Aquatic Habitat Enhancement Plan for the Placement of Natural and Artificial Habitats in Indiana's Reservoirs

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This document is designed to serve as a guide for the construction and placement of natural and artificial habitats in Indiana reservoirs. There are many types of structures available, but the use of tires and other hazardous materials are strongly discouraged. The proposed habitats are aimed to provide long-term and long-lasting habitats that fit a reservoir's native habitat features and provide improved angling opportunities.

Fluctuating reservoirs and other impounded waters often have very little structure and aquatic vegetation, especially in older reservoirs in which woody debris present at inundation is long gone (Wagner 2013). Miranda et al. (2010) conducted a survey of fisheries scientists throughout the United States to identify the major factors that are degrading reservoir fish habitats. Lack or loss of structural habitat (e.g., submerged woody debris, boulders, etc.) was identified as a major factor in midwestern and southeastern reservoirs. Artificial habitats can also help congregate fish to improve angling (Bohnsack et al. 1997). Adding substrates for spawning can also augment target species if spawning habitat is limiting (Fitzsimons 1996).

Most of the information presented in this document is not new but is gathered from other states (Missouri, Utah, Nebraska, and Pennsylvania). Before considering any project, permits must be addressed. Projects may require permits from various state and federal agencies and the type of permit depends on the scale of the project, amount of substrate disturbance, and ownership or managing authority of the impoundment. Lakes identified as Public Freshwater Lakes by IC 14-26-2 fall under a different set of rules and regulations. The following guidelines do not apply to those lakes listed as Public Freshwater Lakes which can be found at: http://www.in.gov/legislative/iac/20110601-IR-312110313NRA.xml.pdf

When planning projects it is important to make contact with the various permitting agencies to assure compliance:

- Corps of Engineers (COE) http://www.lrl.usace.army.mil/Portals/64/docs/regulatory/Contact/OPF%20Telep%20Contact%20%20Info1.pdf,
- Department of Natural Resources (DNR) Division of Water http://www.in.gov/dnr/water/2455.htm,
- Indiana Department of Environmental Management (IDEM) http://www.in.gov/idem/wetlands/2347.htm).

Approval from the property managers (COE, DNR, and municipalities) is required in all projects. In instances where material (or structure or device) is placed in any waterway (stream or impoundment) with a flow greater than five cubic feet per second Section 404 of the Clean Water Act may require a Nationwide Permit (NWP) 27 for Aquatic Habitat Restoration, Establishment, and Enhancement Activities http://www.usace.army.mil/Portals/2/docs/civilworks/regulatory/engform_4345_2014dec.pdf. In instances where the cumulative footprint of open water for all the habitat structures exceed 0.10th of an acre the project will require an IDEM Individual Section 401 Water Quality Certification (WQC) application (State Form 51821; R/10-04) found under the Storm Water and Wetlands heading at the following web link: http://www.in.gov/idem/5157.htm. The WQC 401 permit is accepted by the COE and can be used in place of the Section 404 NWP 27. In order to reduce redundancy and paperwork we recommended submitting only a WQC 401 to both IDEM and COE and omitting NWP 27.

All projects should be submitted to the DNR Division of Water for evaluation of the need for a Floodway Permit. In instances where the drainage area in the proposed project areas is less than one square mile a floodway permit may not be required. The need for a floodway permit should be determined by the Division of Water.

Several key factors must be considered when choosing which structure is best suited for the situation. Aquatic habitat is only beneficial when placed in areas where fish can exist. An accurate temperature and dissolved oxygen profile is key when placing structure. If structure is placed too deep it will be unusable to fish during summer months when oxygen levels are not sufficient at deeper depths. Many impoundments in Indiana do not have adequate oxygen levels below 20 feet during summer months. If structure is too shallow it may be a boating hazard or during low summer water levels or winter drawdowns it may be high and dry. Department of Natural Resources Division of Law Enforcement recommends 3 feet of water clearance above structures to reduce boating accidents (Terry Hyndman, personal communication). The water column which is shallow enough for adequate oxygen levels but deep enough for adequate water depth during low water will be called the Habitat Enhancement Zone. Structures will be placed within the Habitat Enhancement Zone. Other factors to consider are the proximity to other structures, obstruction of boat navigation and swimming, longevity of structure, costs, the creation of floating debris as structure decomposes, and making sure structure is secured.

The amount of structures placed in an impoundment should be dependent on the amount of habitat already available, waterbody size, and the amount of water volume that is available for fish to use throughout the year. No hard rule has been documented on a specific acreage or percentage of surface area for a target, but data from aquatic vegetation manipulation studies and reviews suggested that about 20 to 30% vegetated cover was optimal for age-0 Largemouth Bass survival (Durocher et al. 1984; Dibble et al. 1996; Maceina 1996). However, in most cases the deciding factor on the amount of habitat added is budgets and personnel. Different habitat structures provide a different amount (acreage) of habitat. The exact impact (acreage) that structures create is not explicitly documented, but based on the recommended number of structures per a given acre we can surmise that the habitat impact would be slightly larger than an acre. This is due to interstitial space between structures and habitat created around the edge of the complex. Other structures, where documentation is not available, the best estimate of how much habitat is created is based on being slightly larger than the structure (length of tree, etc.). Based on these factors our projects will target increasing available habitat by 5% to 20% in the Habitat Enhancement Zone.

Type of structure	Estimated habitat impact area (acre)
Rock piles (20/acre)	1.5 acres per complex
Felled shoreline tree	0.05 acre per tree
Brush pile	0.10 acre per pile
PA porcupine crib (20/acre)	1.5 acres per complex
PA porcupine crib junior (20/acre)	1.5 acres per complex
PA post cluster (25/acre)	1.5 acres per complex
Georgia cube (20/acre)	1.5 acres per complex
PA black bass nesting structure (10/acre)	1.5 acres per complex

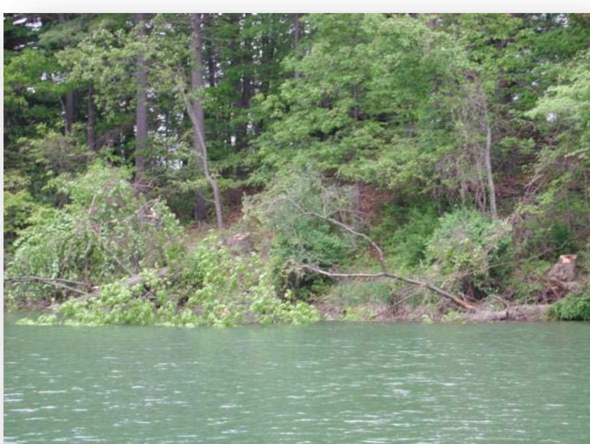
Below we have provided a short description of recommended habitat structures and placement locations. Further information about construction specifics can be found in the Appendices.

ROCK PILE/REEFS

Rock piles provide forage-type habitats for a variety of aquatic insects, crustaceans and baitfish. Largemouth Bass juveniles used rocks (~ 1 in diameter) placed from conservation pool shoreline to about 1 m depth (Jackson et al. 2000). The use of rocks by age-0 Largemouth Bass did not differ between a continuous patch 65 ft long or three intermittent patches of 22 ft or between steep slope (3 ft depth at ≤ 15ft from shore) or shallow slope (3 ft depth at ≥ 30 ft from shore). Rubble humps may also act as fish attractors for Walleye, black bass and panfish, due to natural colonization by various types of aquatic insects. Fish use depends on location, hump or reef size and stone size diversity. Traditionally, rubble humps are placed on flats or shoals in impoundments. The best method for placement is during maintenance or annual drawdowns, with heavy machinery. Suitable rubble includes sandstone or limestone, in sizes from fines to riprap. Broken concrete blocks are also utilized as rubble material. Rubble humps are defined as rock or concrete piles between 1 and 3 cubic yards (less than 2.5 tons). Rubble reefs are defined as rock or concrete piles between 3 and 10 cubic yards (2.5 to 7.5 tons). Typical placement density is 20, 2-ton humps (40 tons) per acre (Houser 2007). Photo courtesy: Pennsylvania Fish & Boat Commission.

FELLED SHORELINE TREES

Where sufficient depths exist near shore (greater than 15 ft), felling and cabling shoreline trees provide excellent fish habitat. Sportfish use submerged trees in a variety of ways. Spawning, recruitment, foraging and refuge tasks are accomplished by many species and age-classes using felled trees. Large, spreading hardwood trees are particularly suitable, because their complex branching systems create more complex habitat. Trees are felled and cabled to their stumps with ¼ in galvanized wire rope and cable clamps or hinge cut. Typical placement density is 5 trees per acre (Houser 2007). Photo courtesy: Pennsylvania Fish & Boat Commission



BRUSH PILES, LOG PILES, STUMPS

Woody structure is one of the more readily available structures. Hardwood and cedar structures were found to attract both black bass and crappies and are some of the more cost-effective habitat structures utilized (Allen et al. 2014). Christmas tree piles are economic, easy to construct, and easy to place; however, there longevity is less than other wooden structures. Mabbott (1991) noted that evergreen trees had a lifespan of 4 to 7 years in Idaho reservoirs, whereas stumps lasted 20 to 25 years. Groups of cedar or pine trees 6 to 10 ft in height are recommended. Trees should be secured with weight (cinder blocks, cement in bucket, etc.) and are most efficient when placed upright, creating a 3-dimensional structure. Cedars tend to have smaller interstitial spaces favored by juvenile sunfish (Wagner 2013). Hardwoods such as oak last longer before decomposing, but can also snag more lures (Cofer 1991). Bryant (1992) compared three different aggregation methods for brush bundles: dense (115 ft row and 13 ft wide), continuous open center (brush stems oriented to the center of the long row, creating a corridor), or discrete open center (several circles of brush with stem toward the center); age-0 bass increased at all sites, but were more common in the discrete center formation. Daugherty et al. (2014) found that adult bass and Bluegill were also more likely to be found in cluster-shaped structures. Greater protection from predation is likely related to the increased interior space provided by the clustered design (i.e., lower edge: area ratio), which reduces visual encounters with predators (Crowder and Cooper 1979) and excludes predators from the structure interior (Lynch and Johnson 1989). Photo courtesy: Arkansas Game & Fish.

AQUATIC VEGETATION

Native aquatic vegetation in reservoirs is often lacking, due to both high fluctuations in water levels and lack of propagules for colonization. Aquatic plants support higher fish densities, reduce the risk of predation, and provide habitat for species that are reliant on structure (Savino and Stein 1982; Dibble et al. 1996). Ecologically, established native aquatic plant communities can also help prevent invasion of aquatic weed species (Smart et al. 1994). Strakosh et al. (2005) evaluated the ability of American water willow to withstand water fluctuations. Plants were inundated for 2 to 8 weeks at depths of 2.4, 5, or 7 ft; drying durations of 2 to 8 weeks were also evaluated. The willow generally survived desiccation (5% died overall), but even 2 weeks of inundation led to 40% mortality across all depth treatments. Smart et al. (1996) suggested a variety (N = 10 species) of aquatic plants to consider for propagation, including annuals such as *Chara sp*., small pondweed, and *Najas sp*., as well as perennials such as American pondweed, American eelgrass, and *Elodea sp*. In shallow Mississippi Delta lakes, squarestem spikerush and arrowhead had greater coverage and a lower probability of extinction compared to American lotus and blunt spikerush (Smiley and Dibble 2006). However, blunt spikerush had a higher stem density than American lotus or arrowhead (Smiley and Dibble 2006). For establishment, peat-potted stock or transfer of tubers is recommended (Smart et al. 1996). Hammer (1992), Doyle and Smart (1993), Smart et al. (1998), and Smart et al. (2006) also provide guidance on establishing aquatic macrophytes. Fleming (2010) found that if plants were not kept in enclosures, they disappeared within 2 days after planting in Little Bear Creek Reservoir, Alabama. Fleming (2010) found that propagules survival was in the order American pondweed > American eelgrass > sago pondweed; survival did not vary with planting depths that ranged from 0.3 to 1.0 m. On Cooper Lake, Dick et al. (2004) found that by 'chasing water level', i.e., continuing to plant in hoop cage enclosures as lake levels dropped, they were able to establish founder colonies. Photo courtesy: Mark Fowlkes, North Carolina Wildlife Resources Commission.

PENNSYLVANIA PORCUPINE CRIB

Houser (2007) gives a great description of the porcupine cribs. Porcupine cribs are long-lasting, deep-water, complex structures designed as a refuge-type habitat (Houser 2007). This design should provide protection for juvenile fish and improve recruitment of sportfish in impoundments that lack abundant, deep-water, submerged aquatic vegetation. Construction materials consist of rough-cut, true-dimensional, green (fresh cut) hemlock or poplar (50 pieces of 2 in x 2 in x 4 ft), eight two-core 8 in concrete blocks (minimum 35 lbs each) and 2 lbs of 16d common bright nails (two strips of

12d strip nails for nail guns), plus a 14 ft piece of ½" nylon security banding and one plastic buckle. Placement is traditionally accomplished by specially-equipped watercraft, during soft-water periods (no ice). These structures may also be constructed on-site, during drawdown periods. Submerged structures are normally placed in a row or alternating row pattern, with 4 to 8 ft spaces between individual structures. Normally, 10 to 20 porcupine cribs are placed at one site. Structures are submerged in 10 to 15 ft depths along the bottom contour, parallel to the shore. Typical placement density is 20 structures per acre. Estimated cost per unit: $134.

PENNSYLVANIA PORCUPINE CRIB JR. (Houser 2007)

The porcupine crib junior (junior) is an adaptation of the original porcupine crib, which was designed as a deep-water structure. The junior is a shallow-water version, with additional density in the gable ends. The junior was first designed to mimic the habitat provided by native stumps. Stumps in shallow water provide an important habitat value in reservoirs and are sometimes the only true woody cover in an impoundment. As impoundments age, native stump fields may disappear, due to erosion by wind or by annual or seasonal maintenance drawdowns. As the stump fields disappear, so does that type of cover. Some impoundments do not contain any native stumps, as a result of policies in place during impoundment construction. Juniors can provide alternative cover for pre- and post-spawning adult sportfish, plus seasonal ambush and refuge cover for juveniles. Construction materials consist of rough-cut, true-dimensional, green (fresh cut) hemlock or yellow poplar (38 pieces of 2 in x 2 in x 4 ft), 8 two-core 8 in concrete blocks, and 2 lbs of 16d common bright nails (two strips of 12d strip nails for nail guns), plus a 10 ft piece of ½ in nylon security banding and one plastic buckle. Specially-equipped boats traditionally accomplish placement during soft-water periods (no ice). These structures may also be constructed on-site during drawdown periods. Normally 10 to 20 juniors are placed at one site. The junior is generally placed in a random fashion on shallow-water flats, in depths between 6 and 10 ft (unlike full-sized porcupine cribs, which are placed in rows near deep-water breaks), with varied distances between each individual structure. The junior is only 28 in high, so even in 6 ft depths, the structures are not a navigation hazard. The exception would be during drawdown periods, when the structure could become exposed. Typical placement density is 30 structures per acre. Estimated cost per unit: $100.

PENNSYLVANIA POST CLUSTER STRUCTURE (Houser 2007)

Most artificial wood habitat structures are designed on a horizontal cover principle. Post clusters are designed to create long-lasting, functional, vertical, shallow-water cover for sportfish. Post clusters utilize common agricultural fence posts, driven into the impoundment's substrate in a cluster pattern, to create shallow-water, vertical ambush cover for black bass. Post clusters also create simple microhabitat for aquatic invertebrates. These microhabitats may also serve as habitat for prey resources of black bass (and other predators), increasing prey/predator efficiency. Simple vertical habitat also provides camouflage-related benefits to sportfish. Posts are typically placed in 3 to 4 ft depths, at slight angles to the water surface. Placement is accomplished during seasonal or maintenance drawdown periods, by specialized construction or agricultural type equipment, with a hydraulic fence post driver. Typically, 8 ft by 6 in posts are driven into the substrate, approximately 3 to 3 1/2 ft, allowing 12 to 18 in of the post to be above the water surface in 3 to 4 ft depths. Post clusters are placed 6 to 8 ft apart, with 25 posts to a cluster. Typical placement density is 4 (25 post) clusters per acre. Photo courtesy: Bob Donald.

GEORGIA CUBE (Kansas Department of Wildlife, Parks and Tourism 2015)

The Georgia cube is constructed from PVC pipe which will last much longer than those composed of wood. They are also more lure friendly compared to brush piles that can easily be snagged. The PVC cubes are 3 ft tall by 4 ft wide and 4 ft deep and made using 1 ½ in PVC pipe, with 100 ft of 4 in diameter corregated drain line. Structures quickly accumulate periphyton, a complex mix of algae, fungi and bacteria, which further attracts insects and fish. Cost-effective, easy to place and proven in other states, the new structures not only last more than three times longer than natural brush piles, but also have been shown to hold as many fish as the natural counterpart without affecting water quality (Kansas Department of Wildlife, Parks and Tourism 2015). Estimated cost per unit: $95.00

PENNSYLVANIA BLACK BASS NESTING STRUCTURE (Houser 2007)
Black bass nesting structures are a spawning/nesting/nursery-type habitat, designed to accommodate the spawning/nesting/nursery habits of black bass. Bass nesting structures are designed to provide maximum shallow-water (less than 10 ft) cover to adult bass, during the pre- and post-spawn periods, and dense refuge cover for age-0 Smallmouth and Largemouth Bass. Classic native spawning habitats for black bass occur along south-facing shores in bays and inlets, but spawning may occur at main lakeshores, too. Native spawning sites treated with overhead cover appear to enhance adult spawning and nesting activities, plus improve age-0 survival. Construction materials consist of rough-cut, true-dimensional, green (fresh cut) hemlock or poplar (20 pieces of 2 in x 2 in x 4 ft and five pieces of 1 in x 8 in x 8 ft), eight two-core 8 in concrete blocks (minimum 35 lbs each) and 2 lbs of 16d common bright nails (two strips of 12d strip nails for nail guns), plus a 10 ft piece of ½ in nylon security banding and one plastic buckle. Normally, 5 to 10 nesting structures are placed at one site. Bass nesting structures are usually placed in alternating rows, in depths between 5 and 10 ft, depending on water clarity and the target species. The bass nesting structure is only 15 in high, so even at 5 ft depths, it is not a navigation hazard. The exception would be during drawdown periods, when the structure could become exposed. Typical placement density is 10 structures per acre. Estimated cost per unit: $157.

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Date: September 18, 2015

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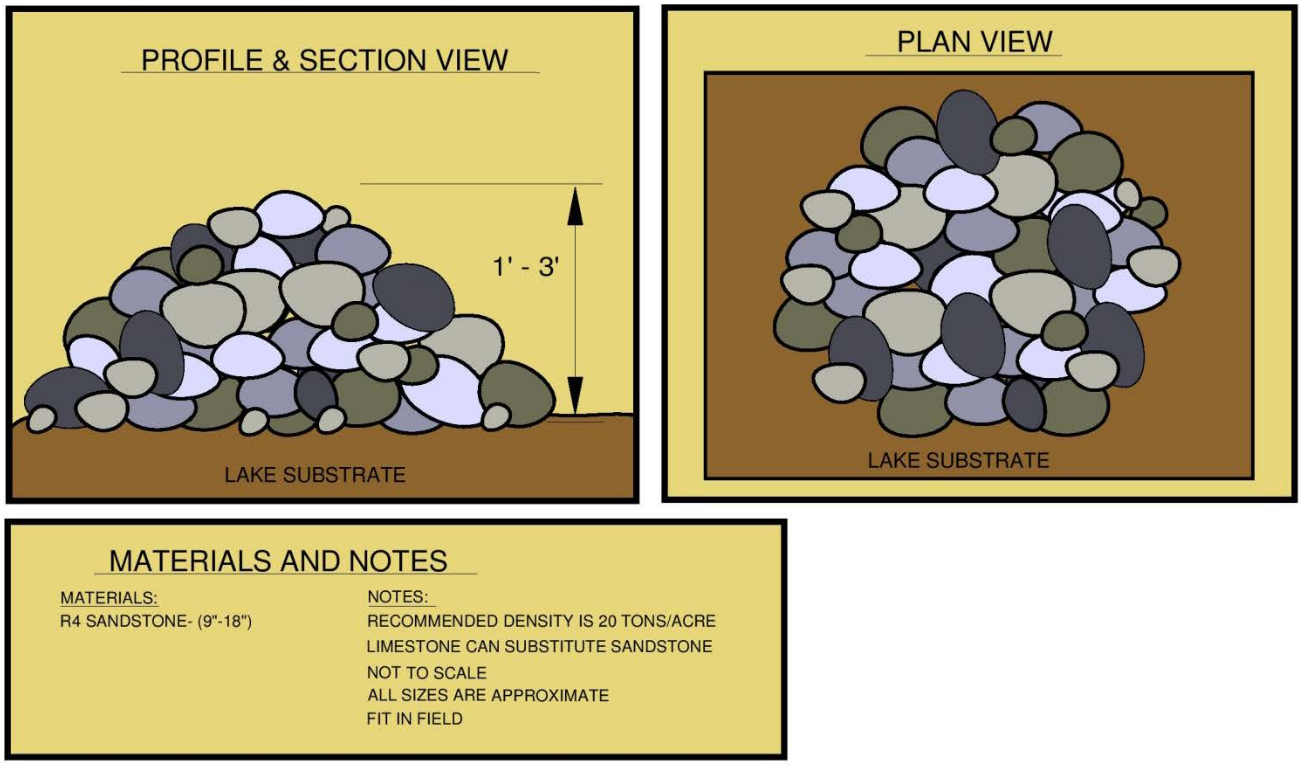
Date: December 8, 2015

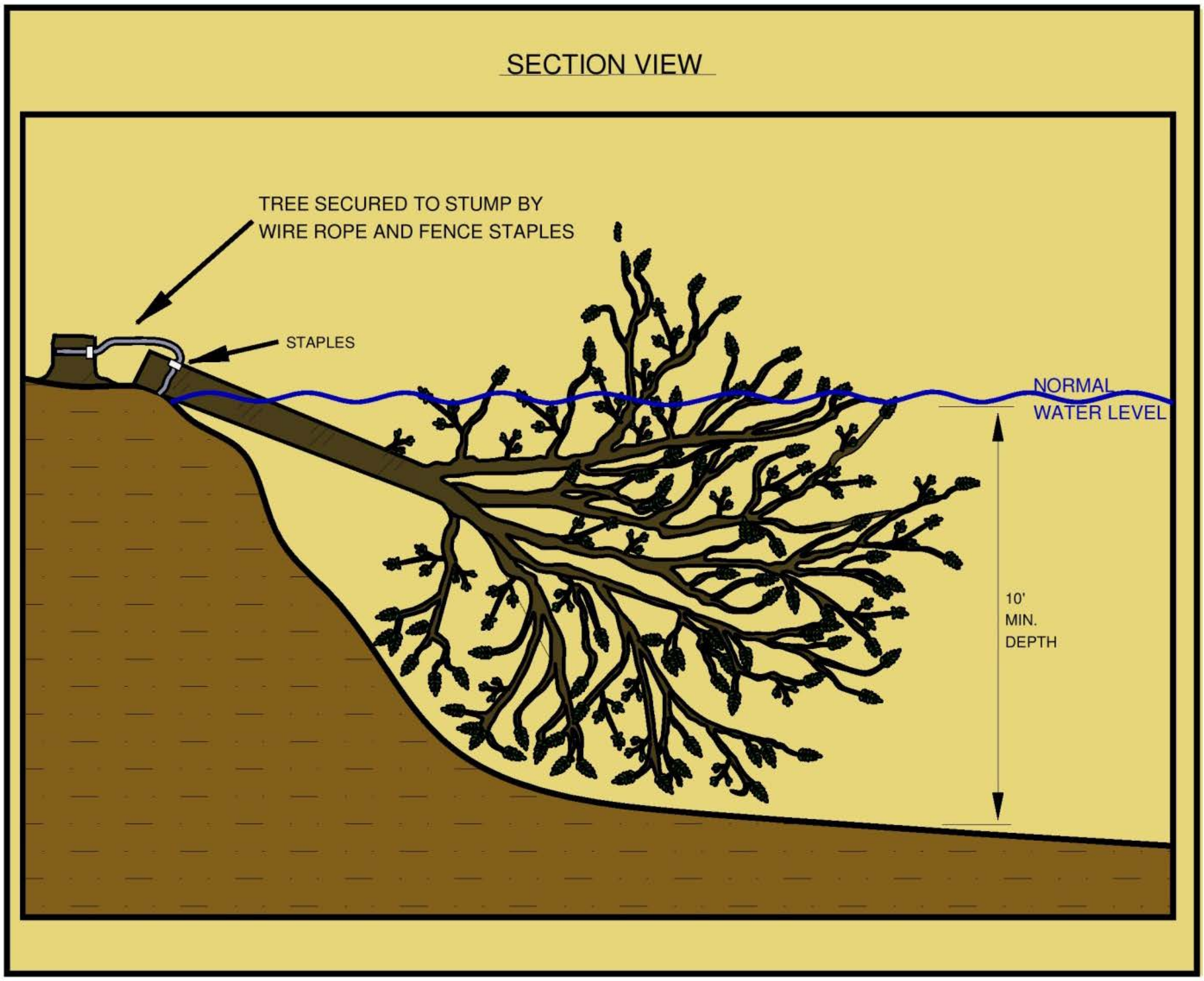
Appendix

Rock Rubble Humps
Felled Shoreline Trees
Porcupine Crib
Porcupine Crib Junior
Georgia Cube
Black Bass Nesting Structures

ROCK RUBBLE HUMPS (Houser 2007)



FELLED SHORELINE TREES (Houser 2007)



MATERIALS AND SUGGESTED EQUIPMENT

MATERIALS:

- LARGE HARDWOOD TREE - 1 PIECE
- 1/4" GALVANIZED CABLE 20' - 1 PIECE
- FENCE POST STAPLES - 4 TOTAL

SUGGESTED EQUIPMENT:

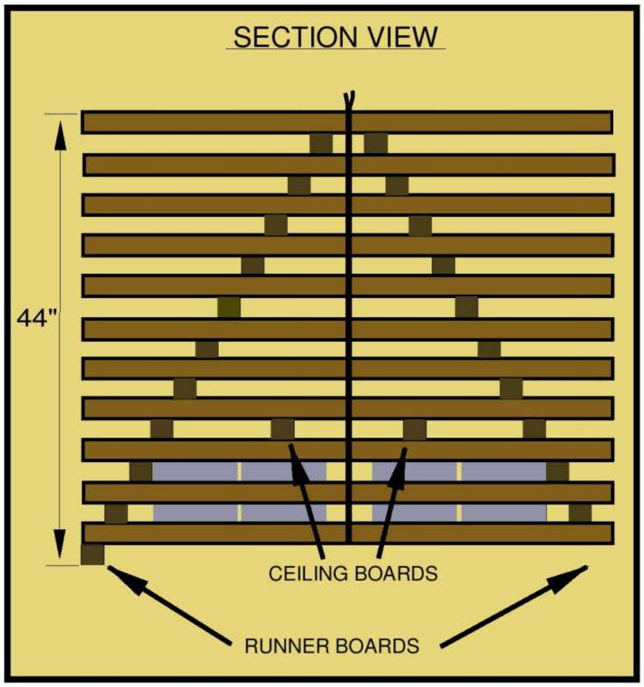
- CABLE CUTTERS
- CHAINSAW
- WEDGES
- MINI SLEDGEHAMMER

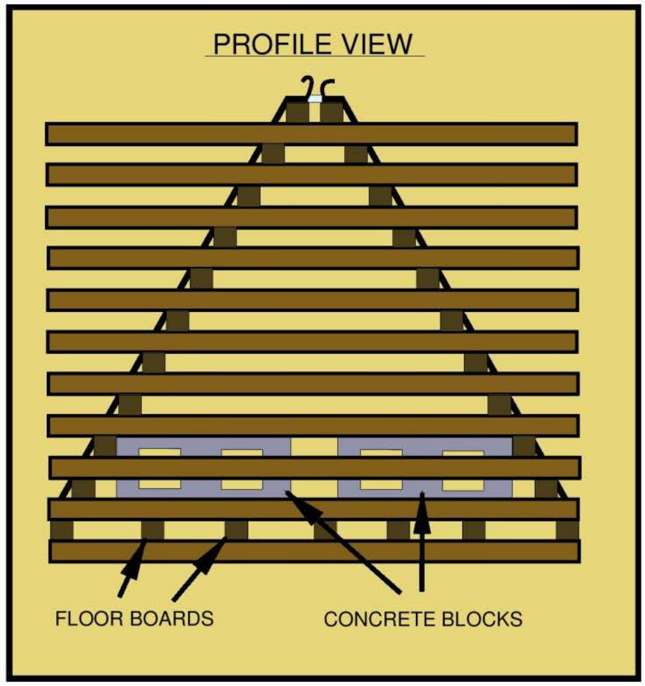
NOTES

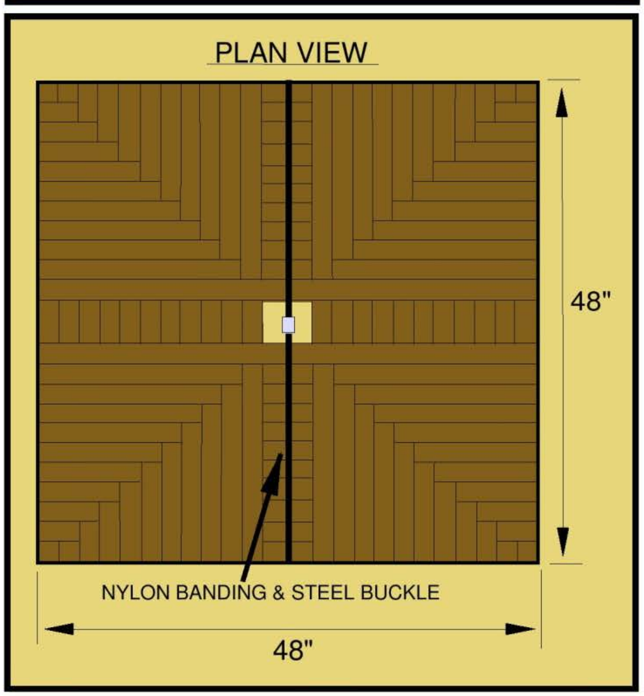
NOTES:

- WIRE ROPE AND STAPLES MUST BE USED
- TREES SHOULD BE CUT IN SUMMER WHEN THEY HAVE MAX. FOLIAGE
- TREE CANOPY SHOULD BE MOSTLY SUBMERGED
- TREES SHOULD BE CUT BY PROFESIONALS
- AREA MUST BE RESTRICTED TO OTHERS DURING THE CUTTING
- NOT TO SCALE
- ALL SIZES ARE APPROXIMATE
- FIT IN FIELD

PENNSYLVANIA PORCUPINE CRIB (Houser 2007)







MATERIALS AND NOTES

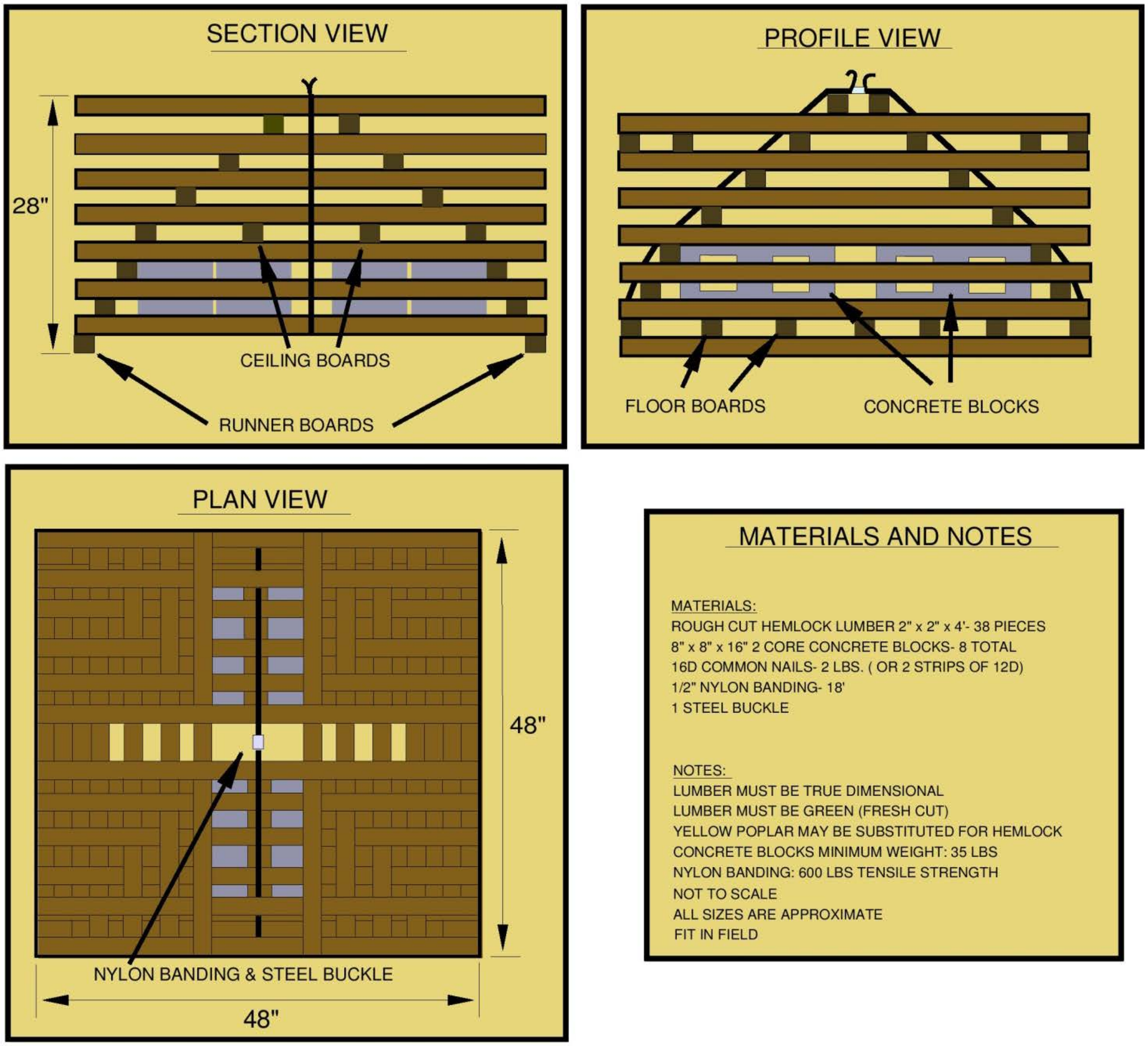
MATERIALS:

ROUGH CUT HEMLOCK LUMBER 2" x 2" x 4'- 50 PIECES
8" x 8" x 16" 2 CORE CONCRETE BLOCKS- 8 TOTAL
16D COMMON NAILS- 2 LBS. (OR 2 STRIPS OF 12D)
1/2" NYLON BANDING- 18'
1 STEEL BUCKLE

NOTES:

LUMBER MUST BE TRUE DIMENSIONAL
LUMBER MUST BE GREEN (FRESH CUT)
YELLOW POPLAR MAY BE SUBSTITUTED FOR HEMLOCK
CONCRETE BLOCKS MINIMUM WEIGHT: 35 LBS
NYLON BANDING: 600 LBS TENSILE STRENGTH
NOT TO SCALE
ALL SIZES ARE APPROXIMATE
FIT IN FIELD

PENNSYLVANIA PORCUPINE CRIB JR. (Houser 2007)



GEORGIA CUBES (Kansas Department of Wildlife, Parks and Tourism 2015)

Georgia Cube Materials Cost Estimate*	
Materials to build 1 attractor	Cost per Attractor unit
8 – $1^1/_2$ in dia. PVC deep fit** elbows	$8.12
8 – $1^1/_2$ in dia. PVC deep fit** "T's"	$13.20
40ft - $1^1/_2$ in dia. sch. 40 PVC pipe	$17.16
100ft – 4 in dia. Corr. drain line	$37.89
10 high tensile strength zip ties***	$6.23
80 – 1 in **self-tapping** screws	$5.47
1 – 8 in x8 in x16 in concrete block	$1.00
Heavy duty PVC primer/cement	$5.98
Total cost per unit:	$*95.05 ea.*

*** -** Prices based on purchases made by Indiana DNR

****** - deep fit has a larger lip on the fitting, allowing for a better fit compared to shallow fittings.

*** - lower tensile strength zip ties break under the stress of deploying the attractor.

Construction:

1) The 1 ½ in white PVC pipe comes in 10ft. lengths. Cut 3, 3 ft. lengths from each 10ft piece of PVC. The remaining 1ft piece can be cut into 2-3 in pieces, which will be used to connect some of the fittings.
2) Connect and glue the 3ft white PVC pipe to the fittings to form a cube frame. Use the self-tapping screws to reinforce the glued fittings (see photo below).
3) Drill several 3/8 in holes in various locations around the completed PVC frame. This will allow it to fill with water when deployed – making it easier to sink.
4) Once the PVC frame is complete use a heavy-duty zip tie (or aluminum wire) to attach one end of the 100 ft piece (uncut) of black corrugated drain line to the PVC frame.
5) Once the end of the corrugated drain line is attached to the PVC frame, begin to push the corrugated drain line in and out of the PVC frame. Use additional zip ties to attach the corrugated drain line to various locations on the PVC frame. Use the entire 100 ft. length of corrugated drain line. It does not matter how the corrugated drain line is strung through the PVC frame. It is simply providing the cover for the fish to hide in.

PENNSYLVANIA BLACK BASS NESTING STRUCTURE (Houser 2007)