DEVELOPMENT AND MAINTENANCE OF DIKE COVER IN THE SOUTHEASTERN COASTAL PLAIN

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The possibilities for waterfowl management in southeastern impoundments are well known. On many of the national wildlife refuges catering to waterfowl we prescribe to the principle of intensive management on a portion of habitat improved by diking and subsequent water control. Many southeastern state game commissions are broadening their programs to participate in this phase of waterfowl management. The construction of dikes and structures is costly enough to make this the most expensive type of land management for wildlife in the southeast. The dikes are very susceptible to erosion, and a modicum of maintenance is necessary. An adequate vegetative cover will minimize wind and water erosion. Too often such cover has been developed improperly or too late to prevent costly soil loss.

Criteria for evaluating the merits of dike cover are more exacting than those for ordinary roadway embankments. In addition to the slope erosion from rain water that is common to both, dikes must be protected from wave erosion on the toe and from the terrific overflow force of storm water when dikes are "topped." To fulfill these requirements dike toe cover should be aquatic perennials that make upright growth in dense beds capable of maintaining their ecological niche on the dike. Dike slope cover should be aggressive, rhizome- and/or stolon-bearing perennials that will spread rapidly, form a dense sod, endure a wide range of soil and moisture conditions, and resist brush invasion. The ideal species would offer this protection without spreading into the impoundments, and without growing so tall as to hinder human movement and observation. Some grasses fulfill these requirements very well.

HABITAT DESCRIPTION

A decade's experience with this problem on our southeastern management areas can be summarized best by considering separately several habitats.

Stabilized Dune Type

This seaside type is typified by conditions at the adjacent Pea Island National Wildlife Refuge, North Carolina, and Cape Romain National Wildlife Refuge, South Carolina. Here, one is struck by the rapidity with which drifting sand builds up around stationary objects to form dunes often stabilized by pioneering grasses. These grasses are *Uniola paniculata* (sea oats), *Ammophila breviligulata* (American beachgrass), *Panicum amarum, Panicum amarulum,* and *Spartina patens* (salt-meadow cordgrass).

This natural "building" movement has been utilized by the placement of brush fences to form sand ridges, subsequently stabilized by methodical grass plantings. On Pea Island dikes constructed by dragline the planted grass clumps (even

before lateral spread was commenced) retard further wind drifting of the piled sand. It has been found that *Ammophila* and *Spartina patens* lend themselves best to planting. Refuge Manager Paul W. Sturm states that the past summer's planting, on one foot centers, cost $112.00 per acre. The cost can vary considerably, however, depending on availability of plants and size of crew.

During CCC days some dikes were planted to wax myrtle, black locust, and mimosa to emulate the stabilized dune woods. However, the resultant barren condition of the dike slopes under shade makes it appear less desirable than the heavy, close mat obtainable from *Ammophila.*

At Cape Romain, South Carolina, sand-clay dikes sprigged with *Spartina patens* made heavy sod. Coarse sand dikes so planted proved too dry on the upper slopes for a dense *Spartina* growth, with succession going to an undesirable open dune stand of *Uniola paniculata, Croton punctatus, Yucca* spp., and *Strophostyles helvola.* Recent experiments here with three strains of bahia grass seed *(Paspalum notatum)* show that the Pensacola bahia has been able to colonize under these extremely droughty conditions, and it may be able to accomplish what the cordgrass could not.

Brackish Marsh Type

This type may be associated with the dune complex, as at Pea Island, or only partially, as at Cape Romain and St. Marks. The subsoils brought up by dragline are principally clays or sand-clays, acid to strongly alkaline. Except for an occasional alkaligalled spot, these soils quickly become vegetated, particularly if desirable plants are introduced.

Spartina patens has done well, but is not too dense on hard or coarse sandy soils. A tall clump *Spartina (spartinae* type) at St. Marks appears too bunchy to give good slope protection. Two other tall grasses were introduced at St. Marks almost a decade ago from Department of Agriculture plantings at Brooksville, Florida. One of these was Cogan grass *(Imperata cylindrica),* a native of the Philippine Islands. It has done exceptionally well on dry dikes, making maximum cover, and of all grasses observed, this species has proven most resistant to herbaceous invasion. Given every opportunity, it has not yet spread to shallowly flooded fresh marsh. Probably it should not be introduced anywhere inland where it could spread to upland fields, as it would rival Johnson grass and Bermuda as a pest in cultivation.

The other introduction at St. Marks was torpedo grass *(Panicum repens).* Although making heavy root growth and cover, it does not do quite as well on dry dike crown as Cogan, but grows better under wet conditions. In fact, it resmebles the abundant *Panicum hemitomon* in its ability to spread in water several feet deep. This makes it undesirable for fluctuating water-level areas, and we are testing methods of herbicidal control on our plantings. Despite its value for cattle in wet land pasturage, it should be introduced only after careful consideration.

Low grasses employed at St. Marks are Bermuda *(Cynodon dactylon),* carpet grass *(Axonopus compressus)* and centipede grass *(Eremochloa ophiuroides).* Unlike the aforementioned tall grasses, short ones should be moved to be maintained in best condition. Bermuda grass has demonstrated its usual aggressiveness except on the driest dike crowns, where invasion by the miserable sand-bur grasses *(Cenchrus)* has occurred. The carpet grass on poor, moist soils has stood heavy

grazing well, and (because of its flatter stoloniferous structure) appears to maintain better soil coverage under heavy grazing than Bermuda.

Centipede grass is a species having more value for dike cover than most realize. The dense springy turf gives good soil protection, and the creeping stolons of the plant permit rapid extension over barren areas. It may not be the best for steep slopes. In the coastal plain it grows as far north as North Carolina.

St. Augustine grass *(Stenotaphrum secundatum)* has been observed to possess a special value at several maritime locations, because of its ability to persist on shaded woodland dikes.

Toe cover for the brackish marsh dikes is of two types. Salinities on the outside toe generally precludes the use of anything except needlerush *(Juncus roemerianus)* and cordgrass *(Spartina alterniflora* and *patens).* On the fresher impoundment side we have found that southern bulrush *(Scripus californicus)* most nearly fulfills the requirements of good toe cover. Its normal range extends at least as far north as Waccamaw River, South Carolina. Usually evergreen in the southern part of its range, its tall, rigid scapes (even if killed back by frost) are resilient enough to reduce wave action. The slow spread of the plant from rootstocks is objectionable; however, once established, it can persist in clear water as deep as six feet.

The softstem bulrush *(S. validus),* three-square *(S americanus)* and salt marsh bulrush *(S. robustus)* are widely distributed, and make good berm cover on protected dikes, but do not provide late winter protection under heavy wave action. Three-square often volunteers on wave-washed coastal dikes, and when introduced to inland impoundments needs some such site to persist. At Pea Island this species volunteered abundantly at the berm edge, but muskrats fed so avidly on the rootstocks that erosion was continuous. This was countered by planting strips of needlerush sod. Undisturbed by 'rats, needlerush is filling in the eroded spots and halting further damage.

Of the many other marsh plants that offer dike toe protection, only two cattails seem of value. The large coastal *Typha domingensis* offers better protection than the more widely distributed *T. latifolia.* A wide band of cattail is required to afford good winter protection. Cattails should be used only as a last resort and should be isolated by borrow pits since, by lateral spread, they can "take over" a marsh.

Fresh River Delta Type

A good example of this type is the Savannah Refuge, South Carolina, where the dominant marsh vegetation is giant cutgrass *(Zizaniopsis miliacea)* and maidencane *(Panicum hemitomon).* Dikes of the delta type are not as large as most of those on salt marsh, and dike soils are acid — of peat, sand, and clay. For dike toe cover in this habitat we have found it too expensive to plant bulrushes against the competition of these two grasses.

Giant cutgrass is better berm cover than the maidencane, but both persist under moderate flooding. Having little value as waterfowl food-plants and being vigorous perennials difficult to eradicate, they should be introduced where absent only after careful consideration.

In delta ponds alligator-weed *(Alternanthera)* and water primrose *(Jussiaea grandiflora)* quickly form protective floating mats along dike berms, but they are difficult to keep under control and introduction is not recommended.

For the dike slopes common Bermuda grass has proven excellent cover, although recent plantings of the relative new "coastal" variety indicate it may spread faster and make heavier cover on droughty soils. Introduced in 1949 on a sand dike "coastal" Bermuda quickly covered the crown even under cattle grazing. Some Savannah dikes, lacking Bermuda, have, upon release from brush cover, gone completely into maidencane, and this species appears to offer satisfactory protection against floods covering it once or twice a year. Vasey grass *(Paspalum urvillei)* is a common volunteering species, but of a clump type that offers poor winter cover. Mowing helps Bermuda compete with this and maidencane.

At Savannah the ideal dike cover now developing is a crown and upper slope of Bermuda (maintained by mowing and 2,4-D), a lower slope of maidencane, and a toe cover of giant cutgrass.

Inland Pond Type

Dams constructed across most inland streams have had the soil stabilized by Bermuda grass, and occasionally Johnson grass *(Sorghum halepense).* Toe cover that develops is usually broad-leaved cattail, softstem rush *(Juncus effusus),* wool-grass *(Scirpus eriophorum),* switch-cane *(Arundinaria tecta)* and plume-grass *(Erianthus* spp.). None of the latter makes as protective a cover as some of the species discussed earlier. A desirable dam toe species for inland ponds, used at Santee Refuge, South Carolina and Piedmont Refuge, Georgia, is square-stem spikerush *(Eleocharis quadrangulata).* It spreads rapidly from rootstocks even on clay subsoils, and is an excellent duck foodplant. It cannot stand too much wave action.

Reservoir Type

Dams within coastal plain reservoir systems exhibit the condition of an annual drawdown of five to 20 feet, which precludes a dense toe growth of perennial species. At Santee Refuge (Santee-Cooper Hydroelectric Project), with an average drawdown of seven or eight feet, the best volunteer toe cover has been willow *(Salix),* button bush *(Cephalanthus)* and maidencane. Considering their tolerance for drawdown and for wave action, maidencane and willow, if planted systematically in the drawdown zone, offer partial control of serious wave erosion at Santee.

A dam slope cover of Bermuda grass and lespedeza *(L. stipulacea)* has been employed principally at Santee. Experimental plantings of kudzu have been made by the South Carolina Public Service Authority on steep dikes at Santee-Cooper. It remains to be seen if kudzu can be used to best advantage on dikes, because of the tendency of the vine to blanket toe cover plants and its lack of dense winter mat. Its value lies in the ability to withstand brush invasion without mowing. Another close cover vine, also relatively resistant to invasion by brush is Japanese honeysuckle *(Lonicera japonica);* it is superior to kudzu in that it is often evergreen in winter as far north as Virginia. No doubt plants like *Lespedeza sericea* would also be of value in certain instances.

A summarization of this information show the relative values in descending order of these dike cover species.

Stabilized Dunes (Coastal sands-salt): *Ammophila, Spartina patens, Uniola paniculata, Panicum amarum.*

Brackish Marsh (sand to clay — brackish): *Spartina patens,* Bermuda centipede, carpet, St. Augustine, Cogan. If the Cogan grass could be properly isolated from uplands, it might be considered as first choice.

Fresh River Delta (peat, sand, clay — fresh): Bermuda, centipede, maidencane, giant cutgrass, possibly Cogan.

Inland Pond (firm upland soils): Bermuda, centipede, Johnson grass, maidencane.

Inland Reservoir (firm upland soils): Bermuda, maidencane, willow, Johnson grass, centipede.

ESTABLISHING DIKE COVER

The best method of securing dike toe cover is to introduce the rootstocks in yard square blocks, at close intervals. This can be done best on a moist soil before flooding. Or, the planting process can be speeded up by plowing several furrows along the future water line and planting the rootstocks at intervals.

A new dike should not have water held at full level against it until an adequate toe cover has developed, or the dike definitely will erode. Furthermore, there is no vegetative cover known that can replace protective booms, rip-rap and proper dike slope in combatting heavy wave action.

To secure slope cover, after proper leveling and harrowing of the soil, seeding is the quicker operation but sprigging is more certain. In addition, seeds of many grasses are not available and vegetative propogation is the only means. A topsoil dressing on the subsoil piled for the dike is a wise precedure, as it insures better plant growth. This is rarely possible on saline areas, but is on upland developments. At Santee Refuge it was found that barren clay subsoil dikes, when sprigged with Bermuda, exhibited grass survival only where pine bough mulching was applied; growth at mulched sites was luxuriant.

If dikes are completed in winter it is best to cover the slopes temporarily in a stand of oats or other grain. At Cape Romain one sand dike received adequate winter protection by seeding Italian rye grass.

MAINTENANCE OF PROPER COVER

The foregoing discussion has indicated that the best dike slope cover is of grass, preferably a spreading, matting perennial with a height of four to 30 inches. This permits good access to the dike for observation and maintenance. The plant succession is rapid on dikes, and herbs, shrubs and trees soon encroach to kill out the shorter sod species. To avoid this the same practices applying to care of lawns and pastures may be practiced.

Mowing

Low grasses should be mowed during the summer, but there is some evidence that the higher grasses (like cordgrass, maidencane, and Cogan grass) give more protection without mowing. The lesser herbaceous invasion in the latter can be discouraged by 2,4-D spraying. Permitting trees to mature on dikes will result in serious damage from subsequent storm "blow-downs."

The St. Marks dikes are mowed in June and September, and it is evident that they should be mowed once more between these dates. According to Manager Paul T. Kreager, in 1949 a total of 35 acres, along 10.5 miles of dike, was tractor-moved at a cost of $2.15 per acre per treatment. At Savannah Refuge the 1948 mowing costs approximated $2.80 per acre. Vegetative growth is so rank on Savannah's delta soils that four summer mowings are recommended.

Herbicidal Treatment

The use of 2,4-D sprays to eliminate herbaceous growth from grassy cover makes dike maintenance much more practical. This is particularly true when toe plantings are also of grass species, for airplane spraying can then be employed on extensive systems. Airplane use is not feasible where the toe plantings are of bulrushes or similar plants, and truck-spraying of the grassy slopes must be done carefully.

Herbicidal tests at Savannah and St. Marks show that dike slopes can be sprayed with 2,4-D and 2,4,5,-T preparations for $5.00 to $20.00 per acre, depending on the strength of the chemical employed. A minimum of two or three treatments is recommended when attacking established brush and briars. It has been found that blackberries *(Rubus),* which are common invaders of bare dike soil, can partially resist 2,4-D for years but will be knocked out by the addition of 2,4,5,-T applications. In every habitat a few herb or brush species will be resistant to these hormone sprays, and spot treatments with other herbicides is required.

Our present use of 2,4-D supplements mowing; in the future it could replace mowing on most grass dikes.

Other Treatments

At times, discing, burning and grazing have a definite place in dike cover management. While it is wise to avoid soil disturbance on dikes, occasionally dike crowns of clay become too hard for plant survival, and the only alternative is discing to rejuvenate cover. Frequent discing, however, to control herbaceous weeds is not only dangerous and destructive to dike elvations, but also disregards the fact that each soil scarification usually results in another crop of weeds. Under such conditions mowing and 2,4-D should be employed.

Burning of dike cover is another practice usually frowned upon, because of the danger to peat dikes or the potential effect of unexpected adverse weather. Some species, like maidencane and saltmeadow cordgrass, when unmowed for three to five years on rich soils, will accumulate such a mat of their own debris that plant vigor declines. Invasion by taller undersized herbs and shrubs follows. When such matting occurs careful spotburning, on a rotation basis, seems the best procedure.

Grazing of dikes has much merit, for it eliminates a major portion of the cover maintenance costs. Dikes with broad slopes are best suited for cattle; it has been observed at Savannah that cows easily break down steep sandy slopes. Grazing well sodded dikes, however, is justified so long as the cover is not grazed too low for good freshet protection. Sheep also may be used if grazing pressure is controlled. Goats appear to have most value in the initial reduction of brush on poorly managed dikes to release low species like Bermuda grass.

Fertilization of existing dike cover appears to have some merit, particularly on sandy soils, but our experience with this is too recent and too limited to discuss at this time.

Without attempting to summarize, we wish to emphasize that in a program of diking the development and maintenance of satisfactory cover should receive proper consideration. It has been our experience in the southeast that the amount spent in such work will be much less than the soil replacement costs incurred by excessive erosion on improperly protected dike soil.