MOIST-SOIL IMPOUNDMENTS FOR WETLAND WILDLIFE

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ABSTRACT

The term and concept of "moist-soil" plant production, introduced by Frank Bellrose in the 1940s, refers to plant species that grow on exposed mud flats after surface water retreats in spring or summer. The purpose of moist-soil management has been to increase wetland productivity and waterfowl use on migrating and wintering grounds. The current goal of wildlife managers utilizing moist-soil techniques is to maximize production of naturally occurring wetland vegetation in order to optimize use of wetland habitats by wildlife. Moist-soil management promotes the production of naturally occurring wetland vegetation by emulating and manipulating natural wetland functions (e.g., hydrology and successional stage).

In the United States, moist-soil management procedures have been most widely applied to waterfowl management in areas of migrational and wintering habitat. Although moist-soil management technology was initially developed and extensively tested in the upper Midwest and Mississippi Alluvial Valley, the practice has potential application in other areas. Moist-soil management is used to some extent throughout the Southeast, including portions of Georgia, and the Chesapeake Bay and North Carolina sounds region. Various levels of moist-soil management have also been applied in the western states, including the Southern High Plains of Texas.

INTRODUCTION

As wetland acreage continues to decline in the conterminous United States (Dahl 1990), intensive management of remaining habitat to meet the biological needs of wetland wildlife (especially waterfowl) has become increasingly important (Reid et al. 1989). Changes in policy emphasis, such as management of nongame wildlife species, natural habitats, and biodiversity also confront wildlife managers (Faaborg 1986, Fredrickson and Reid 1986, Sweeney and Henderson 1986). Budgetary constraints continue to increase, thus demanding that managers gain the greatest benefit for the least expenditure (Mangun 1986). Moist-soil management provides managers with a mechanism to meet these challenges. The term and concept of "moist-soil" plant production, introduced by Frank Bellrose in the 1940s, refers to plant species that grow on exposed mud flats after surface water retreats in spring or summer (Fredrickson and Taylor 1982). Bellrose observed that waterfowl often concentrated on these sites and consumed natural foods. The purpose of moist-soil management has been to increase wetland productivity and waterfowl use on migrating and wintering grounds (McEwan 1979, Fredrickson and Taylor 1982, Bolen et al. 1989, Kadlec and Smith 1989). The current goal of wildlife managers utilizing moist-soil techniques is to maximize production of naturally occurring...
wetland vegetation in order to optimize use of wetland habitats by wildlife. Moist-soil management promotes the production of naturally occurring wetland vegetation by emulating and manipulating natural wetland functions (e.g., hydrology and successional stage).

**Study Sites**

Managed moist-soil habitats are shallow-water areas impounded by levees, which contain water-control structures that enable flooding during fall and winter and dewatering during spring and summer. Flooding provides foraging habitat and cover for diverse communities of migrating and wintering waterfowl and other waterbirds (Fredrickson and Taylor 1982, Reid 1989, Reid et al. 1989, Reinecke et al. 1989). Drawdowns (dewatering to mud flat conditions) promote germination and growth of plants adapted to moist or shallowly flooded sites (Low and Bellrose 1944, Fredrickson and Taylor 1982). These plants produce rich food sources of aquatic invertebrates, seeds, tubers, and browse for waterfowl, shorebirds, other waterbirds, and some upland wildlife (Reid 1983, Reinecke et al. 1989, Krapu and Reinecke 1992). Although moist-soil management is most often applied to man-made impoundments (Fredrickson and Taylor 1982), natural wetlands with modified hydrology or degraded habitats can be enhanced, and value for wildlife can be increased by utilizing moist-soil management techniques (Reid et al. 1989). Sites too wet for consistent production of row crops or establishment of upland vegetation, yet too dry for the management of aquatic plants, are especially well-suited for development of moist-soil impoundments (Fredrickson and Taylor 1982). From 1968 to 1982, the concepts and techniques of moist-soil management were developed at Mingo National Wildlife Refuge in southeastern Missouri and published by Fredrickson and Taylor (1982). The information in this report has been drawn predominantly from their work, with the integration of additional findings since 1982.

**MATERIALS AND METHODS**

Wetland hydrology is usually controlled by constructed water delivery, control, and discharge systems. The successional stage of an area is manipulated by soil or vegetative disturbances or prolonged inundation. Vegetative composition and density of a moist-soil site are influenced by altering the timing and duration of drawdowns and stage of succession. To maximize habitat availability and utilization, depth and timing of flooding are manipulated according to the habitat requirements and migration or breeding phenology of wildlife species (Fredrickson and Taylor 1982). Through precise control of hydrology and manipulation of plant succession, wildlife managers can achieve desired plant communities and provide habitat requirements for a variety of wildlife species throughout their annual cycles.

Moist-soil management techniques provide a mechanism for enhancement of established wetlands, restoration of former wetlands, and creation of new wetland habitat. Enhancement of wetlands occurs in areas where hydrology and habitat have been
degraded and active management is required to renew wetland functions and improve value as wildlife habitat. Areas where wetlands previously existed are often unproductive for alternative land uses because of altered hydrology but are well-suited for restoration. Creating wetlands where none previously existed helps offset wetland habitat losses (Weller 1990).

Moist-soil management contributes to increasing and maintaining the biodiversity of an area. Moist-soil impoundments more closely resemble natural habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Taylor 1977, Rundle and Fredrickson 1981, Fredrickson and Taylor 1982, Fredrickson and Reid 1986).

RESULTS

Over 80 percent more species have been found to occur in moist-soil impoundments than in adjacent row crops and include invertebrates, herpetofauna (amphibians and reptiles), prairie and marsh passerines (small- to medium-sized perching birds), shorebirds, wading birds, waterfowl, gallinaceous birds (e.g., pheasants, wild turkeys), raptors, and mammals (Table 1) (Fredrickson and Taylor 1982). Fredrickson and Reid (1986) observed >150 avian species on moist-soil impoundments on the Ted Shanks Wildlife Area and Mingo National Wildlife Refuge, Missouri. Areas managed for upland wildlife attract ring-necked pheasants, wild turkeys, and northern bobwhites, which use the sites for brooding and feeding. White-tailed deer forage in moist-soil habitats and use areas of abundant, dense vegetation as nurseries when impoundments are dry. Rabbits and other small mammals find food, cover, and nesting sites during dry periods, and passerine birds are attracted to the new vegetative growth (Fredrickson and Taylor 1982). Furbearers such as raccoons, minks, and muskrats benefit from wetland conditions provided by moist-soil impoundments.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Birds and Mammals that have Responded to Moist-Soil Management in the Midwest</th>
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<tbody>
<tr>
<td>Pied-billed grebe</td>
<td>Golden eagle</td>
<td>Barred owl</td>
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<tr>
<td>American bittern</td>
<td>Northern harrier</td>
<td>Short-eared owl</td>
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<tr>
<td>Least bittern</td>
<td>Red-shouldered hawk</td>
<td>Common nighthawk</td>
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<td>Great blue heron</td>
<td>Red-tailed hawk</td>
<td>Chimney swift</td>
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<td>Great egret</td>
<td>Wild turkey</td>
<td>Belted kingfisher</td>
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<tr>
<td>Snowy egret</td>
<td>Northern bobwhite</td>
<td>Eastern kingbird</td>
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<tr>
<td>Little blue heron</td>
<td>Ring-necked pheasant</td>
<td>Tree swallow</td>
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<tr>
<td>Cattle egret</td>
<td>King rail</td>
<td>Bank swallow</td>
</tr>
<tr>
<td>Green-backed heron</td>
<td>Virginia rail</td>
<td>Barn swallow</td>
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<tr>
<td>Black-crowned night heron</td>
<td>Sora</td>
<td>American crow</td>
</tr>
<tr>
<td>Yellow-crowned night heron</td>
<td>Common moorhen</td>
<td>Sedge wren</td>
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<tr>
<td>Tundra swan</td>
<td>American coot</td>
<td>Marsh wren</td>
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<tr>
<td>Snow goose</td>
<td>Killdeer</td>
<td>Common yellowthroat</td>
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<tr>
<td>Canada goose</td>
<td>Greater yellowlegs</td>
<td>Indigo bunting</td>
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<tr>
<td>Wood duck</td>
<td>Lesser yellowlegs</td>
<td>Dickcissel</td>
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<tr>
<td>Green-winged teal</td>
<td>Solitary sandpiper</td>
<td>Song sparrow</td>
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<tr>
<td>Blue-winged teal</td>
<td>Willet</td>
<td>Swamp sparrow</td>
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Moist-soil management is a more cost-effective technique than row-cropping for providing food and cover for a variety of wildlife species (Fredrickson and Taylor 1982). Productive row-cropping requires annual seeding and periodic applications of fertilizer, herbicides, and pesticides. Moist-soil management has been productive without these applications (Fredrickson and Taylor 1982); however, seed bank establishment may be required at highly degraded sites (van der Valk and Pederson 1989), and herbicide application may be required in extreme cases. Return of energy (kilocalorie of food in the form of seeds) for each unit of energy input (kilocalorie of fuel, chemicals) for moist-soil plant production is regularly 7.17 kilocalories (Fredrickson and Taylor 1982). This does not include root, tuber, browse, herpetofauna, or invertebrate production, which would increase this figure. The national average energy return for corn is 2.82 kilocalories. Many wetland plant seeds also resist deterioration longer when flooded than do cereal grains (Neely 1956, Shearer et al. 1969). Neely (1956) showed that after 90 days of continuous inundation, soybeans and corn deteriorated 86 and 50 percent, respectively, while saltmarsh bulrush and smartweed deteriorated 1 and 21 percent, respectively. Many wetland plant seeds may persist for several months or even years while flooded (Fredrickson and Taylor 1982). Adverse weather conditions may reduce row crop production but have less effect on natural vegetation because of the diversity of plant species adapted to wetland conditions (Figure 1).

Agricultural row crops are important sources of high-energy foods for large concentrations of migrating and wintering waterfowl, mainly geese and mallards¹ (Gilmer et al. 1982, Reid et al. 1989, Reinecke et al. 1989, Ringelman 1990), but fail to provide adequately for many other waterfowl and wildlife species (Fredrickson and Taylor 1982, Heitmeyer 1985, Reid et al. 1989). The value of wetland plants for waterfowl foods is well-documented (Martin and Uhler 1951, Wright 1959, Wills 1971, Heitmeyer 1985, Delnicki and Reinecke 1986, Combs 1987, Fredrickson and Reid 1988a). Many wetland plants have higher overall nutritive qualities, contain more essential amino acids, and provide more cover than cereal grains (Burgess 1969, Fredrickson and Taylor 1982, Fredrickson and Reid 1988a, Heitmeyer and Fredrickson 1990, Laubhan 1992). Moist-soil impoundments also contain a variety of aquatic invertebrate species (Wiggins et al. 1980, Reid 1983) that are critical to waterfowl diets during periods of the annual cycle (Chura 1961; Swanson and Meyer 1973, 1977; Krapu 1974, 1979; Drobney and Fredrickson 1979; Eldridge 1990). Consequently, a more diverse waterfowl population is attracted to moist-soil impoundments than to flooded agricultural row crops (Taylor 1977).

¹ Common and scientific names of animal species are given in Appendix A.
Figure 1. Distribution of common moist-soil plants along a flooding gradient (Fredrickson and Taylor 1982)
DISCUSSION AND CONCLUSIONS

Moist-soil management procedures have been most widely applied to waterfowl management in areas of migrational and wintering habitat. Although general ecological and management principles of moist-soil habitats have broad applications, specific techniques (e.g., timing of draw-downs and flooding) and their results vary with changes in latitude because of various aspects of wetland plant distribution and seed germination traits. To be successful, wetland managers must duplicate hydrologic conditions of their regions, monitor plant and animal responses, and adjust management to conditions at their specific locations (Fredrickson and Taylor 1982).

Although moist-soil management technology was initially developed and extensively tested in the upper Midwest and Mississippi Alluvial Valley, the practice has potential application in other areas. Moist-soil management is used to some extent throughout the Southeast to stimulate growth of waterfowl food plants (Johnson and Montalbano 1989; Gordon et al. 1989), but little experimental work has been published on the effectiveness of moist-soil management in the south-central United States where the growing season is long, the climate is warmer, and southern plant assemblages are involved (Polasek et al. 1995). Preliminary studies indicate that moist-soil management can potentially improve waterfowl habitat in portions of Georgia (Larimer 1982; Jensen and Reynolds 1997). Partial drawdowns, drawdown timing, and soil disturbance were effective tools in creating diverse habitats in shallow impoundments in northern Texas (Polasek et al. 1995).

Several National Wildlife Refuges in the Chesapeake Bay and North Carolina sounds region have recently been using moist-soil management along with other traditional practices to improve waterfowl habitat (Hindman and Stotts 1989). In North Carolina, moist-soil impoundments are drawn down in April to encourage annual plants, such as barnyard grasses, panicums, American bulrush, squarestem spikerush, smartweeds, redroot flatsedge, and beggarticks. Impoundments are reflooded in October-November to make food resources available to migratory waterfowl. Various levels of moist-soil management have also been applied in the western States. Mushtet al. (1992) stated that wildlife managers in the Central Valley of California use various water-management techniques to maximize waterfowl use during winter and periods of migration. These managers follow the general pattern of flooding wet areas in late summer and early fall, keeping them flooded in winter, and draining them in spring to stimulate germination of moist-soil annuals. Swamp timothy is considered a target moist-soil species in many Central Valley wetlands; other important waterfowl food and cover plants in the Sacramento Valley are prickle grass, common barnyard grass, and sprangletop. Moist-soil management is being used to promote germination, growth, and seed production of mud flat annuals for wintering waterfowl in playa (desert basin) wetlands (Haukos and Smith 1993, 1996). The effects of moist-soil management were evaluated on soils of eight playa wetlands in the Southern High Plains of Texas. Wetland flooding occurred primarily from overland runoff of precipitation and secondarily from runoff of irrigation.
operations. Moist-soil management reduced soil resistance for germination and raised pH closer to neutrality but had no effect on soil moisture in the top 4 cm of soil. Nitrogen and phosphorus levels in playa soils were not affected during the two seasons of study. Haukos and Smith (1996) stated that moist-soil management is a sustainable and compatible practice for playa wetlands because it enhances naturally occurring events.

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LITERATURE CITED


