Southern Division American Fisheries Society (AFS) Reservoir Committee Habitat Manual for Use of Artificial Structures in Lakes and Reservoirs (http://www.sdafs.org/reservoir/manuals/habitat/Main.htm)

Aquatic Plant Establishment Workshop Presentation: Propagation and Establishment of Native Vegetation, 2006 SDAFS Spring Meeting (http://www.sdafs.org/reservoir/manuals/aqveg/veghome.htm)

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Habitat Manual for Use of Artificial Structures in Lakes and Reservoirs

Compiled by the Southern Division AFS Reservoir Committee
Summarized by Kim Tugend, University of Florida

The Reservoir Committee of the Southern Division of the American Fisheries Society conducted a survey of state agencies to identify: (1) agency goals of habitat enhancements, (2) preferences for different habitat enhancement methods, (3) advantages and disadvantages of various habitat enhancement methods; and (4) efforts to assess fish-population responses to habitat enhancements. The survey began by identifying biologists within each state who have conducted numerous habitat-enhancement efforts for that agency. Once these contacts were identified, they were sent written questionnaires. The questionnaires asked respondents to evaluate each type of structure (e.g., brush piles, substrate modifications) that have been used by the state agency including advantages/disadvantages of each method, agency goals for habitat enhancements, and a summary of efforts to assess fish-population responses to

habitat enhancements. Aeration, fertilization, planting (e.g., aquatic vegetation and trees), and water level fluctuations were omitted from the survey.

This online Habitat Enhancement Manual summarizes the results of the survey and includes the opinions of the respondents. The purpose of this manual is to provide biologists, students, and other interested parties with information that can optimize habitat-enhancement efforts. We reviewed references, including state reports, graduate theses, and peer-reviewed journal articles, for each structure type.

We would like to thank all survey recipients and members of the Southern Division AFS Reservoir Committee for their efforts in compiling the survey data. ***The information contained herein does not reflect the opinions or views of the American Fisheries Society or the Southern Division Reservoir Committee. Contact your state agency prior to placing any of these structures for information concerning specific permits or licenses required.***

To obtain information concerning particular structures, types of structures, an overall summary of survey results, please choose one of the links below.

We welcome any suggestions, concerns or comments you may have with regards to this manual. You may direct your comments to Dr. Mike Allen at msal@gnv.ifas.ufl.edu.

Manual last updated on August 30, 2000

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Cover

As the name implies, this category is defined by structures which provide cover. Of all the structures reported (n=159 responses), 81% were intended for use as fish attractors to increase angler catch and harvest, 39% as nursery habitat for juvenile fish, 34% as adult habitat/sanctuary, and 20% as spawning habitat. For our purposes, we have divided cover into two classes: natural (e.g., brush piles, felling) and artificial (e.g., tires, wooden structures, plastic structures). For more information, please select one of the following:

Natural Cover
- Submerged Trees
- Felling

Artificial Cover
- Plastic Structures
- Tires
- Wooden Structures

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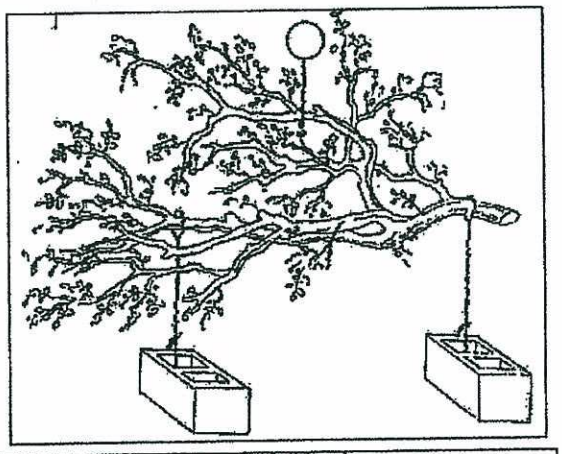
Submerged Trees

A variety of tree types are used by state agencies depending on availability. These include: ash, cedar, citrus, cottonwood, elm, fir, hickory, juniper, locust, lodgepole, manzanita, mesquite, persimmon, pine, and willow. Some common configurations are pictured below (a-suspended horizontal placement; b-suspended vertical bundle; c-horizontal bundle; d-tepee or pyramid type).

a)



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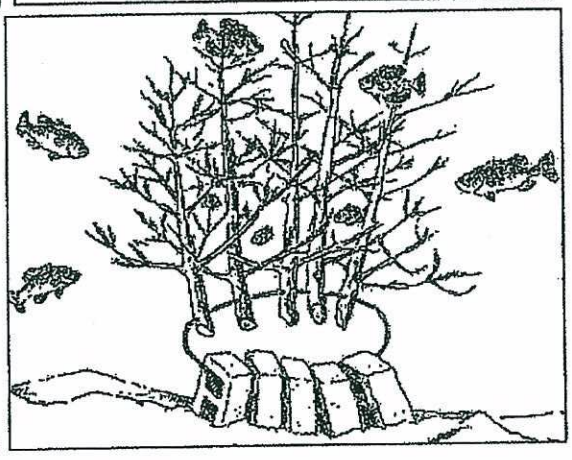

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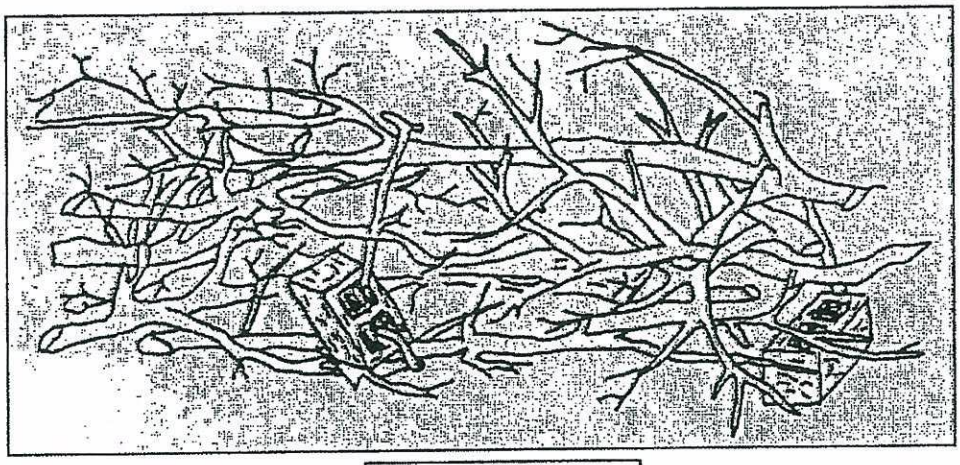

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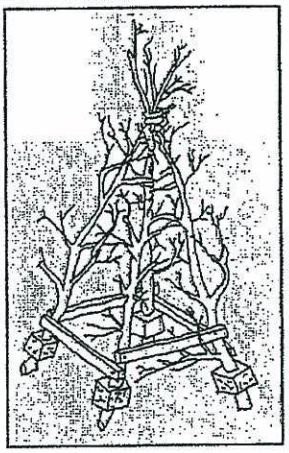

Click here for map of states that used this method.

Major reasons used:

- low or no cost
- availability of materials

Reported advantages:

Most studies indicate increased angler catch rates and/or catch per unit effort of sportfish around structures, including largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* sp.), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*) (see references below).

Some structures provide nursery habitat for young fish (e.g., Cofer 1991).

Structures can be colonized by periphyton, a food source for macroinvertebrates.

Good for public relations (e.g., Christmas tree recycling programs).

Reported disadvantages:

Materials may deteriorate with age, so fish use may decrease over time.

Structures are prone to snagging tackle.

Due to lure loss, angler use may decrease.

Recommendations:

Trees placed vertical in the water column may be more effective for longer periods of time than those lying horizontal.

One solution for limiting snags is tying multiple trees together in the vertical position forming rows of trees. This allows fisherman to cast between rows and avoid snagging.

If suspended off the bottom, problems with siltation or fluctuating water levels can be minimized.

Species of tree may be important. Trees which provide more dense cover, such as cedar, concentrate smaller
fish; whereas trees which provide less dense coverage, such as oak, concentrate larger fish (Cofer 1991).

Mean reported time to create/place one structure/unit: 15 hrs (range 0.1 - 160, n=63)

Mean reported life of structure/unit: 9 yrs (range 1 - 100, n=61)

Degrees of Satisfaction:

***average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied.**

- fish attractor to increase angler catch and harvest 1.8 (n=53)
- fish production/spawning habitat 2.0 (n=11)
- adult habitat/sanctuary 2.1 (n=21)
- recruitment 2.6 (n=30)

Related references:

Boxrucker, J. Oklahoma. 1983. Evaluation of brush pile installation as a method to increase catch rates of largemouth bass and other sport fishes. Final Report F-39-R-9, Oklahoma Department of Wildlife Conservation, Oklahoma City.

Cofer, L. 1991. Oak versus cedar trees as fish attractors: comparisons by angling and electrofishing. U.S. Forest Service General Technical Report 207:67-72.

Glenn, T. R. 1983. Effects of fish attractors on sport fishing success on Norris Reservoir, Tennessee. Masters Thesis, University of Tennessee, Knoxville.

Johnson, D. L., and W. E. Lynch, Jr. 1992. Panfish use of and angler success at evergreen tree, brush, and stake-bed structures. North American Journal of Fisheries Management 12:222-229.

Lawson, C. S. 1981. Fish utilization of midwater and bottom fish attractors in a fertilized community fishing lake. Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 35:372-375.

Lemons, B. 1992. Lake Powell artificial habitat project. Final Report, Arizona Game and Fish Department, Page.

McGuckin, A. W. 1995. A comparison of natural and synthetic forms of man-made habitat in two Oklahoma reservoirs. Master's Thesis, University of Oklahoma, Norman.

McKinney, S. P., and five co-authors. 1992. Longevity of fish attractor materials. 1991 - 1992 Fish Management Annual Progress Report, Florida Game and Fresh Water Fish Commission, Tallahassee.

McKinney, S. P., and four co-authors. 1993. Longevity of fish attractor materials. 1988-1993 Completion Report, Florida Game and Fresh Water Fish Commission, Tallahassee.

Myatt, D. O. III. 1996. Midwater fish attractors. Pages 303-315 *in* F. M. D'Itri, editor. Artificial Reefs: Marine and Freshwater Applications.

Pierce, B. E., and G. R. Hooper. 1980. Barkley Lake symposium: fish standing crop comparisons of tire and brush fish attractors in Barkley Lake, Kentucky. Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 33:688-691.

Richards, T. 1997. Placement and monitoring of synthetic and evergreen tree fish attracting devices. Massachusetts Division of Fisheries and Wildlife, Westborough.

Rold, R. E., T. S. McComish, and D. E. Van Meter. 1996. A comparison of cedar trees and fabricated polypropylene modules as fish attractors in a strip mine impoundment. North American Journal of Fisheries Management 16:223-227.

Timmons, T. J., and W. E. Garrett. 1985. Effectiveness of residual stumps as fish attractors at Aliceville Lake, Alabama-Mississippi. North American Journal of Fisheries Management 5:309-310.

Timmons, T. J., and W. L. Shelton. 1982. Marking fish attractors in lakes with fluctuating water levels. North American Journal of Fisheries Management 2:97.

Wilbur, R. L. 1974. Florida's fresh water fish attractors. Florida Game and Fresh Water Fish Commission, Fisheries Bulletin No. 6, Tallahassee.

Wilbur, R. L. 1978. Two types of fish attractors compared in Lake Tohopekaliga, Florida. Transactions of the American Fisheries Society 107:689-695.

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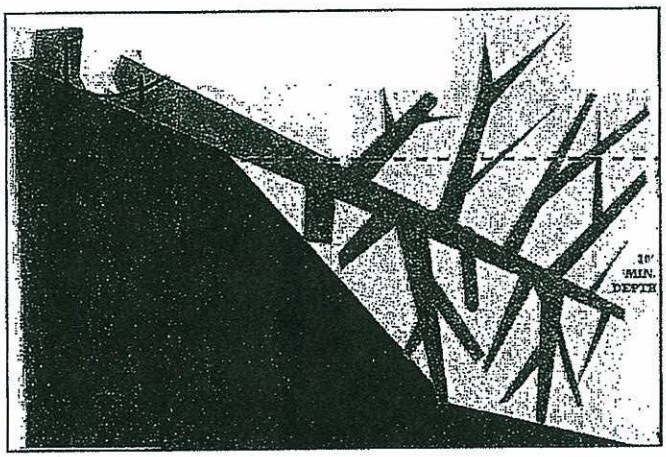
Tree Felling

Species used depend on those which were locally available. Survey responses included alder, cottonwood, hardwood, oak, sycamore, and willow. A typical configuration is pictured below. The shoreline tree is felled into the lake or reservoir and anchored to the remaining stump via cable.



Click here for map of states that used this method.

Main reasons used:
- availability of materials (i.e., shoreline trees)
- low cost

Reported advantages:

Trees do not have to be moved to the lake/reservoir (i.e., saves money and time).

Reported disadvantages:

Felling may lose its effectiveness at low water levels.

Recommendations: none reported

Mean reported time to create/place one structure/unit: 0.7 hrs (range 0.2 - 2, n=14)

Mean reported life of structure/unit: 15 yrs (range 2 - 10, n=15)

Degree of Satisfaction:

****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied**

- fish attractor to increase angler catch and harvest 1.7 (n=12)
- adult habitat/sanctuary 2.2 (n=6)
- fish production/spawning habitat 2.6 (n=5)
- recruitment 3.0 (n=6)

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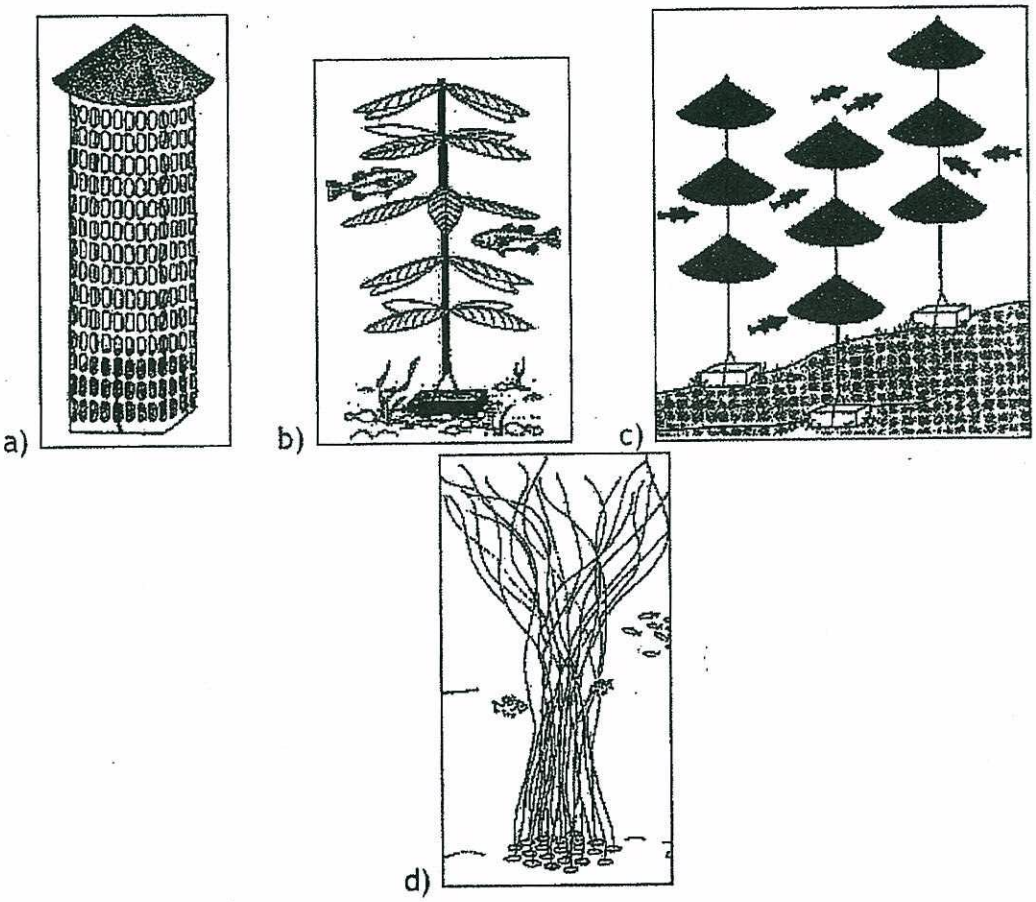
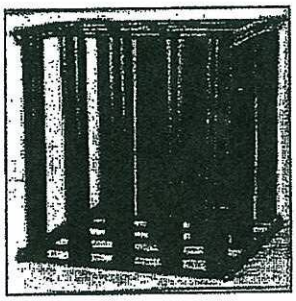
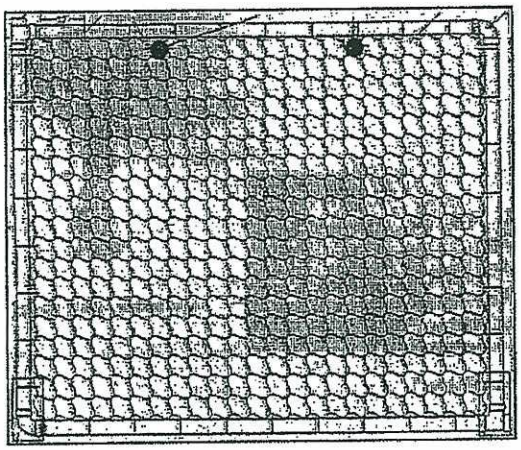
Plastic Structures



e) 

f) 

Pictured above are (a) a fish condo, (b) a Fish 'N Tree (c) Mushroom Hat Structures, (d, e) Berkley FISH HABs (string and pallet varieties, respectively), and (f) a GeoWeb panel. Other structures included in this category are PVC pipe stake beds, plastic streamers and ribbons, plastic buckets, and pipes. Below, we have listed the survey responses for these different types of plastic structures.

Fish 'N Trees

Fish 'N Trees are manufactured by Plastics Research and Development Corporation (PRADCO),POB 1587
Fort Smith, AR, 800-422-FISH.

Click here for map of states that used this method.

Main reasons used:

- perceived effectiveness
- experimentation
- longevity of materials
- water quality concerns.

Reported advantages:

Structures are durable and long-lived.

Because the leaves are buoyant and rotate freely, lures tend not to snag.

Reported disadvantages:

These structures may be expensive and prone to vandalism during exposure in reservoirs with fluctuating water levels.

Leaves may sag when covered with periphyton or silt.

Recommendations: none reported

Mean reported time to create/place one structure/unit: 19 hrs (range 2 - 48, n=3)

Mean reported life of structure/unit: 6 yrs (range 4 - 8, n=2)

Related state reports:

McKinney, S. P., and five co-authors. 1992. Longevity of fish attractor materials. 1991 - 1992 Fish Management Annual Progress Report. State of Florida Game and Fresh Water Fish Commission, Tallahassee.

McKinney, S. P., and four co-authors. 1993. Longevity of fish attractor materials. 1988-1993 Completion Report. State of Florida Game and Fresh Water Fish Commission, Tallahassee.

Plastic Mesh-Type Structures

Some structures included in this category have perforations for the sole purpose of providing cover for small fish by excluding others on the basis of size. These include, among others, cubed structures such as plastic chicken crates, which may be stacked on top of each other and structures composed of plastic netting or snow/safety fencing. Cylinders composed of netting may or may not be topped with "Chinese hats" (e.g., fish condo,Fig. a). Snow fencing may also be stretched around and between trees. Other structures are used to provide cover for adult fish and include such structures as GeoWeb panels (Fig. f) which may be hung vertically or in pairs to form a puptent.

Click here for map of states that used this method.

Main reasons used:

- longevity
- low cost
- few tackle hang ups
- availability of materials

Reported advantages:

Most reports indicate use of these structures by juvenile sportfish, including largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*).

Structures are good for use in water supply reservoirs where organic materials are not allowed.

Structures are durable and long-lived.

Reported disadvantages:

Structures may entangle the lower units and propellers of outboard motors at low water levels or when placed in
shallow areas.

Structures may experience silting problems and so limit fish access in some reservoirs.

Growth of periphyton, an important food source for macroinvertebrates, on structures is limited in low fertility waters.

Recommendations:

Structures are not recommended for low fertility or silt-laden systems. As mentioned above, silting may coat the structures limiting fish access, and periphyton growth on structures is limited in low fertility waters (Lemons 1992).

Mean reported time to create/place one structure/unit: 12.9 hrs (range 1 - 90, n=10)

Mean reported life of structure/unit: 26.7 yrs (range 8 - 100, n=9)

Degree of Satisfaction:

****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied.**

- recruitment 2.3 (n=3)
- fish attractor to increase angler catch and harvest 2.3 (n=7)
- adult habitat/sanctuary 2.5 (n=2)

Related state reports:

Lemons, B. 1992. Lake Powell artificial habitat project. Final Report. Arizona Game and Fish Department, Page.

McKinney, S. P., and five co-authors. 1992. Longevity of fish attractor materials. 1991 - 1992 Fish Management Annual Progress Report. State of Florida Game and Fresh Water Fish Commission, Tallahassee.

McKinney, S. P., and four co-authors. 1993. Longevity of fish attractor materials. 1988-1993 Completion Report. Florida Game and Fresh Water Fish Commission, Tallahassee.

Owen, G., A. L. Egbert, and J. V. Shireman. 1995. Fish attractors. 1994-1995 Completion Report. Florida Game and Fresh Water Fish Commission, Tallahassee.

Berkley FISH HAB

FISH HABs come in two varieties, string and pallet types, and are manufactured by Berkley, One Berkley Drive, Spirit Lake, IA 51360, 800-237-5539. All states which reported this type of structure utilized the pallet variety, and one state utilized both.

Click here for map of states that used this method.

Main reasons used:

- ease of construction and installation
- snag resistant
- cooperative efforts with local fishing clubs

Reported advantages:

Reported use of structures by juvenile sportfish and to a lesser degree harvestable size fish.

Structures are durable and long-lived.

Reported disadvantages:

none reported

Recommendations:

none reported

Mean reported time to create/place one structure/unit: 8 hrs (range 1 - 32, n=6)

Mean reported life of structure/unit: 58 yrs (range 10 - 100, n=6)

Degree of Satisfaction:

**average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied.

- fish attractor to increase angler catch and harvest 2.6 (n=5)
- recruitment 3.5 (n=2)

Related state reports:

Herrig, D. J., and L. R. Miller. 1985. Comparison of Berkley Fish Hab and stakebeds in two small Western Iowa impoundments. Iowa Department of Natural Resources.

Other Structures

State agencies use just about any material that is of low/no cost and is readily available. These may include (among others) buckets, barrels, spools, streamers, and ribbons. Plastic buckets and barrels have been tied together and suspended in the water column. Spools have also been used and have been filled with a variety of materials such as gravel and discarded Christmas trees. A pincushion structure was used by one state agency and is similar to a stake tree but is made out of PVC pipes with pieces of ribbon attached. Ribbons have also been used to form structures similar in form to the string variety FISH HAB, but may be prone to sinking in silt-laden systems. Finally, 'mushroom hat' structures (Fig. c) and tree collars have been used to provide cover for predatory fish.

Other references:

Richards, T. 1997. Placement and monitoring of synthetic and evergreen tree fish attracting devices. Massachusetts Division of Fisheries and Wildlife, Wesborough.

Wege, G. J. 1981. Fish and fishing in ponds with and without artificial structure. Master's Thesis. University of Missouri, Columbia.

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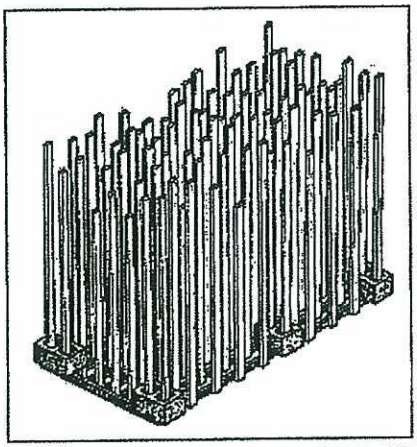
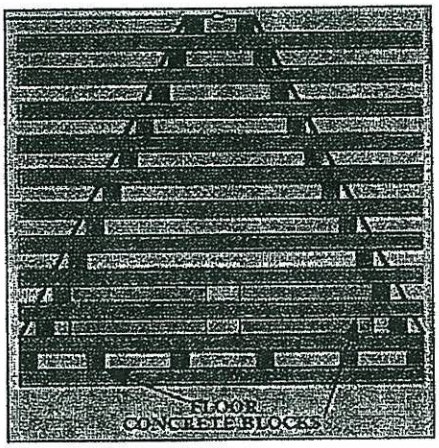
Wooden Structures



a)



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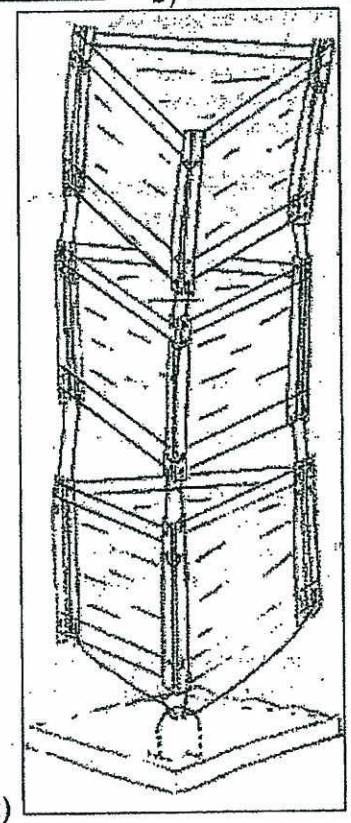

c)

Pictured above are the three main structure types included in this category: a) stake beds, b) log cribs, and c) wooden pallets.

Stake Beds
This structure is most often constructed using wooden stakes (as shown above or in the form of stake trees). One state agency reported the use of river cane in the place of wooden stakes.

Click here for map of states that used this method.

Main reasons used:
- low cost
- ease of construction and installation
- effectiveness

Reported advantages:

All reports indicate increased catch rates of sportfish, including largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and crappie (*Pomoxis* sp.).

Reported disadvantages:

none reported

Recommendations:

Structures are sometimes used in conjunction with submerged trees.

Mean reported time to create/place one structure/unit: 5 hrs (range 0.25 - 16, n=6)

Mean reported life of structure/unit: 8 yrs (range 2 - 13, n=6)

Degrees of Satisfaction:
****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied.**
- fish attractor to increase angler catch and harvest 1.5 (n=4)

Related references:

Herrig, D. J., and L. R. Miller. 1985. Comparison of Berkley Fish Hab and stakebeds in two small Western Iowa impoundments. Iowa Department of Natural Resources.

Johnson, D. L., and W. E. Lynch, Jr. 1992. Panfish use of and angler success at evergreen tree, brush, and stake-bed structures. North American Journal of Fisheries

Management 12:222-229.

Petit, G. D., III. 1972. Stake beds as crappie concentrators. Proc. 26th Annual Southeast. Assoc. of Game and Fish Comm. 26:401-406.

Log Cribs
Log cribs consist of square log structures and may contain several layers of brush (e.g., Wisconsin log crib).

Click here for map of states that used this method.

Main reasons used:
- availability of materials
- low cost
- preference for natural materials
- longevity
- ease of construction and installation
- interest of anglers

Reported advantages:

none reported

Reported disadvantages:

none reported

Recommendations:

none reported

Mean reported time to create/place one structure/unit: 17 hrs (range 0.25 - 60, n=4)

Mean reported life of structure/unit: 25 yrs (range 15 - 50, n=4)

Degrees of Satisfaction:
****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied.**
- fish attractor to increase angler catch and harvest 1.0 (n=2)
- recruitment 1.0 (n=2)
- adult habitat/sanctuary 1.5 (n=2)

Wooden Pallets
These structures consist of wooden pallets that may be arranged in a variety of different forms. Pallets may be arranged in a triangle or square and used as individual units or stacked to form pallet towers. Individual pallets can also be placed vertically

in the water column or stacked on top of each other horizontally.

Click here for map of states that used this method.

Main reasons used:

- low cost
- availability of materials

Reported advantages:

none reported

Reported disadvantages:

Depending on the configuration, some structures may be heavy and difficult to move.

Recommendations:

Structures are sometimes combined with submerged trees.

Mean reported time to create/place one structure/unit: 6 hrs (range 0.9 - 16, n=7)

Mean reported life of structure/unit: 10 yrs (range 5 - 15, n=7)

Degrees of Satisfaction:

****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied.**

- fish attractor to increase angler catch and harvest 2.1 (n=7)
- recruitment 2.5 (n=2)

Other Structures

One agency used a floating wood platform to attract sportfish. This structure was used due to its low cost, ability to withstand water level fluctuations, and the availability of materials.

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Substrate

There are a variety of substrate types used including: concrete, earth mounds, rock, and shells. Of all the structures reported (n=19 responses), 89% were intended for use as adult fish attractors, 58% as spawning habitat, 47% as nursery habitat, and 37% as adult sanctuary. For more information on a specific type of substrate structure, please click one of the links below.

- concrete/rip rap structures
- earth mounds
- rock
- shells

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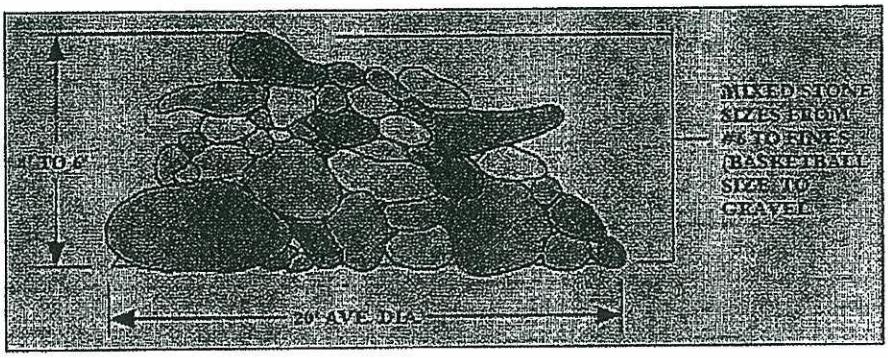
Rock



Click here for map of states that used this method.

Main reasons used:
- effectiveness
- availability of materials
- durability

Reported advantages:

none reported

Reported disadvantages:

none reported

Recommendations:

none reported

Mean reported time to create/place one structure/unit: 25 hrs (range 0.5 - 120, n=7)

Mean reported life of structure/unit: 68 yrs (range 10 - 100, n=6)

Degree of Satisfaction:

****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied**

- fish attractor to increase angler catch and harvest 1.8 (n=4)
- adult habitat/sanctuary 2.0 (n=2)
- recruitment 2.5 (n=4)
- fish production/spawning habitat 4.3 (n=3)

Earth Mounds

Earth mounds are mounds of soil that are placed beneath the water surface. They may also contain concrete chunks or rocks and are sometimes covered with rock, gravel, and/or brush.

Click here for map of states that used this method.

Main reasons used:

- low cost
- permanence of structure
- availability of materials (e.g., waste material from construction sites)

Reported advantages:

One report indicated increased catch-per-unit-effort for earthen reefs as compared to tires, stakes and brush for both crappie (*Pomoxis* sp.) and bluegill (*Lepomis macrochirus*).

Reported disadvantages:

none reported

Recommendations:

Sometimes structures are placed in combination with brush piles (i.e., submerged trees).

Mean reported time to create/place one structure/unit: 12 hrs (range 5 - 24, n=5)

Mean reported life of structure/unit: 30 yrs (n=3)

Degree of Satisfaction:

****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied**

- recruitment 1.0 (n=2)
- fish attractor to increase angler catch and harvet 2.3 (n=6)
- fish production/spawning habitat 2.3 (n=3)
- adult habitat/sanctuary 3.0 (n=2)

Rip Rap/Concrete Structures

Click here for map of states that used this method.

Main reasons used:
- low cost
- durability

Reported advantages:

none reported

Reported disadvantages:

none reported

Recommendations:

none reported

Mean reported time to create/place one structure/unit: 23 hrs (range 4 - 100, n=6)

Mean reported life of structure/unit: 31 yrs (range 20 - 50, n=4)

Degree of Satisfaction:

****average ratings on a scale of 1 - 5 with 1 being very satisfied and 5 being very dissatisfied**
- fish attractor to increase angler catch and harvest 1.3 (n=4)
- adult habitat/sanctuary 2.5 (n=2)
- fish production/spawning habitat 3.5 (n=2)
- recruitment 4 (n=2)

Shells

Florida was the only state which reported the use of shells for substrate. Creel surveys and electrofishing sampling both revealed large increases in catch-per-unit-effort over shell beds as compared to control areas.

Related references:

Metz, M. T. 1996. The influence of habitat modifications on the fish community in the Weaver Bottoms Backwater of Mississippi River Navigational Pool 5. Master's Thesis.

The University of Wisconsin, Madison.

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Native Vegetation - Plantings

3 Implementation

Site Selection

Founder colony sites should be selected based upon several criteria. Choose well-protected (from winds and wave action), shallow (less than 2 m depths) coves – preferably with gradual slopes – for establishment of aquatic plants. A fine-textured substrate is most suitable, and generally indicates a favorable, low energy environment. Areas of high sediment resuspension and thus high turbidity can usually be avoided by selecting such wind- and wave-protected coves. These are generally the clearest shallow waters available.

Other than as an indicator of physical conditions, sediment texture does not seem to be critical to successful establishment, and we have had similar results on sandy to muddy substrates. The major consideration is that plant roots must be able to penetrate the sediment to a depth of at least 15 cm in order to anchor the plant. Hardpan or rocky substrates should be avoided when possible.

Although we have had very few problems with vandalism of sites, we recommend avoiding high-use areas such as developed shorelines and areas favored by bank anglers, swimmers, and users of recreational watercraft. In addition, heavily wooded shorelines can be a problem due to excessive shading, which greatly reduces the light available to submersed aquatic plants. Areas with signs of heavy animal activity – particularly hogs, cattle, or beaver -- should also be avoided.

Planting Depths

The two greatest abiotic influences on aquatic establishment are water level fluctuations and high turbidity. Because submersed aquatic plants require light to survive, planting at proper depths is critical, particularly if the water is turbid. Water levels of most reservoirs are influenced by both natural (seasonal or climatic) events and operations (storage or release of flood waters or water supplies, power generation, etc.), both of which are generally beyond our control. For planning purposes, we review historic water level fluctuations to estimate expected levels during early establishment. Based on expected water levels and knowledge of the biology of the plant species, we assign an appropriate depth or depth range for each species. In general, submersed plants will establish best at depths of 50 to 125 cm, floating-leaved plants from 25 to 75 cm, and emergent plants from 0 to 25 cm.

Species selection

We suggest using only native plant species, as these tend not to reach weedy proportions, reducing the likelihood of future problems. We also suggest establishing as great a diversity as possible. This will ensure long-term establishment of at least some species (e.g., drought-tolerant species will survive long drawdowns, while others may not). Diverse communities of native plants also provide the greatest water quality and habitat benefits over the long-term.

Plants should be selected based on specific lake habitats or anticipated environmental conditions. For instance, in a lake known to follow a pattern of water elevation change, concentrating on drought-tolerant species may be best. However, because predicting environmental changes in a reservoir is difficult, we strongly recommend conducting a test

planting of as many species as possible to ensure an adequate evaluation. Species that have demonstrated potential for lake restoration are provided, along with information about their culture and planting, in Appendix A.

Timing

Timing can be as critical as species selection. Planting should occur before or during periods of active growth to ensure establishment. Unlike seeds or less robust propagules, mature transplants can be planted over a wider seasonal range. Depending on location, this may range from mid-spring to late summer. In reservoirs that experience spring floods, planting should be delayed until water levels drop to their normal summer levels. In general, plants should be planted as early as practicable. Establishment of a viable population from mature transplants is possible in late summer, but late planting reduces the length of growing season remaining and may decrease the likelihood of success.

Planting

Planting potted aquatic plants is much like planting landscape plants, but is usually done at depths of 25 to 100 cm. When installing plants, care must be taken to ensure that root balls are not buried too shallow or that apical tips (especially in rosette-forming species) are not buried too deeply. Figure 5 provides instruction for planting.

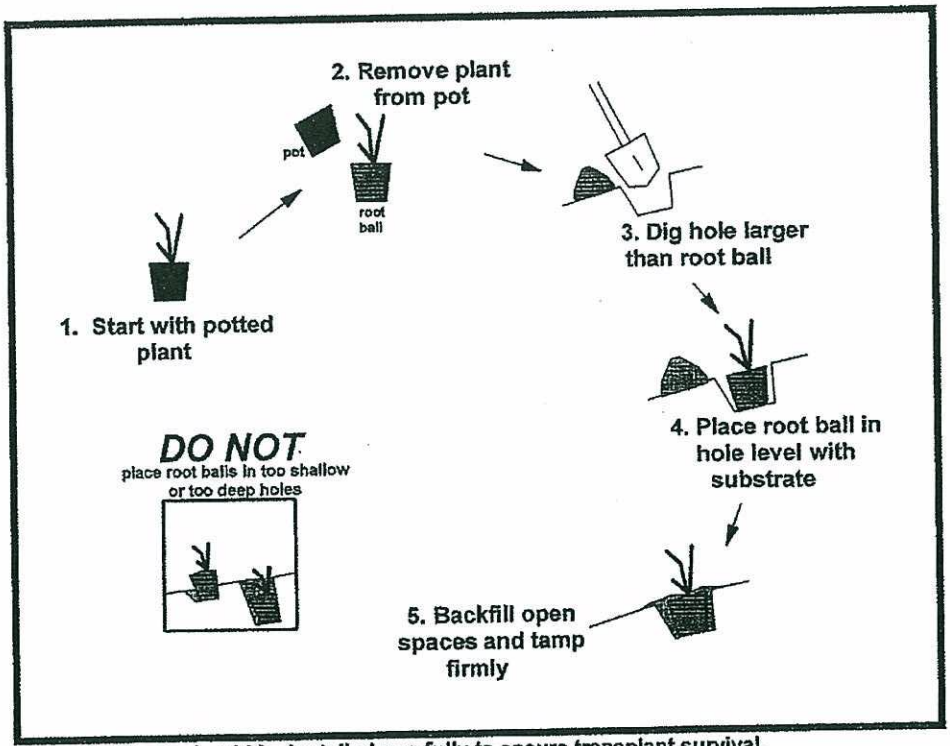


Figure 5. Plants should be installed carefully to ensure transplant survival.

Planting densities will vary dependent upon species and exclosures (next section). Table 2 provides a general planting density guideline for most aquatic plant species. Higher densities will ensure faster establishment of founder colonies and reduce the likelihood of

establishment failure (if one dies, others will survive).

Table 2. Planting densities are dependent upon growth form and exclosure type.		
Growth form	**Small exclosures**	**Large exclosures**
Submersed	2 to 8 plants	1 to 3-m centers
Floating-leaved	2 to 4 plants	2 to 3-m centers
Emergent	2 to 6 plants	1 to 2-m centers

Herbivore Protection

Establishment of new colonies of aquatic plants in unvegetated reservoirs requires protection from herbivores (Smart et al. 1996, Doyle et al. 1997). We have used several types of protective exclosures, dependent on the expected level of herbivory. Site visits, discussions with lake and fisheries managers, and trapping can provide preliminary estimates of the densities of herbivorous species that may be encountered.

PVC-coated galvanized welded-wire is more expensive but much more durable than non-coated wire, and we highly recommend its use in aquatic restoration projects. We do not recommend the use of plastic mesh wire due to its high susceptibilities to damage and degradation. In most cases, 2" x 4" mesh (nominal size) is adequate to exclude common grazers such as carp and turtles. Occasionally, smaller mesh may be required (1" hexagonal mesh excludes nearly all problematic grazers). We recommend conducting small-scale tests to ascertain the levels of protection from grazers in any particular water body.

Large-scale protection: Larger herbivore exclosures offer protection from omnivores such as carp and other rough fish. These are used in situations where rough fish population densities are expected to be high, or in reservoirs previously stocked with grass carp. Multiple species can be planted in large exclosures without initial concerns of planted species outcompeting one another. A major drawback to large exclosures is that a single breach may put the entire founder colony at risk.

We have used several large exclosure designs to successfully establish founder colonies in both large and small reservoirs (Figure 6). Exclosures are constructed from T-posts (approximate 3-m spacing) and 2" x 4" PVC-coated welded-wire (12 or 14 gauge) fencing. After T-posts are set (and safety caps installed), fencing is attached using aluminum wire ties. Fencing should extend 25 cm or more above normal high water levels that occur during the growing season. The bottom of the fencing should be firm against the substrate at all points to prevent burrowing under by grazers. The interface between the fence and the bottom sediment is critical, and an outward flap at the bottom of the fence helps prevent entry of turtles, carp, and other large grazers. Optionally, a 2' wide fencing flange attached to the bottom of the fence with cable ties (extending away from the protected area) will discourage burrowing.

Cove fences are constructed across the mouths of coves to exclude water-borne grazers such as common carp and semi-aquatic turtles from planting sites. As designed, fenced coves do not exclude herbivores that can move over land and plants may require a double-layer of herbivore protection (smaller exclosures for individual plants plus the cove fence). Enclosing the open sides of the cove fence is generally not practical; however, the potentially large area protected for founder colony development makes the use of cove fences worthwhile in some cases. Avoid coves with inflowing creeks because the fence will trap logs and other debris and may be subject to damage or undercutting during

high flow events. Additionally, such coves appear to be preferred by large burrowing mammals, such as beavers, which are capable of damaging even the stoutest of fences.

Shoreline fences are generally irregular in size, and extend from the shoreline out to a desired depth (generally 1 to 1.5 m) and then along that contour parallel to the shoreline. Shoreline fences may be three-sided or include a backing to exclude terrestrial herbivores. Although they do not typically protect as much area as cove fences, in our experience shoreline fences are less likely to be breached. As with cove fences, when not using a backing on shoreline fences we recommend a double-layer of herbivore protection (individual plant exclosures plus the shoreline fence).

Some sites are suitable for construction of free-standing pens, constructed similarly to cove and shoreline fences. Large, flat areas that are somewhat protected from wind and waves are ideal for using pens; we have established founder colonies in pens ranging from 3-m x 3-m to 30-m x 30-m. As in other fence types, we recommend adding a bottom flange to reduce the likelihood of breaching by burrowing herbivores.

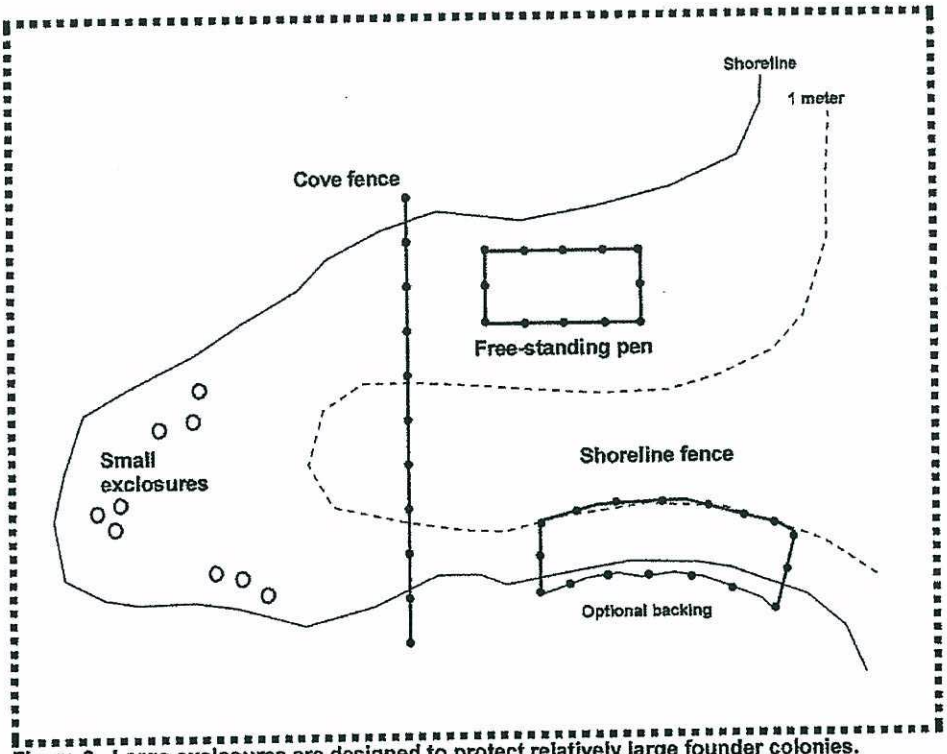


Figure 6. Large exclosures are designed to protect relatively large founder colonies.

Small-scale protection

Several of the following small exclosures provide near-complete protection from herbivory if constructed of appropriate materials and properly deployed. However, because these exclosures protect only a relatively small area of plants, they may be most useful in situations where herbivory is low to moderate. Small exclosures are most suitable for single-species planting: different species planted within small exclosures will invariably compete with one another for resources, and one will likely be dominant, negating the

effort of establishing diverse plant communities. One advantage of using small exclosures is that they are less likely to be breached than large exclosures, and when clusters are planted in the same area, breaches that may occur do not threaten the entire founder colony.

Ring cages are wire cylinders that serve to protect single or small groups of aquatic plants (Figure 7). 2" x 4" mesh welded-wire is cut into 3 to 6-m lengths, rolled into cylinders, and ends fastened using c-rings (or hog rings). The resultant cages (1 to 2-m in diameter) should be anchored using earth staples or tent stakes. 14-gauge PVC-coated welded-wire is recommended for smaller diameter cages (less than 1.5 m), with 12-gauge wire recommended for larger diameter cages (greater than 1.5 m). Height of ring cages should not exceed 1.25 m to ensure cage strength. If protection from smaller grazers is required (e.g., juvenile turtles and/or crayfish), exclosures can be made from finer mesh material. Alternatively, a sleeve of a finer mesh material can be placed over the wire mesh cylinder. The advantage of this approach is that the sleeve can be removed and reused after initial establishment of the transplant(s).

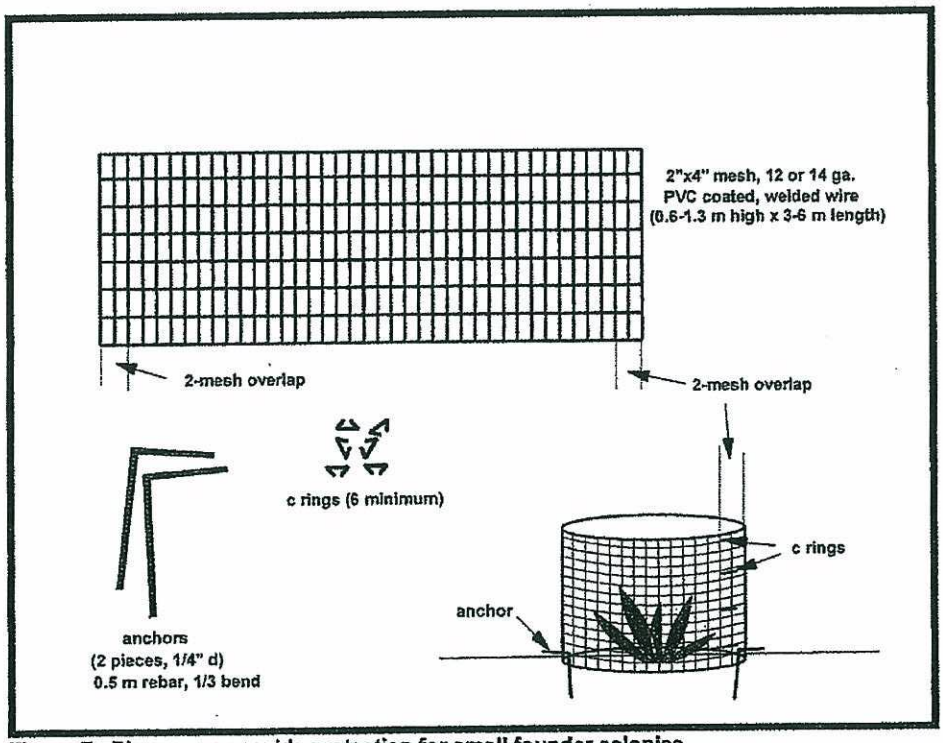


Figure 7. Ring cages provide protection for small founder colonies.

Hoop cages are larger versions of ring cages that allow for planting submersed species at greater depths (Figure 8). Hoop cages are taller (2 m) and always constructed from 12 gauge, PVC-coated wire. Six to ten meter lengths of wire are cut and formed into cylinders about 2.5 to 3 m in diameter. Because of their height, hoop cages tend to be unstable, so hoops of 1" diameter (nominal size) plastic irrigation tubing are attached to the top and bottom of the cylinder for structural support. The cages are then anchored by weaving PVC piping through the mesh and pressing the pipe into the bottom mud.

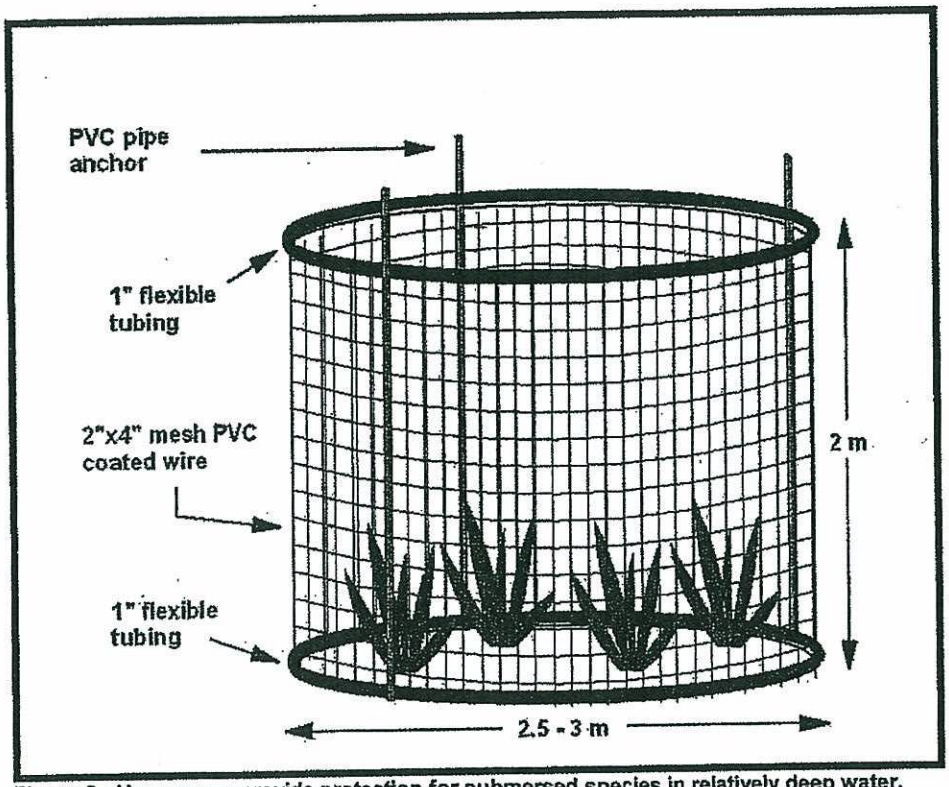


Figure 8. Hoop cages provide protection for submersed species in relatively deep water.

Tray cages are designed to protect roots, stem bases, and lower leaves of all aquatic plants, but are most effective when used to protect emergent species and the submersed species *Vallisneria americana*. Cages are constructed from 2" x 4" welded-wire (Figure 9). Shorter trays (15 cm tall) are suitable for emergent plants, while taller trays (25 to 50 cm tall) are best for submersed species.

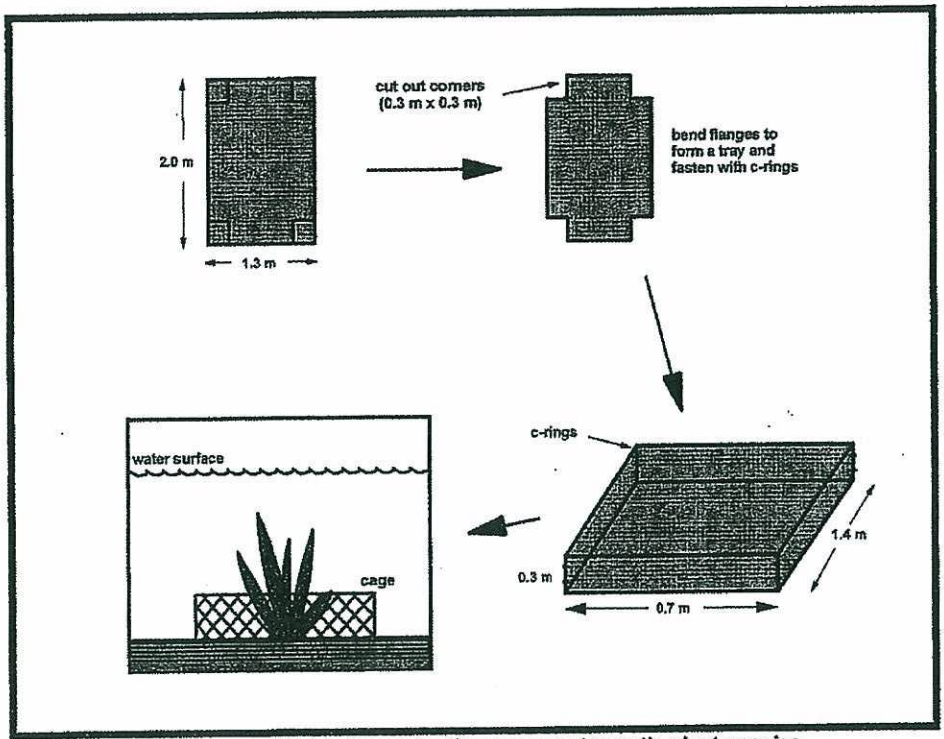


Figure 9. Tray cages are suitable for protecting emergent aquatic plant species.

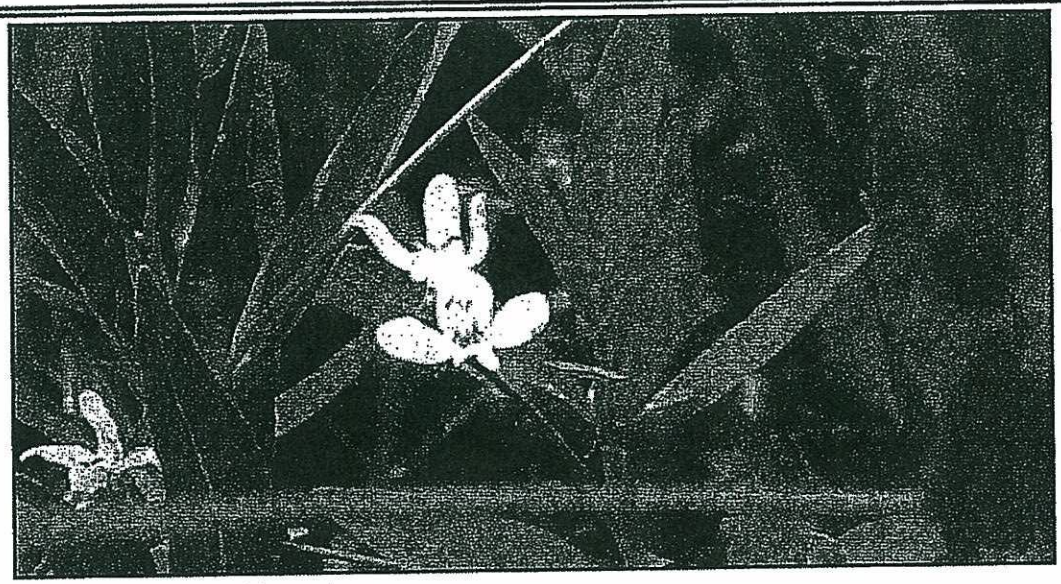
Monitoring and Adaptive Management

Once suitable sites are selected and exclosures constructed, the restoration project should proceed in three phases. Phase 1 involves planting and monitoring (over a full growing season) of test plants of a variety of species within small protective exclosures. Assuming suitable sediments, water quality, and water levels, these plants will establish and expand beyond their protective cages, depending on the level of herbivory. During Phase 1, the level of herbivory and, if possible, the sizes and types of herbivores, should be noted. Monitoring during Phase 1 is important because the response of the plants will dictate the best course of action to take during subsequent growing seasons.

During the second growing season, those species performing best during Phase 1 should receive additional plantings. However, in many unvegetated reservoirs, expansion of the plantings will require provision of a larger-scale protected environment such as a fenced cove. Phase 2 may involve construction of a fence across the cove mouth to exclude carp and other rough fish in combination with additional plantings of selected or preferred species. Phase 2 should result in the successful establishment of founder colonies of several species.

During Phase 3, colonies expand to fill the area protected by the fenced cove, and begin to spread into unprotected areas by vegetative and/or sexual modes of reproduction. Monitoring should be continued at this stage as large-scale disturbances can have serious consequences on newly established plant communities. Additional species may also be desirable to ensure maximum diversity, stability, and resilience of the aquatic plant community.

Water willow



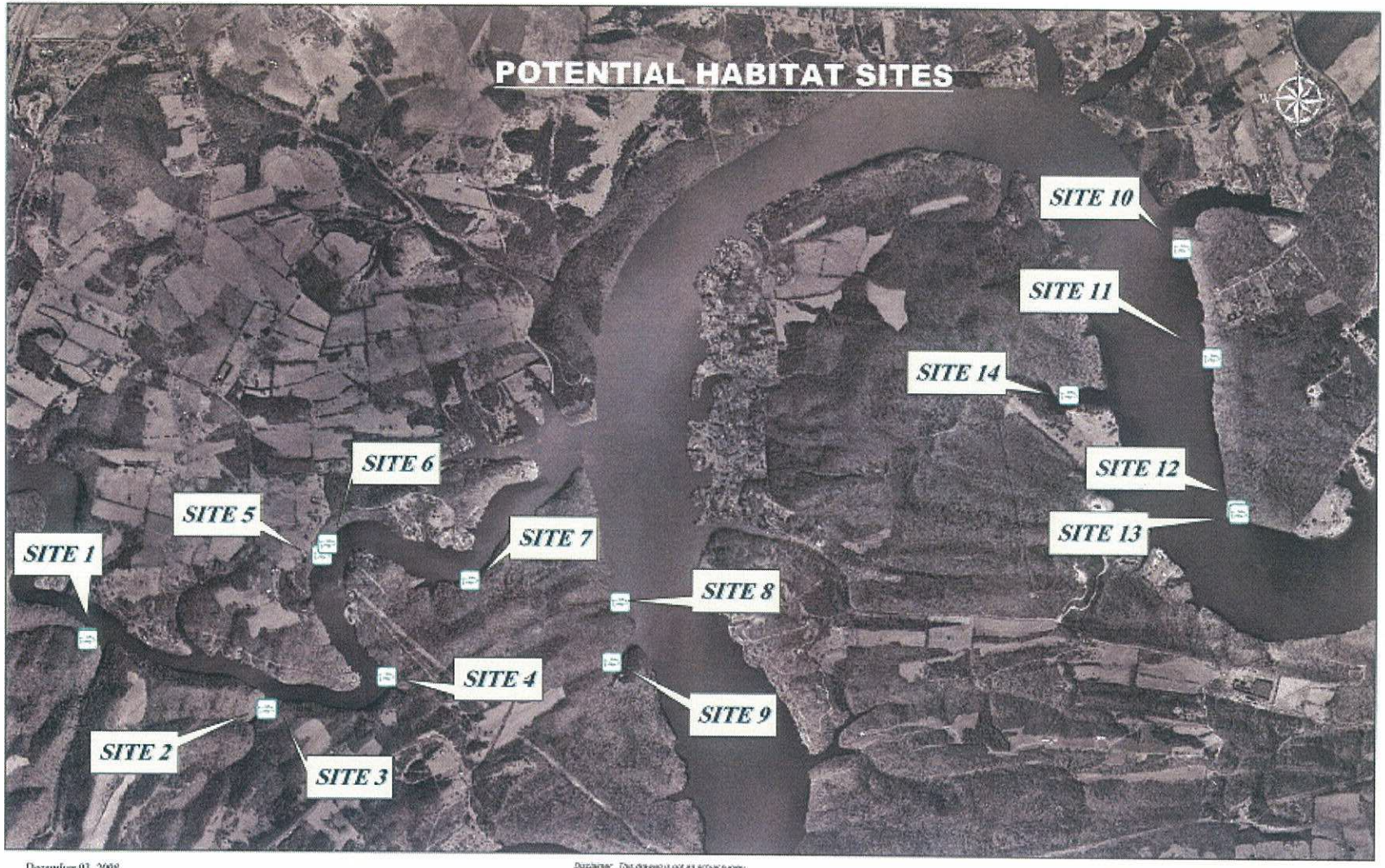
Scientific name	*Justicia americana*
Common names	Water willow, American water-willow
Growth form	Rhizomatous emergent forb.
Reproduction	Produces new shoots along rhizomes. Also reproduces by fragmentation and seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes.
Range	Eastern U.S.
Use	Valuable for fish habitat and erosion control.
Culture	
Plant	Apical cuttings from spring to midsummer.
Produce	Mature transplants.
Light	100% full sunlight.
Container	4" (1 quart) or 6" (1 gallon) nursery pots.
Substrate	Most soil types.
Fertilization	20 grams 10-5-5 fertilizer per L of potting medium.
Water depth	Saturated to 25 cm.
Comments	Field-ready transplants can be produced in 6 to 8 weeks.
Field Planting	
Propagule	Mature potted transplants.
Season	Early spring to midsummer.
Substrate	Sand to muck.
Depth	Moist soil to 75 cm.
Comments	Highly tolerant of drought; not susceptible to herbivory; will tolerate depths of 1.3 m once established.

Appendix B –
Initial 5-year Enhancement Plan
Sites Identified for Additional Habitat

Claytor Lake

Site	Type of Habitat	Schedule	Consulted Parties
Appalachian owned properties	Cover / Structure in cove areas	2012 – 2016	Technical Committee
Vicinity of public boat ramps and fishing piers	Cover / Structure	2014	Technical Committee (Sites located adjacent to VDGIF, VDCR, and Pulaski County facilities)
Demonstration Project (erosion control and habitat)	Details will be provided to the Commission for final review and approval prior to implementation	2015	Technical Committee
Island areas	Cover / Structure	2016	Technical Committee

Appendix C – Map


POTENTIAL HABITAT SITES
SITE 10
SITE 11
SITE 14
SITE 12
SITE 13
SITE 6
SITE 5
SITE 7
SITE 1
SITE 8
SITE 4
SITE 9
SITE 2
SITE 3
December 03, 2008
Cartography: Mark McGladdin, AFP Shoreline Management

June 2009