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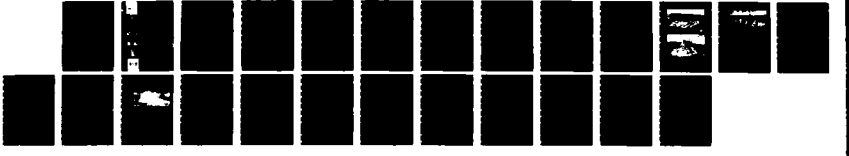

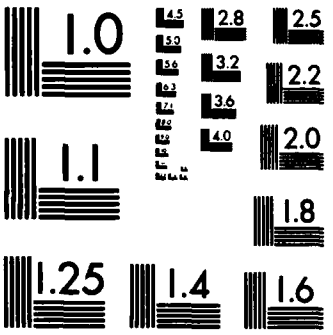

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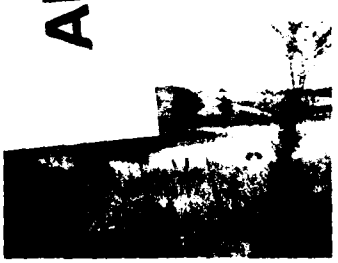

ENVIRONMENTAL IMPACT RESEARCH PROGRAM

TECHNICAL REPORT EL-86-13

BRUSH PILES

Section 5.3.1, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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A management techniques report on brush piles is provided as Section 5.3.1 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report was prepared as a guide to assist Corps biologists and resource managers in developing habitat management programs for project lands. Topics covered for brush structures include wildlife value, design and construction, placement, maintenance, labor and equipment, target species, and cautions and limitations.

The provision of adequate resting and escape cover is critical to proper management of ground-nesting birds, rabbits, and other small game. Although living brush is preferred in most situations, artificial structures can be built to provide immediate shelter where natural cover is limited. Guidelines are presented for the design, construction, maintenance, and proper placement of brush piles for a variety of wildlife species. Management for the

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19. ABSTRACT (Continued).

northern bobwhite (*Colinus virginianus*) and cottontail rabbits (*Sylvilagus* spp.) is emphasized. Brush piles are recommended for use in conjunction with other habitat management practices designed to improve food, cover, and water.

PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. Dave Mathis, Water Resources Support Center.

This report was prepared by Mr. Chester O. Martin, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES), and Mr. John L. Steele, Jr., Recreation-Resource Management Branch, Operations Division, US Army Engineer District (USAED), Fort Worth. Mr. Martin, Team Leader, Wildlife Resources Team, WTHG, was principal investigator for the work unit. The authors wish to acknowledge Dr. Fred S. Guthery, Texas A&I University, Kingsville, for providing photographs and specifications for mesquite brush piles. Information on Christmas tree brush piles was provided by Mr. Lonnie E. Mettler, USAED, Walla Walla. The brush piles photographed for Figure 1 were constructed by Mr. Larry E. Marcy, Texas A&M University, and Mr. Ted B. Doerr, Colorado State University. Review and comments were provided by Mr. Marcy, Mr. Doerr, and Drs. Wilma A. Mitchell and Thomas H. Roberts, WES.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Publications and Graphic Arts Division (PGAD). Figure 4 was prepared by Mr. David R. (Randy) Kleinman, Scientific Illustrations Section, PGAD, under the supervision of Mr. Aubrey W. Stephens, Jr.

At the time of publication, COL Allen F. Grum, USA, was Director of WES, and Dr. Robert W. Whalin was Technical Director.

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NOTE TO READER

This report is designated as Section 5.3.1 in Chapter 5 -- MANAGEMENT PRACTICES AND TECHNIQUES, Part 5.3 -- COVER AND EDGE DEVELOPMENT, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 5.

BRUSH PILES

Section 5.3.1, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

The provision of adequate resting and escape cover is critical to proper management of ground-nesting birds, rabbits, and other small game. Although living brush is preferable in most cases, artificial brush piles can be constructed to supply immediate shelter where natural cover is limited, especially in agricultural areas, prairies, and open rangelands (Edminster 1954, Shomon et al. 1966, Allen 1969, Burger 1973, Evans and Probasco 1977, Yoakum et al. 1980). When properly constructed and located, brush piles can serve as a versatile management technique for many species of wildlife; benefits include concealment and protection from predators, protection from the elements, and establishment of a medium for seed germination and plant growth (Burger 1973, Warrick 1976, Yoakum et al. 1980).

WILDLIFE VALUE

Construction of brush piles has most often been recommended as a management practice for northern bobwhite (*Colinus virginianus*), scaled quail (*Callipepla squamata*), and cottontail rabbits (*Sylvilagus* spp.). Other upland game birds known to use brush structures include the California quail (*Callipepla californica*), Gambel's quail (*C. gambelii*), ring-necked pheasant (*Phasianus colchicus*), ruffed grouse (*Bonasa umbellus*), and wild turkey

(*Meleagris gallopavo*). Benefits from specially constructed brush piles have also been reported for waterfowl (Warrick 1976) and javelina (*Tayassu tajacu*) (Yoakum et al. 1980).

Brush piles constructed for game animals will also be used by many nongame species. Skunks (*Mephitis* and *Spilogale* spp.), raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), river otters (*Lutra canadensis*), woodchucks (*Marmota monax*), ground squirrels (*Spermophilus* spp.), and woodrats (*Neotoma* spp.) are known to utilize them for denning and refuge. Webb and Guthery (1983) reported that a habitat management program for bobwhite, which included construction of brush piles, increased the diversity and abundance of nongame birds at the site; mockingbirds (*Mimus polyglottos*) were especially attracted to brush structures. Use by white-crowned sparrows (*Zonotrichia leucophrys*) and Harris' sparrows (*Z. querula*) was reported by Graber (as cited in Yoakum et al. 1980). Mettler (1984) noted that numerous species of nongame birds were observed to use brush structures in eastern Oregon and Washington.

DESIGN AND CONSTRUCTION

Construction of brush piles is best accomplished during the dormant growth season. If possible, the work should accompany clearing or thinning operations to eliminate extra handling and travel costs (USACE 1977). Land management practices that provide suitable material include timber-stand management, brush control, pasture or cropland clearing, release cutting and pruning, fence repair, and clearing of fire lanes and openings (Burger 1973, Yoakum et al. 1980).

General information on the design and construction of brush piles is given below. Detailed plans and specifications are discussed under the heading Target Species.

Materials

Materials used for brush piles will generally depend on what is available in the vicinity of the site. Oaks (*Quercus* spp.), locust (*Robinia* spp.), and other rot-resistant trees make durable bases; other suitable materials include large stumps, cull logs, old fenceposts, stones, and tractor tires (Allen 1969, Giles 1978). Small trees and limbs of almost any species can be used as filler material. Cutting and stacking fir trees (*Abies* spp.) can provide good brush cover (Shomon et al. 1966), and discarded Christmas trees can supply

winter shelter for several seasons where natural cover is scarce (Burger 1973, Craven 1981, Mettler 1984). Honey mesquite (*Prosopis glandulosa*) has been commonly used for brush pile construction in the Southwest (Jackson 1969, Guthery 1980, Webb and Guthery 1982). Care should be taken not to use noxious trees and shrubs that could drop seeds at the site and become a potential control problem.

Basic Designs

Brush piles are usually mound or tepee shaped, with the largest material forming the base and layers of smaller limbs and branches added as filler. The base should consist of sturdy trunks or limbs at least 6 in. in diameter to allow adequate escape entrances at ground level. Artificial supports are recommended for weak-limbed brush and trees with acute limb angles between the main stem and branches. When available, large stumps provide adequate support and help prevent the stack from settling and rotting down too quickly.

Burger (1973) recommended forming the base by placing alternate layers of logs at right angles, with the logs approximately 4 to 6 in. apart in each layer (Fig. 1). The base may also be constructed by bringing the butt ends of several trees together so that the canopies form an outer circle; whole trees may be used if those available are small (USACE 1977, Steele 1984). Smaller trees and limbs are used to build up the center of the brush pile and to fill gaps in the outer canopies. Appropriate dimensions are discussed later for target species.

Christmas trees have been successfully used for constructing brush piles in the arid western states (Craven 1981, Mettler 1984) (Fig. 2). All tinsel must be removed before using the trees for brush piles. An A-frame built from scrap lumber, poles, or branches can serve as a support structure for the trees; the lumber is wired and nailed together to form a support approximately 8 ft wide and 8 to 20 ft high. Cross braces can be attached at various levels along the frame. Trees are then piled against the structure on both sides and in layers within the frame. This results in a diversity of use because nesting and roosting sites are provided at both ground level and several elevations above ground, and there is greater freedom of movement within the pile for small birds (Mettler 1984).

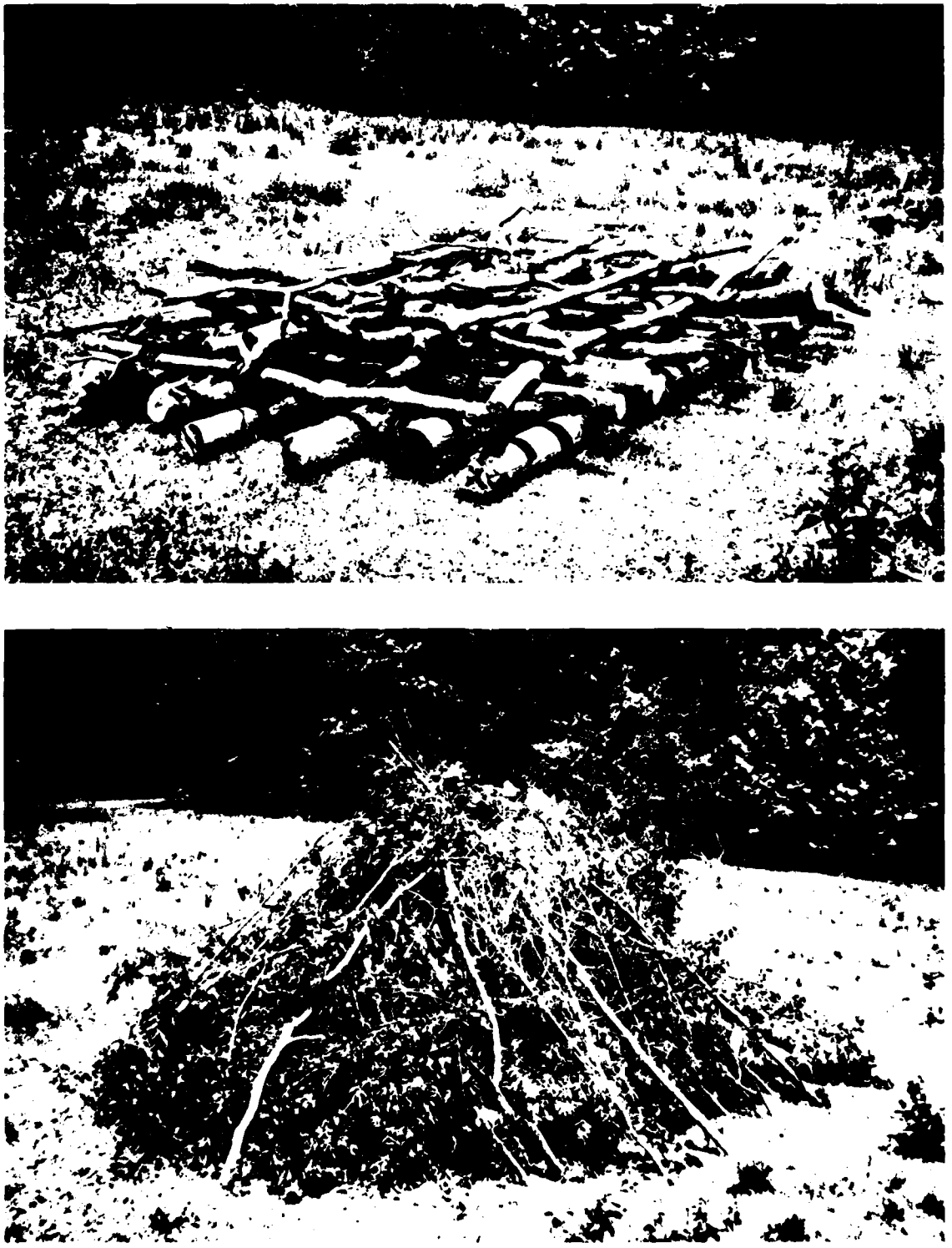

Figure 1. Brush pile construction, showing (top) alternating layers of logs and large limbs, and (bottom) completed structure with filler material added

Figure 2. Brush pile constructed of Christmas trees stacked along a fencerow at Mill Creek Project, Walla Walla, Washington

Longevity

The functional life of a brush pile will depend upon the durability of materials, quality of construction, rate of decomposition, and amount of vandalism. Chapman et al. (1982) stated that most brush piles would last 3 to 5 years, with primary use for only 1 to 2 years. However, Burger (1973) and Giles (1978) reported that well-built structures could last for 10 or more years. Brush piles built over oak bases have an average useful life of at least 4 years (USACE 1977). Brush piles built entirely of mesquite last for about 3 years, but mesquite stacked on top of metal supports may last from 7 to 10 years (Guthery 1980, Webb and Guthery 1982). Because of faster decay rates, brush structures in the warm, humid Southeast will generally not last as long as those installed in more arid regions.

Plantings

Brush piles provide a medium for seed germination and plant growth. If soil conditions and sunlight are favorable, grasses, vines, and other vegetation will grow up through the brush and add diversity and permanence to

the pile (Burger 1973, Warrick 1976). This process can be aided by digging up a few sprouts of vines such as Virginia creeper (*Parthenocissus quinquefolia*), wild grape (*Vitis* spp.), blackberry (*Rubus* spp.), bittersweet (*Celastrus scandens*), or other suitable species and planting them along the edge of the brush. The vines will continue to grow as the piles rot down, and within several years a "living brush pile" should replace the original structure (Shomon et al. 1966, Allen 1969).

PLACEMENT

Suitable locations for brush piles include open fields and rangeland, fence corners, field edges and shoulders, woodland borders, clearings, and other sites adjoining feeding and nesting cover (Madson 1959, Allen 1969, Burger 1973, USACE 1977). Although brush piles are most beneficial where natural cover is lacking (Allen 1969), they are also well used in areas newly planted to tree and shrub cover (Burger 1973). Tree plots generally require approximately 4 years to develop functional cover and can be improved for wildlife by the establishment of interim brush structures (USACE 1977).

Installing brush piles adjacent to food strips will make the plots more attractive and available to both game and nongame species. Brush piles should be located at both ends of an elongated food strip where the surrounding area is lacking in natural cover. The optimum distance between brush piles, or between existing cover and brush piles, is from 200 to 300 ft but will vary according to site characteristics and target species (USACE 1977, Martin and Steele 1984). Brush piles may also be placed close together in a series to provide travel lanes between permanent food and cover (Burger 1973). Details on spacing are covered later under the appropriate target species.

Waterway projects (e.g., flood control channels and open-river waterways) may also offer opportunities for brush pile construction. Brushy material is often available from streambank clearing and snagging operations and can be positioned along eroding banks and anchored in place to create a brush pile revetment (Shields and Nunnally 1984). However, sediment will often be rapidly deposited around the base of the brush pile, thus eliminating essential escape entrances at ground level. For levee projects, brush structures are recommended landward of rooted vegetation in the foreshore area or on the landside of levees where they will be protected from high-velocity flows

during flood periods. They are best located far enough from the toe of the levee so as not to interfere with inspection or attract burrowing animals to the levee banks (Hynson et al. 1985).

Construction of brush piles should also be considered for habitat development on dredged material disposal sites. They can be especially beneficial on upland sites being revegetated to grasses where woody cover and movement corridors are lacking. Brush structures may also be appropriate near sub-impoundments, stock ponds, potholes, guzzlers, and other watering places in open terrain (Martin and Steele 1984). Brush piles can help prevent erosion as well as provide wildlife cover at gully sites, but they should not be placed in the middle of an eroding wash (Allen 1969). Instead, they should be located along the head of a gully where they can help retard runoff and keep water out of the cut. Brush structures are not recommended along well-used roadsides where they could become a traffic hazard and increase the incidence of road-killed animals (Allen 1969).

MAINTENANCE

Brush piles should be inspected periodically and refurbished with new limbs and branches as older material rots down and as limbs become dislodged. Brush piles in the Southeast tend to settle rapidly and may need new material added several times during the spring and summer. Insect damage to mesquite may necessitate annual refurbishing. Chapman et al. (1982) recommended that 1/3 to 1/4 of the brush piles in an area be replaced annually where they are a major part of a habitat management program. However, this is generally not necessary in the Central Plains or arid regions. Structures that have lost their functional value may be removed by burning.

LABOR AND EQUIPMENT

Personnel requirements and costs will depend on the number and size of brush piles to be installed and travel distances to and from the management sites. A major program will generally require a large truck, tractor, log-chains, axes, saws, and 2 to 3 laborers. Several trees can be chained together and dragged by a tractor from the clearing area to the management site; tractors can also be used to emplace bases too large to be hand-rolled into position. Two workers with a tractor can build a brush pile 7 ft tall by

25 ft in diameter in 6 man-hours (USACE 1977); without a tractor, 12 to 15 man-hours would be required.

TARGET SPECIES

The design and placement of brush piles for management of bobwhite and cottontails are emphasized in this section. General information is provided for other game species known to use brush structures.

Bobwhite Quail

Top quality covey ranges for bobwhite are compact units of interspersed food and cover. Therefore, construction of brush piles should be part of a broader management program to include such practices as half-cutting, disking, and establishment of food and cover plants (Jackson et al. 1966, Jackson 1969, Webb and Guthery 1982, Steele 1984). Brush piles can be used to extend the winter range of quail, but the most feasible use is to improve a marginal site by supplying hawk-proof escape coverts and completing the travel lanes that unify food and cover. A vital role that brush fulfills is to provide secure sites for resting between morning and evening feeding periods; these loafing sites are generally referred to as quail "headquarters" areas. Robinson (1957) found that the number of coveys in an area was dependent on the number of headquarters areas dense enough to provide adequate protection during periods of intense heat and sunlight.

Design specifications. Brush piles constructed for quail should be generally mound or tepee shaped and circular at the base, and the canopy must be dense enough to repel aerial predators such as Cooper's hawks (*Accipiter cooperii*). Brush clippings should cover the base and touch the ground, and approximately 6 in. of clearance should be allowed at several points along the base to admit quail (Lay 1965, USACE 1977, Martin and Steele 1984).

When using woody material, the base must be constructed of sturdy supports such as oak logs. Post oak (*Quercus stellata*) and blackjack oak (*Q. marilandica*) trees 12 to 16 ft tall (dbh 4 to 8 in.) were used successfully on quail range in Oklahoma (Steele 1984). A sturdy foundation may be formed by bringing the butt ends of 4 trees together (as described under the heading Basic Designs). Large stumps, stones, and artificial materials may also be used as bases. Metal grills (8 × 8 ft) supported by cinder blocks

Figure 3. Quail brush pile constructed by stacking mesquite on metal grill supported by building blocks (*courtesy of Fred S.* Guthery, Texas A&I University)

in each corner (Fig. 3) were used successfully on mesquite range in northwest Texas (Guthery 1980, Webb and Guthery 1982).

The size of brush piles should be selected to meet specific functional needs, such as headquarters areas or emergency cover in feeding areas. A headquarters covert should normally be from 6 to 7 ft in height and at least 15 ft in basal diameter. Brush piles 24 to 36 ft in diameter were found to provide the best headquarters coverts in the Oklahoma plains (Steele 1984). Smaller brush structures should also be installed on quail range to provide escape cover and can serve as emergency cover while tree and shrub plantings are being established. Brush piles designed for escape cover should be from 4 to 5 ft tall and approximately 10 to 12 ft in diameter, but smaller structures may be provided where woody material is sparse.

Placement. Woody cover requirements of quail are affected by a number of variables that must be determined on a site-by-site basis. Birds in areas with frequent disturbances, flat topography, low food supplies, and sparse

herbaceous vegetation require more woody cover than those occurring where habitat conditions are more favorable. Although woody cover is essential for good quail range, the amount required in relation to open land is comparatively low; too much brush can affect nest site availability because the quantity of important grasses and other herbaceous species will be reduced. Therefore, a major objective of brush development is to provide the minimum amount needed to support a healthy quail population (Guthery 1980).

Cover units should be spaced to complement existing coverts or to extend the area to new food resources. Quail coverts spaced no more than 300 ft apart are generally within a bird's physical ability to outdistance a predator, but Yoakum et al. (1980) recommended that brush piles built for quail in the West be within 200 ft of other escape cover. Lehmann and Ward (1941) found that the distribution of woody cover in southern Texas was ideal when clumps were available from 300 to 600 ft apart, and Guthery (1980) reported that bobwhite in northwest Texas generally ventured no farther than 600 ft from brush when herbaceous vegetation provided good screening cover.

Depending on existing features and the size, shape, and topography of a management area, brush piles may be placed in a hexagonal pattern or in a meandering line near adjacent cover. Guthery (1980) recommended a hexagonal design for covey headquarters on mesquite rangelands. Such a pattern could consist of a large headquarters structure surrounded by smaller escape coverts. A series of large and small brush piles can also be offset along a line parallel to and about 200 ft from existing rows of trees or brush; this arrangement will give quail a choice of 3 to 4 directions to escape from predators. Steele (1984) described a quail management project at Canton Lake in northwest Oklahoma, where 8 large brush piles (7 ft tall × 25 ft in diameter) were stacked in a meandering line along a low, broad ridge over 900 ft long (Fig. 4). The ridge, referred to as "Brush Pile Hill," served as a headquarters area and was managed as part of a larger unit that included food and cover plantings, half-cuts, and smaller (12-ft-diam) brush piles.

Cottontails

Brush piles are often emphasized as one of the most effective management techniques for improving cottontail habitat. When sturdily constructed and properly interspersed with other habitat components, they generally result in a rapid increase in rabbit populations (Madson 1962). Brush structures are

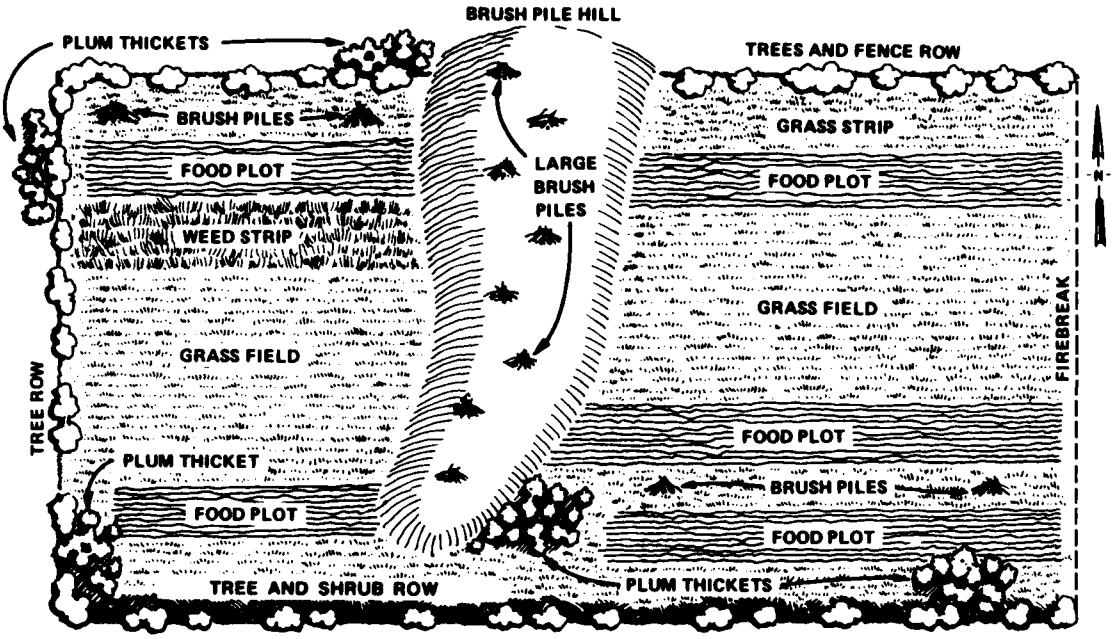

Figure 4. Northern 40 acres of the Canton Lake, Oklahoma, quail management area, showing Brush Pile Hill and other habitat components (drawing not to scale)

especially important as winter cover when sufficient food items are available (Haugen 1942). Linduska (1947) found that brush piles provided good insulation against temperature extremes and were used by rabbits even in subzero weather.

Design specifications. Brush structures for rabbits may be either mound or tepee shaped or built in a long continuous row. Yoakum et al. (1980) reported that longer brush piles were preferred, but Madson (1959, 1962) found that several midsized heaps were far better than one very large structure. The design chosen will depend on physical characteristics of the management area, available materials, and other habitat features present at the site. General procedures for construction should follow those previously discussed under Basic Designs.

The height of the brush pile should be from 4 to 7 ft; recommended widths (or basal diameter, if circular) usually range from 10 to 20 ft (Madson 1962, Allen 1969, Burger 1973, Yoakum et al. 1980, Chapman et al. 1982), but there is considerable variation in the literature as to preferred dimensions. Shomon et al. (1966) suggested that brush piles for rabbits be from 25 to 30 ft in length, and in certain cases they have been built as long as 1/4 mile. The major objective is to build brush piles dense and large enough

to provide adequate shelter from the weather and predators; if a dog can burrow through them or a person can kick them over, they are too small (Shomon et al. 1966, Allen 1969).

Burger (1973) described a more permanent structure for rabbits that may be built where a source of flat rocks is available. The rocks should be piled as though building a small igloo, leaving a 4- to 6-in.-wide tunnel system at ground level with at least 2 or 3 exits; the structure is then topped with brush. Giles (1978) depicted a similar design using alternate layers of stones and logs, and Shomon et al. (1966) described a structure consisting of large flat rocks, sheet iron, or roofing above a base layer of rocks. Constructing brush piles over sections of 6-in. pipe or drain tile is also recommended for cottontails (Shomon et al. 1966, Burger 1973, Giles 1978). Providing several tiles positioned at angles to each other will help discourage hunters from using sticks to dislodge rabbits from the shelter (Shomon et al. 1966). Care should be taken to prevent clogging at the ends of the pipes (Giles 1978).

An added attraction for cottontails is to place clippings of palatable vegetation near the base of the brush pile or within reach along the sides. Suitable plants include sumac (*Rhus* spp.), apple (*Malus* spp.), basswood (*Tilia* spp.), and maple (*Acer* spp.) (Burger 1973). Such clippings will often be available as a by-product of pruning and thinning operations.

Placement. Suitable brush pile locations for rabbits include woodland borders and openings, weedy fencerows, pasture and field edges, margins of streams and marshes, and other sites where forbs and grasses already provide food and limited cover (Dalke 1942, Madson 1959, Shomon et al. 1966, Chapman et al. 1982). Yoakum et al. (1980) recommended that brush piles be placed in the upper portions of broad arroyos or low-profile ravines in arid regions. Madson (1962) reported that brush structures were suitable in valleys and other sheltered areas; however, they should not be placed in low areas subject to flooding. Linduska (1947) found that in Michigan brush piles were more intensively used in open upland habitats than in swales and woods. Locating brush piles adjacent to food plots (USACE 1977) and newly planted fruit trees (Giles 1978) will increase their attractiveness to rabbits.

Brush piles constructed for rabbit management should be no farther than 300 ft from other brush piles or natural cover. Giles (1978) suggested placing approximately 1 brush pile/acre in management areas that included

other cover developments, but any number can be built to supplement existing cover. Graves (1970) found that 2 to 5/acre provided excellent escape, loafing, and nesting cover in California.

Other Species

Western quail. Scaled quail will readily use brush piles designed for bobwhite coverts in the Southwest (Guthery 1980). Artificial roosting cover may be provided for California and Gambel's quail by constructing raised cribs or platforms and filling them with brush (MacGregor 1950, McMillan 1959, USACE 1979); this technique is described in detail in Section 5.1.5 of this manual. Yoakum et al. (1980) recommended that brush structures for western quail be within 200 ft of adjacent cover and no more than 1/4 mile from water.

Pheasant and turkey. Brush or trees piled loosely in field corners or along fencerows can be useful in extending pheasant habitat. Brush piles constructed for pheasant are most appropriate where the birds have been introduced into open plains deficient in travel lanes, secure nesting cover, and overwinter cover, such as that described by Guthery et al. (1980) in the Texas Panhandle. Slash remaining after a timber harvest provides material for improving turkey habitat and may be beneficial as nesting cover. Brush piles constructed for turkeys should be situated at the bases of trees or around logs adjacent to openings and should be within 1/2 mile of water (Yoakum et al. 1980).

Waterfowl. Warrick (1976) described a technique using brush piles to provide nest sites for dabbling ducks in areas lacking natural cover. Recommended sites were islands surrounded by water, sparsely vegetated shorelines, and newly constructed wetlands; islands offer the greatest potential for success because they are relatively free of mammalian predators. Ideally, the structures should be located 1 to 3 ft from the water's edge. Nest construction consists of the following steps: (1) dig a bowl-shaped depression in the soil approximately 6 in. deep and 12 in. wide; (2) place 18- to 24-in.-long twigs in a network to provide a supportive canopy over the depression; (3) push the twigs approximately 8 in. deep into the soil at a 60-deg angle; (4) leave a 6- × 6-in. opening free of obstructions at ground level; (5) line the inside with native grasses; (6) weave more twigs in and around the canopy; and (7) place a layer of dense brush over the structure to provide additional concealment and protection. Limbs should be pushed into the soil or weighted

down on one end. The best time for construction is in early spring before the arrival of migratory ducks.

Javelina. Javelina range may be extended by constructing a specialized brush pile that can be situated against a bank or cliff (Yoakum et al. 1980). The structure consists of a wooden platform approximately 3 ft high and 6 × 6 ft wide supported by rocks or treated poles; brush is placed on top and along 2 sides. These structures should be located near food in an area protected from wind (Yoakum et al. 1980). Brush piles could also be designed to serve as travel corridors where brushland tracts are broken by extensive acreages of pasture or cropland.

CAUTIONS AND LIMITATIONS

Brush piles will not provide adequate functional cover if improperly located and built by merely stacking limbs in a loose haphazard heap (Burger 1973). The structures should be incorporated into a well-planned management unit and spaced appropriate distances from adjacent food and cover. They must be tight enough to impede predators, and escape entrances must be available at the base. The structures settle over time and will not be used if there is no space at ground level for free movement.

Care should be taken not to create barriers when constructing elongated brush piles. Brush may be placed at the head of a wash to help retard erosion but should not be located in the middle of a gully. The following precautions are necessary with regard to Civil Works projects: (1) brush structures could wash out and become hazardous debris if located in flood-prone areas; (2) if placed too close to the toe of a levee, the piles could attract undesirable burrowing mammals, interfere with inspection, or wash into the levee during a flood; and (3) they are generally not suitable near recreational sites and other heavily used project areas (Hynson et al. 1985). Brush structures should not be located where they could become a fire hazard.

Where brush piles are located in areas open to hunting, an effort should be made to inform hunters that the structures are part of a management program and must not be damaged. Appropriate signs explaining the value of brush piles could be located at major hunter access points, and information on wildlife management practices should be included in project brochures and hunting guides. Safety is a major concern when building and inspecting brush piles. Proper clothing, including gloves, work boots, and snake leggings should be

worn when working around the structures because they are a frequent hiding place for rattlesnakes.

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