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Light Disking to Enhance Early Successional Wildlife Habitat in Grasslands and Old Fields:

Wildlife Benefits and Erosion Potential



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Introduction

In the Midwest and Southeast, annual plant communities provide essential resources for bobwhite and other early successional species. Annual plant communities are characterized by grasses, forbs, and legumes that occur following some form of soil disturbance such as agriculture, timber harvest, or disking, and live a single growing season. Plant species characteristic of annual communities include ragweed, partridge pea, lespedezas, beggar tick, Illinois bundle flower, wooly croton, foxtail, and panic grasses (fig. 1).

Annual plants reproduce by prolific seed production, providing granivorous (seed eating) birds and mammals with abundant food resources. Additionally, this plant community supports an abundant and diverse insect community. The insects associated with annual plant communities provide critical nutrients, including protein, energy, and essential amino acids, for growing nestlings and chicks. Annual plant communities are typically open at ground level, with abundant bare ground and little litter accumulation. This combination of invertebrates, seeds, bare ground, and herbaceous canopy creates optimal bobwhite brood rearing habitat, simultaneously providing food and cover (fig. 2).

Figure 1 Annual plant community



Figure 2 Optimal bobwhite brood rearing habitat



Annual plant communities are short-lived, lasting only 1 to 2 growing seasons. In the absence of further disturbance, the plant community composition changes over several years through normal successional processes. The annual plants are replaced by perennial forbs, grasses, and eventually, woody plants (fig. 3). Changes in vegetation composition are accompanied by changes in vegetation structure. As a plant community ages, bare ground declines, litter accumulates, and vegetation density increases. The rate of successional change is a function of site fertility, rainfall, local hydrology, temperature, and length of the growing season. Planned disturbance is required to maintain this ephemeral community in a managed landscape.

Land managers targeting early successional wildlife species implement disturbance regimes to create and maintain these essential early successional habitats. Disturbance not only influences the plant communities' composition and invertebrate resources, but also the structural characteristics which may influence the accessibility of food resources to ground foraging birds.

Disking

Rotational (strip) disking (fig. 4) is an efficient and cost-effective vegetation management practice commonly used to create early successional plant communities for bobwhite and other early successional wildlife species. Disking enhances habitat quality for bobwhite chicks because it inhibits woody growth, promotes favored seed producing plants, reduces plant residue, increases bare ground, and increases insect abundance.

When to disk

Disking can enhance habitat quality in dense, monotypic stands of broomsedge (fig. 5), abandoned pastures, Conservation Reserve Program fields, old fields

succeeding to brush, and dense cool- or warm-season grass plantings.

Implementation of this management technique is appropriate within areas established to grass for at least 3 years. Sites that have not been disturbed for 2 to 3 years are good candidates for disking. Disking is very effective in broomsedge communities and can enhance habitat quality for several years.

Benefits of light disking will be more modest and short-lived (1 year) in established stands of fescue (fig. 6). Disking should not be used on bermudagrass sod because the disking stimulates growth and spread of the bermudagrass. Disking will be most beneficial on sites dominated by fescue and bermudagrass, after the exotic forage grasses are eradicated with herbicidal

Figure 3 Perennial forbs, grasses, and eventually, woody plants replace annuals



Figure 5 Dense monotypic stand of broomsedge



Figure 4 Rotational strip disking



Figure 6 Stand of fescue



treatments. Disking should not be used on sites where sensitive, remnant native ground cover exists (wiregrass, native tallgrass prairie). However, disking may be appropriate in dense, native warm season grass plantings.

How to disk

Frequency—To maintain annual plant communities, fields should be disked on a 1 to 3 year rotation, depending on rate of succession, specific plant community, and management objectives (fig. 7). In pine/grassland systems where small fields provide the only annual plant communities and primary brood habitat, annual disking may be desirable. More often, disking will be conducted on a 2- to 3-year rotation, with half to 1/3 of each field being disked each year in a strip pattern. Strip disking creates a mosaic of 1-, 2-, and 3-year old plant communities. Strip disking will maintain nesting cover and produce adjacent brood habitat within each field.

Seasonal timing of disking—Disking can be done from late fall through early spring. Fall disking should not be initiated until after the end of the nesting season for resident birds (October). Spring disking should be completed prior to the beginning of the reproduction season of most wildlife species (late March). The seasonal timing of disking influences the vegetation structure and composition. Fall disking tends to promote hard seeded forbs and legumes (ragweed, partridge pea, lespedeza), whereas spring disking promotes annual grasses (foxtail, millets). Fall disking may be more effective in stimulating important food plants for bobwhite. On sites with an agricultural history, spring disking may promote agricultural pest species such as sickle-pod, johnsongrass, and rattlebox. For the best diversity of plants, timing of disking can be varied with some disking being conducted during each season.

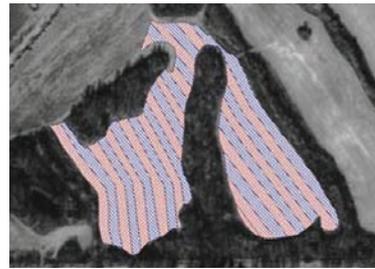
Figure 7 Disk rotation



2-year rotation example

Divide each field into adjacent plots, with each plot containing two strips of land 30 to 50 feet width, resulting in each plot being 60 to 100 feet wide (fig 8). In fall or spring of the first year, within each plot, disk the first strip of land, and leave the second strip undisked. In fall or spring of the second year, within each plot, disk the second strip, and protect the first strip disked the previous year. In fall or spring of the third year, within each plot, disk the first strip disked during year 1, protecting the strip disked in year 2. Continue this rotation treatment, disking strips every other year.

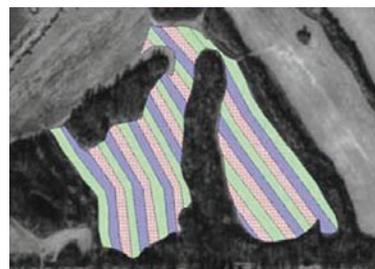
Figure 8 2-year rotation



3-year rotation example

Divide each field into adjacent plots, with each plot containing three strips of land 30 to 50 feet in width, resulting in each plot being 90 to 150 feet wide (fig. 9). In fall or spring of the first year, within each plot, disk the first strip of land and leave the second and third strip undisked. In fall or spring of the second year, within each plot, disk the second strip and protect the first (disked during previous year) and third strip. In fall or spring of the third year, within each plot, disk the third strip and protect the first (disked during year 1) and second (disked during year 2) strips. In the fall or spring of the fourth year, within each plot, disk the first strip (disked in year 1) and protect the second (disked during year 2) and third (disked during year 3) strips. Continue this rotation treatment, disking strips every third year.

Figure 9 3-year rotation



Disking intensity—Disking intensity can be altered by adjusting the depth of the disk and/or the number of passes. Creation of an annual plant community does not require a seedbed quality site preparation. Light disking (one to two passes 3 to 5” deep) can effectively stimulate germination of an annual plant community. In general, the more intensively the site is disked, the less residual perennial grass and greater annual plant component. Sites with dense stands of perennial grass or sod-forming grasses like fescue will require greater disking intensity. Sites dominated by exotic forage grasses (fescue, bermudagrass, bahiagrass) may require herbicidal renovation prior to implementation of a disking regime.

Highly erodible land—Strip disking on highly erodible lands requires special precautions. Research in Mississippi and Missouri has demonstrated, that strip disking, when implemented along the contour, created minimal erosion (0.01 to 0.17 ton/acre) at the field level, with observed erosion rates well below soil specific T-levels. Specific guidelines for strip-disking on HEL or CRP must be formulated by NRCS at the state level. In Mississippi, the NRCS developed the following specific guidelines for strip disking on HEL.

- Strips shall be disked light enough to provide for a minimum of 30 percent residue on the soil surface after disking operations are complete.
- Disking should be done on the least erosive parts of fields and not in places where gully formation is a problem. In addition, a disked strip must be no wider than 30 feet.

- Strips shall be disked along field contours as near as practical.
- Strips may be disked from late October through late March. Strips disked in late fall may be seeded to a winter cover crop suited for wildlife.
- Light disking should be performed on a 2- to 3- year cycle. Rotate and/or alternate the location of the lightly disked strips each year. Continue this rotation, disking strips every second to third year. When the disked area is rotated, the old area should have sufficient permanent cover to provide wildlife habitat and soil loss protection.
- Disking must follow technical specifications in table 1.

Combinations—Strip disking can be used in combination with prescribed fire to create an even greater diversity of desirable plants. Disked strips can be used as fire breaks. Within a given year, half of the undisked areas between strips can be burned to create a mosaic of annual and perennial, burned and unburned plant communities (figs. 10 through 12). Fertilizer (0-20-20) may be applied to disked areas to improve production of legumes. Legumes or other wildlife food plants can be seeded on disked areas to provide early ground cover and additional food resources.

Table 1 Requirements for light strip disking on highly erodible fields in Mississippi

E1 range	Amt of field to be disked percent	Maximum width of disked strips feet	Minimum width between disked strips feet
8–20	33.3	30	60
20–25	25.0	30	90
25–28	20.0	30	120
28–30	17.0	30	150
30 +	14.0	30	180

Figure 10 Prescribed fire



Figure 11 Partridge pea response to disturbance



Figure 12 New growth after disking



Figure 13 Native warm-season grass planting during growing season



Technical aspects

Effects of disking on soil erosion

Since 1985, an annual average of more than 14 million ha of highly erodible cropland has been taken out of production and enrolled in the Conservation Reserve Program (CRP), much of which was established in perennial grass practices. Plant communities on CRP grasslands are not static, but progress through predictable successional stages over the life of the contract. As plantings age, vegetation composition changes from a diverse annual community with an abundance of bare ground, to a perennial grass and forb community with dense litter accumulation and little bare ground. The rate of succession is a function of fertility, moisture, and length of growing season. The composition and structure of plant communities, including those on CRP fields, can be modified (intentionally or accidentally) by disturbance/management regimes (figs. 13 and 14). Throughout the Midwest and Southeast, habitat quality for early successional and grassland species may decline as CRP grasslands age, but premeditated disturbance regimes may enhance and maintain habitat quality for these species. However, concerns regarding perceived conflicts between wildlife habitat and soil erosion objectives persist among USDA FSA and NRCS personnel. Disturbance regimes will only be accepted if they can enhance wildlife habitat quality without compromising the erosion-controlling benefits of the established ground cover.

Figure 14 Native warm-season plantings during winter



To evaluate effects of rotational light disking, implemented in a strip fashion as prescribed under NRCS guidelines, controlled studies were established in Mississippi and Missouri as part of a cooperative study between Mississippi State University, Missouri Department of Conservation, Mississippi Department of Wildlife, Fisheries, and Parks, and the Missouri and Mississippi state offices of USDA NRCS. This study examined differences in predicted soil loss across treatments using Revised Universal Soil Loss Equation (RUSLE[®]) (copyright 1992, Soil and Water Conservation Society). The value of this work is to help NRCS develop new technologies and evaluate existing conservation standards used in Farm Bill programs and conservation planning.

The Missouri experiment evaluated effects of three treatments (figs. 15a and 15b): fall disk (one pass), fall disk (two passes), and control on vegetation structure, floristics, and soil erosion in five plots/treatment in each of four fescue and four orchard grass CRP fields (20 plots/treatment/planting).

Study sites were established in a split-plot arrangement of treatments in a randomized complete block design. Each study site (blocking factor, $n = 4$) contained 5 hillslope positions (whole plot effect) with three, 10 × 20 meter split-plots per hillslope position. Treatments were randomly assigned to split-plots within each hillslope position with each treatment in five split-plots in each of four study sites for a total of twenty split-plots/treatment/planting.

The Mississippi study evaluated effects of seven treatments (fall disk [one pass], fall disk [two passes],

winter burn, spring disk [one pass], spring disk [two passes], spring burn, and control [no manipulation]) on vegetation structure, floristics, and soil erosion in five plots/treatment on each of four fescue CRP fields (20 plots/treatment). Again, study sites were established in a split-plot arrangement of treatments in a randomized complete block design. Each study site (blocking factor) contained five hillslope positions (whole plot effect) with seven 10 × 20 meter split-plots per hillslope position. Treatments were randomly assigned to split-plots within each hillslope position with each treatment in five split-plots in each of four study sites, for a total of twenty split-plots/treatment.

Evaluation of soil loss response variables

Soil loss is strongly influenced by canopy and ground cover intercepting rain fall. Ground and canopy cover was estimated for soil loss equations using a point intercept method along a 15.4 meter line (string) with 50 points located at 0.3 meter intervals. On each plot, the string was placed along two diagonals for a total evaluation of 100 points/plot. At each point, three forms of canopy, canopy height, plant basal area, and three types of ground cover (residue, live, other) were measured. Measurements were conducted monthly from treatment implementation through 1-year post-treatment.

RUSLE[®], a computer-based application used to predict soil loss from a variety of agricultural practices, was used to evaluate and predict soil loss associated with disking practices. RUSLE[®] uses crop and region specific databases to formulate soil loss predictions (SWCS 1993). The RUSLE[®] equation is:

Figure 15a Disking



Figure 15b Close-up of disking



$$A = RKLSCP$$

where :

- A = annual soil loss
- R = rainfall factor based on geographical locale
- K = soil type
- L = slope length
- S = slope degree
- C = canopy and ground cover management
- P = conservation practices

Rainfall factors (R) are based upon geographical location derived from a city climatic database available within the RUSLE[®] program. K factors are based on soil series and geographical locale, and are a measure of a particular soil series' potential to erode, given rainfall patterns characteristic of the location. The LS factor is based on length and steepness of slopes, and is a measure of the effect of slope length and steepness on soil loss. The P factor is affected by conservation practices such as contour plowing, terracing, drainage systems, and strip cropping. To account for this variability, a C factor is an average soil loss ratio weighted according to the distribution of R during the year (SWCS 1993). Factors R, K, L, and S did not vary among treatments in our experiments. The P factor varied between control and other treatments, but was similar for all manipulations within each experiment. The C factor was the only factor that varied among treatments within each experiment. A C factor database was formulated for each management technique based on canopy and ground cover data (table 1). From these databases, we derived a C factor for each management practice. The C factor represents effects of plants, soil cover, soil biomass, and soil disturbing activities on soil erosion. Calculated values of C are weighted averages of soil loss ratios (SLR's) that represent soil loss under the given conditions recorded from unit plots under clean-tilled continuous fallow management.

In addition to data collected, RUSLE[®] requires estimated residue at harvest, row spacing of crop, plant population, a surface residue decomposition coefficient, subsurface residue decomposition coefficient, root mass in top 4 inches, and residue at 30, 60, and 90 percent canopy cover for input into crop databases used in formulation of C factors. These parameters were estimated from fescue, brome, and plant databases currently available in RUSLE[®]. Residue at harvest was estimated as 3,000 lb/ac from brome and plants databases. Plant population was estimated from the brome database as 600,000 plants per acre. Residue decomposition rates were estimated from the plants da-

tabases because of the high plant component on these study sites. Residue at 30, 60, and 90 percent canopy cover was estimated from plants and brome databases as 640, 1,650, and 4,100 lb/ac, respectively. Root mass in the top 4 inches was estimated as 7,000 lb/ac from the fescue pasture database and was assumed constant throughout the time period. Root mass was not measured, so it was not possible to estimate change after manipulations. RUSLE[®] crop databases stipulate canopy cover at given intervals post-treatment; however, the program is mainly geared toward a row crop situation where ground cover is low. To address concerns that if canopy cover was included without the ground cover, full effect of ground cover in impediment of soil loss on the study sites would not be adequately addressed. Therefore, both ground cover and canopy fall height were used for each measurement period. RUSLE[®] requires that information be entered on 15-day intervals. Because cover was measured at monthly intervals, researchers interpolated between measured values to provide the required data. During each measurement period canopy height of plants was measured and converted to effective fall height (feet) by assuming effective height was 50 percent of the average canopy height (SWCS 1993). Using these methods, C factor crop databases were formulated for each practice and planting [Missouri: orchard grass fall disk (1 pass), fall disk (2 passes), and control; fescue fall disk (1 pass), fall disk (2 passes), and control, Mississippi: fescue fall disk (1 pass), fall disk (2 passes), spring disk (1 pass), spring disk (2 passes), winter fire, spring fire, and control].

After formulation of crop databases, C factors were derived for each practice by incorporating a schedule of management in an operations database in conjunction with the crop database. For disking treatments, the equipment type selected was a light tandem disk. The addition of residue (ground cover), as a result of the pre-treatment mowing of study sites, was accounted for by stipulating a harvest in the schedule of operations. Addition of residue (ground cover), as a result of plant senescence, was adjusted to detect its influence on soil loss. Following these methods, C factors were derived for each treatment in each planting type. After formulation of C factors for each treatment, RUSLE[®] was solved for each treatment and soil loss was predicted. Soil loss is reported at 2 scales, within strip (strip management scenario) and at the field level (scale of most concern to NRCS).

In the Missouri study, C factors for orchard grass fields ranged from 0.0002 for the control to 0.004 for the fall disk (2 passes). In fescue fields, C factors ranged from 0.0001 for the control to 0.003 for the fall disk (2

passes). A complete listing of database values for each treatment can be found in Greenfield (1997). Predicted soil loss for all treatments on both cover types were well below 1 ton/ac/year for both the treated strip and field scales (table 2). Soil-series-specific tolerable soil loss levels (T) for Leonard silty clay loam in Missouri was 3 tons/ac/year. Overall, soil loss at both the strip and field scale were well less than predictions for all cropping systems. In the Mississippi study, calculated C factors ranged from 0.0001 for the control to 0.012 for the fall disk, two-passes (table 2). A complete listing of database values for each treatment can be found in Greenfield (1997). Predicted soil loss for all treatments, were well below 1 ton/ac/year for both the treated strip and field scales (table 2). Soil-series specific tolerable soil loss levels (T) for Vaiden silty clay loam was 3-4 tons/ac/year. Overall, soil loss at both the strip and field scale were well less than predictions for all cropping systems. Results of these studies are reported in Greenfield et al. (2001, 2002, 2003).

these intensities has negligible effects on soil erosion. To enhance wildlife habitat value disking and burning intensity could likely be increased two to three times without accruing a soil loss greater than soil type specific T and without compromising soil erosion provisions, particularly when applied in a strip-fashion.

These studies demonstrate that enhancements in bobwhite brood-rearing habitat generally increased with increasing disking intensity (two-pass vs. one-pass). RUSLE[®] predictions demonstrates that disking at

Table 2 C-factors and soil loss (ton/ac/yr) predictions based on Revised Universal Soil Loss Equation (RUSLE[®]) for tall fescue and orchard grass CRP fields in Missouri and tall fescue fields in Mississippi managed for northern bobwhite. Predictions were made under assumption that treatments were applied in a strip-fashion on a 3-year rotation. Predicted soil loss reported for treated strip and entire field.

State	Planting	Treatment	C-factor	Soil loss (strip)	Soil loss (field)
MS	Fescue	Control	0.0001	0.0	0.00
		Fall disk-1	0.0100	0.42	0.1400
		Fall disk-2	0.0120	0.52	0.1733
		Sprg disk-1	0.0010	0.06	0.0200
		Sprg disk-2	0.0010	0.06	0.0200
		Wint burn	0.0003	0.01	0.0030
		Sprg burn	0.0002	0.01	0.0030
MO	Fescue	Control	0.0001	0.00	0.0000
		Fall disk-1	0.0020	0.03	0.0100
		Fall disk-2	0.0030	0.03	0.0100
	Orchard	Control	0.0002	0.00	0.0000
		Fall disk-1	0.0030	0.04	0.0133
		Fall disk 2	0.0040	0.06	0.0200

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