WATER LEVEL MANAGEMENT - DRAWDOWN

TECHNICAL GUIDANCE DOCUMENT

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INTRODUCTION

Fluctuations in water levels through occasional periods of drought or late summer conditions can be important natural events for wetlands and the functional benefits they provide. Low water levels can provide the opportunity for regeneration and increased diversity of wetland plant communities, aquatic organisms, and improved fish and wildlife habitat. In many locations, natural or seasonal drawdown of wetland water levels will occur and these regular water level disturbances can achieve adequate management results. In other cases, the artificial drawdown of the wetland will be required to achieve the desired management results.

Changes in water levels is a natural occurrence in many depressional wetlands

The intentional drawdown or manipulation of wetland water levels is a common, low cost management strategy used to simulate biological and chemical changes that occur in many natural wetlands. This management strategy, if done correctly, can greatly enhance wetland function. The use of drawdown as a management strategy will affect the type and diversity of plant and animal communities found in and around the wetland.

Drawdowns can influence a wide range of wildlife species, so it is important that experienced resource managers are involved in all phases of planning and management.

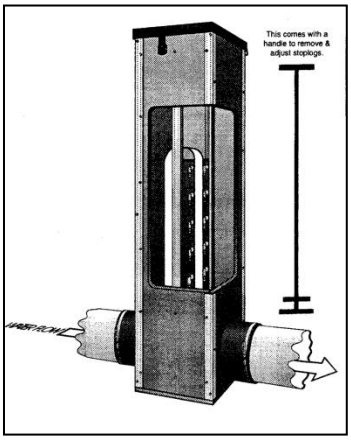
Wetland outlet that can be used to control water levels

APPLICATION

Most emergent wetland species will not germinate in standing water and often decrease in abundance after several years of consistently high wetland water levels. A drawdown entails gradually releasing water from a wetland, to expose seedbank and aerate the wetland soils allowing the germination of various aquatic plant species including early successional forbs and grasses that have high seed production. Removing water from the substrate also causes the oxidation of nutrients and makes them readily available to plants, resulting in vigorous growth. Decomposing vegetation also acts as a food source for invertebrates and other animals.

Drawdowns are completed for other reasons as well. These can include the control of other types of nuisance wetland species including fish and furbearers or possibly to facilitate the repair of an outlet structure or earthen embankment. Depending on the goals of the project, a drawdown may also be conducted to facilitate providing some degree of flood control for the watershed.

The intentional drawdown of a wetland will usually require that an outlet structure with some type of water control mechanism such stop logs, gates, or valves. Depending on the management goals, having the ability to precisely manage water levels may be important and should be considered in the design of the outlet structure. For example, a moist soil management strategy may require incremental water level adjustments as small as one-half inch. These types of requirements can affect the type and design of the outlet structure used. Additional discussion regarding the use and design of wetland outlet structures occurs in Section 4-4, Engineering Design and Construction, Outlet Structures.



Water control structure detail

In situations where a mechanical structure that provides drawdown capability does not exist, other options for drawdown will need to be considered. This includes the reliance on natural seasonal hydrologic changes or drought, however this can be unpredictable and may not suit an identified management need. Other, more extreme options for providing a controlled drawdown include, when practicable, pumping water from the wetland siphoning water, or the intentional breaching of an earthen embankment or ditch plug.

Frequency, Timing and Duration

Frequency

The frequency of drawdowns should be planned to mimic natural water level fluctuations and is largely dependent on watershed size, outlet capacity, and weather, as well as the shape and size of the basin itself. A prairie pothole in the upper reaches of a watershed, for example, typically has a small contributing watershed and no discernible outlet. Water levels are likely to vary seasonally with the deepest water occurring in spring followed by the lowest levels in late summer. Water levels going into winter are dependent on fall rains. Relatively mild year-long droughts may dry out both surface water and underlying soil moisture for the entire cycle.


Shallow lake with diverse aquatic vegetation

Conversely, a shallow lake low in the watershed will typically maintain surface water throughout the year. While seasonal changes in water levels still occur, the basin is not likely to go completely dry except under severe drought conditions. The water levels going into

winter are typically dependent on the shape of the basin in relation to the run out elevation of the outlet. Those lakes with adequate outlets and mid-sized watersheds (> 3:1; < 15:1) tend to have relatively stable water levels. The same lake with a much larger watershed or inadequate outlet will tend to be "flashy" with abrupt increases in water levels resulting from rain events. The key point concerning frequency is that water levels in natural wetland systems typically change seasonally as well as annually, or over multiple years. The frequency of these changes is a significant driver in the wildlife habitat value of these basins. For example, consistently low water levels going into winter limit fish populations. Very low levels, less than 2 feet, may limit amphipods as well.

Intensity

Under natural conditions, drawdowns range from a few inches to total elimination of surface water. As watershed ratios decrease, the intensity, or severity, of drawdowns increases. A great deal of attention has been focused on the impacts of a complete drawdown, that is, the total, or nearly total, elimination of surface water. Certainly complete drawdowns are important, particularly if the management objective is increased density and distribution of emergent aquatic plants. However, there are significant benefits from partial drawdowns as well.

Shallow water concentrates food resources. This potentially increases the foraging efficiency of water birds by reducing the energy required to capture food. Wading birds, dabbling ducks and shorebirds capture food most efficiently in water depths of less than one foot. Shallow depths also increase the amount of light reaching rooted submergent plants, increasing their density and vigor. Partial drawdowns may or may not result in the mudflats necessary for germination of emergent aquatic plants. As noted above, however, late season partial drawdowns can be very important for limiting undesirable fish by increasing winterkill.

Shorebirds attracted to mudflats in a Murray County wetland

For most drawdowns, wetland water levels should be dropped at a slow rate. The recommended removal rate will vary with each situation but a general goal of about one inch per day should be attempted. Slower drawdowns tend to improve diversity of plant production whereas more rapid drawdowns tend to decrease plant species diversity. Wetland water levels should be dropped enough to allow exposure of the wetland soils but not too much where the bottom soils dry out. Care must be taken to ensure that soils do not dry out too quickly as this can influence vegetative response as well as use continued by waterfowl and shorebirds.

If conditions become dry enough, disking of the wetland soils can be considered. Periodic disking will enhance annual plant production and wildlife use. Disking also reduces the dense summer vegetation, creates bare soil and exposes insects found below the surface. The timely addition of shallow water to the disturbed wetland soils will also provide ideal fall habitat conditions for migrating shorebirds and waterfowl.

Timing

River bulrush and broad-leaf arrowhead on the edge of a marsh

A typical annual wetland water budget in the upper Midwest reflects snowmelt and abundant precipitation in the spring, moderate rainfall in early summer, little rainfall in late summer, and moderate precipitation in fall. This typical cycle varies widely, however, with changing weather events. A dry spring and early summer encourages the germination and growth of emergent wetland plants. Bulrush species tend to act as cool season plants, responding well to mudflats early in the growing season. Cattails, on the other hand, respond more like warm season plants with the greatest gains in germination and growth during mid to late summer. Lower water levels throughout the growing season benefit submergent wetland plants by increasing the available sunlight throughout the water column. Lower water levels also benefit foraging birds. Early to mid-summer is a critical time for fledgling survival and growth. Counteracting the stress of migration with abundant food sources is most important during spring and fall. Lower levels going into winter can help reduce undesirable fish. The following table summarizes frequency, intensity and timing considerations for drawdowns.

Water levels are often raised in the fall of the year to provide ideal feeding conditions for a variety of waterfowl and shorebird species. Fall flooding can also stimulate hatching of many invertebrate species. The most challenging part of a drawdown strategy is the re-flooding of the wetland. Ideally, re-flooding should begin in early fall and it should be done slowly and continuously. However, most wetland situations do not have a reliable source of water to properly manage the re-flooding process. Instead, managers are usually reliant on unpredictable fall precipitation events for the re-flooding process. In some cases, pumping or diverting water into the wetland from an adjacent riparian source will provide the best re-flooding conditions.

Frequency, Intensity and Timing Considerations to meet Management Objectives			
Mgmt. Objectives	**Frequency**	**Intensity**	**Timing**
Establish perennial emergent vegetation	As needed, typically every 3 – 10 years	Full drawdown to mud flats where emergents are desired. Ideal conditions are saturated soils to 1" of water.	First two-thirds of the growing season. Early drawdowns favor bulrush sp. Mid to late summer favors cattails. Recovering water levels should not totally inundate new vegetation during the growing season. Water levels should ideally change slowly, less than an inch/day to optimize migration use.
Remove fish	Annually or as needed	Partial to full drawdown. Partial drawdowns should leave less than 1' if no inflows are active. Little or no surface water if there are active inflows such as tile lines. Amphipods may be negatively impacted.	Last third of the growing season into winter. Drawdowns should start early enough to allow reptiles and amphibians to adjust locations. Water levels of less than 1' will attract fall migrant dabbling ducks. Levels should ideally be drawn down slowly, less than an inch/day.
Strengthen submergent vegetation	Annually	Partial drawdown to allow sunlight penetration to the bottom. A full drawdown may be necessary to start the recovery of particularly degraded conditions by consolidating bottom soils. Mud flats should be minimal during the first two-thirds of the growing season unless recovery of emergents is desired.	Throughout the growing season with the first third being the most critical.
Encourage annual seed producing plants (moist soil plants)	Annually	Full drawdown of surface water. Soils should remain moist to saturated. Greater drying may be desirable if tillage will be applied. Reflooding during the first two-thirds of the growing season should not exceed one-third the height of the moist soil plants. Reflooding at the end of the growing season should maximize areas with less than 1' of water.	Water levels should be drawn down during the first third of the growing season. Early mud flats favor smartweeds. Exposed areas mid-term of the first third of the growing season benefit wild millets. Beggarticks tend to dominate later mud flats. Reflooding should occur during the last third of the growing season and extend into September. Levels should be dropped and increased slowly, less than 1"/day. It may be necessary to reflood early, up to one-third the height of the moist soil plants, if cocklebur or other weeds become a problem.
Encouraging wild rice	Annually	Gradual partial drawdown during first one-third of the growing season to achieve ideal depths of 6 – 24". Avoid abrupt changes in water levels.	Draw down to ideal depths during the first one-third of the growing season. Water levels should be maintained at that level during remainder of the growing season. Some water level increases can be tolerated near the end of the growing season if bottom soils are firm such as sand.

Table 1

Table 2 below summarizes the response of wetland vegetation relative to drawdown date.

Response of Wetland Vegetation Relative to Drawdown Date				
	Drawdown Timeframe			
Species	**Early**	**Midseason**	**Late season**	**Winter season**
Rice cutgrass	Excellent response	Fair response		
Crabgrass		Excellent response	Moderate response	
Panic grass		Excellent response	Fair response	
Barnyard grass	Excellent response	Fair response	Fair response	
Spikerush	Excellent response	Fair response	Fair response	
Pennsylvainia smartweed	Excellent response			
Curly dock		Excellent response	Fair response	
Cockleburr	Moderate response	Excellent response	Moderate response	
Beggarticks	Fair response	Excellent response	Excellent response	
Aster species	Excellent response	Moderate response	Fair response	
Morning glory	Moderate response	Moderate response		
Bulrush	Excellent response	Moderate response		
Carex species		Moderate response		
Milfoil species				Decreased
Pondweeds				Moderate response
Sandbar willow				Moderate response
Cattails				Moderate response
Wild Celery				Moderate response

Table 1. Adapted from Cooke et al. 1986 and NRCS 2007

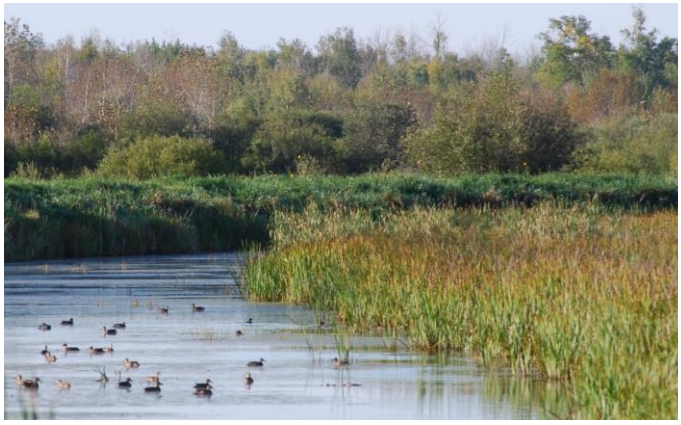
Early drawdown completed within first 45 days of the growing season
Midseason drawdown completed after 45 of growing season and before July 10th.
Late season drawdown completed after July 10th through October 10th
Winter season October 11th through until beginning of growing season

Waterfowl and Shorebirds

Waterfowl and shorebirds are some of the main benefactors of drawdown management strategies. Individual species have different requirements for foraging depths so the timing and extent of drawdown and reflooding will influence species differently. Managing water levels in larger complexes is beneficial as habitat can be created for a wide variety of species due to more hydrologic variation. **Table 3** summarizes foraging depth for a variety of water birds.

Preferred Foraging Depths for Wetland Birds	
Species	**Preferred Depth**
Diving Ducks	>13 inches
Northern Shoveler	11-13 inches
Northern Pintail	6-9 inches
Blue-winged Teal	2-7
Great Blue Heron	4-7 inches
Shorebirds	0-7 inches
Mallard	3-6 inches
Little Blue Heron	<1-5 inches
Yellow-crowned Night Heron	1-4 Inches
Long-billed Dowitcher	<1-3 inches
Canada Goose	<1-3 inches
Greater Yellowlegs	<1-3 inches
American Bittern	<1-3 inches
Virginia Rail	<1-2 inches
Pectoral Sandpiper	<1-2 inches
Common Snipe	<1-2 inches

Table 3. Adapted from Fredrickson 1991



Ducks feeding in shallow water

The food habits, feeding behavior and habitat requirements of shorebirds differ from those of migrant waterfowl and warrant some special consideration in the management of wetland areas. Most shorebirds prefer feeding areas that include shallow water up to 3 inches deep and exposed, bare mud flats containing short, sparse vegetation. Shorebirds migrate later in the spring and earlier in the fall than most waterfowl. Therefore, in the spring, the most effective strategy is simply keeping the same water level throughout the winter, followed by a gradual drawdown to expose only the most elevated areas during the last week of March and the first week of April. Shorebird migrations usually continue through the first week of June. This spring-management sequence is compatible with waterfowl, since deeper water habitats are available during peak duck migrations in late February or March. The shallow areas created by the initial drawdown for shorebirds also are attractive to most late migrant puddle ducks, such as shovelers and teal. Disking, followed by shallow flooding in July, will provide excellent shorebird areas. Flooding up to a 3-inch depth creates a habitat that is used almost immediately by migrant shorebirds. **Table 4** summarizes expected response by bird species to seasonal water level manipulation.

Expected Response by Bird Species to Seasonal Water Level Manipulation		
Time Period	**Water Level Change**	**Expected Water Bird Response**
Early Fall	Gradual flooding before peak of early fall migration, up to 4-inch depth	Use by teal, pintail, rails
Mid Fall	Gradual flooding up to 8-inches	Use by pintail, wigeon, gadwals, rails
Late Fall	Gradual flooding up to 4-inches	Use by mallards, Canada geese
Late Winter	Gradual drawdown before early spring migration	Use by mallards, pintail, wigeon, Canada geese
Early Spring	More rapid or continued drawdown during peak of spring migration	Use by rail, bittern, shovelers, shorebirds and herons

Table 4. Adapted from Fredrickson 1991

Control of Nuisance Vegetation

The drawdown of wetland water levels is typically used to stimulate the growth of desired emergent plant species that normally do not germinate in standing water. It is also used as strategy to control or manage undesired or invasive plant species that have colonized in a wetland. The establishment or colonization of certain invasive or undesired vegetative can cause certain problems for many wetlands. The control or elimination of certain wetland plant species such as narrow leaf cattail, reed canary grass, purple loosestrife, cottonwood, willow, etc. is often an objective of many drawdowns. While a drawdown can help in addressing the presence of these species additional management strategies may also need to be considered for effective control. These include disking, mowing, and the application of herbicide. The amount of drawdown or level of dryness that can be achieved may limit the use of these supplemental strategies.

Ideally, shallow to deep water wetlands will benefit from being disked once every five years or so. Disking is usually conducted (if invasive species establishment is not a threat) to aerate the soil to encourage plant growth of native species from the seedbank. Disking can also help control the establishment of undesirable wetland plants including cattail and woody species. Disking late in the summer will usually provide the best results for vegetation control.

Drawdown allowing for invasive weed control

During a drawdown period, wetland vegetation can sometimes be temporarily controlled by mowing. Narrow leaf and hybrid cattail and other undesired vegetation can be controlled through a mowing and re-flooding strategy. This technique tends to be most effective in wetland areas that will be three or more feet in depth when reflooded.

In addition, a drawdown also provides an opportunity to use herbicides for control of nuisance plant species. Herbicides are most efficiently applied with mechanical equipment. Wetland hydrology should be lowered to a level that will allow for sufficient drying so that equipment rutting will not occur during the herbicide application process. The use of low ground pressure equipment will decrease the need for the site to be totally dry before application. If non-aquatically certified herbicides will be used it is important that no standing water is present and no runoff will result.

Control of Fish

In addition to addressing undesired or invasive vegetative species, a drawdown can also be done to kill-off harmful fish that have become established in a wetland. The presence of certain fish species in a wetland can be detrimental to its success in terms of vegetation and water quality. Bottom feeding fish such as carp and bullhead are of particular concern. These nuisance fish species are usually introduced to shallow wetlands via their annual upstream migration from other, more permanent downstream wetlands, lakes and rivers. Upon gaining access to a shallow wetland, these fish species will uproot wetland vegetation in turn suspending bottom sediments and nutrients. This increase in water turbidity provides for increased algal blooms which prevents sunlight from penetrating the wetland affecting the growth of wetland vegetation. Carp and bullheads are not the only fish species of concern. Studies have shown that fathead minnows can have a significant impact on invertebrate communities and biological health of a wetland.

To be effective at controlling fish, a drawdown needs to done long enough during the summer months to effectively remove wetland hydrology and associated fish habitat. With wetland restorations, be aware of ditches that were left “unfilled” or remnant reaches of subsurface tile systems that still remain as these areas can harbor fish even when it appears the wetland is essentially void of hydrology.

Another option is to consider a drawdown over the winter months to induce a “winterkill”. This strategy is especially useful when only a partial drawdown of wetland hydrology can be achieved. During low water conditions, the available remaining habitat to fish in the wetland can completely freeze out causing a complete fish kill. Where that does not occur, oxygen levels in the water column will usually get low enough that any remaining fish will suffocate and not survive. Cold winters with a lot of snow increases the likelihood for an effective winterkill.

Moist Soil Management

Moist soil management is a specialized form of drawdown that attempts to provide moist soil conditions during a specific timeframe within the growing season. This management strategy mimics wetland conditions often found in riverine environments and requires the ability to both slowly drawdown and then re-flood a wetland under more precise conditions. The premise behind this strategy is that annual plant germination and invertebrate production will be optimized under more ideal soil moisture conditions which in turn lead to increased wetland function lending the site more attractive to waterfowl, shorebirds, and other wetland wildlife species.

Primary factors that influence the success of a moist soil management strategy include the timing and rate of both drawdown and re-flooding along with periodic mechanical actions such as disking that disturb the soil surface. The landscape and condition of most restored wetlands in Minnesota will not lend themselves well to

the specific requirements of this strategy. However, there are elements of this strategy that if applied, will enhance any wetland drawdown whether it occurs naturally or as part of a management action.

Flood Control

Many restored and created wetlands provide significant flood control benefits to surrounding properties and downstream water resources. This typically occurs as a result of outlet rate controls and flood detention storage conditions that are provided by these wetlands. These benefits are enhanced through natural seasonal drawdown that occurs within many of these wetlands.

For some wetlands, flood control may a defined primary goal. The design and operation of an outlet structure with drawdown capabilities is often an integral part of the project's purpose. The intentional drawdown of wetland water levels in the fall is often done to provide additional spring runoff storage benefits for these projects.

OTHER CONSIDERATIONS

While it is hoped that the native seed bank will germinate as a result of most managed drawdowns, there is also a great potential that invasive species will re-colonize the exposed wetland soils. Wetlands that contain significant amounts of reed canary grass or hybrid cattail or have it in their watersheds will be prone to invasion of these species during the drawdown period. Mowing, disking, herbicide application and prescribed fire are some strategies to consider should these invasive undesired vegetative species develop during the drawdown period. Planting of more desirable wetland vegetation can also be conducted in areas of bare soils after water levels are decreased.

With the added management benefits of being able to temporarily drawdown a wetland comes the additional cost to design and construct outlet structures that allow water level management, additional maintenance issues, the potential for increased vandalism, and the possibility of undesired or unauthorized management of water levels. The benefits of being able to manage water levels with a control structure should be weighed against the additional cost and these potential issues.

Consideration is also needed with respect to potential downstream impacts of the drawdown activity. The timing and rate of drawdown may need careful observation to ensure downstream impacts are avoided. In some situations, temporary easements or permissions may need to be secured.

COSTS

The potential costs of drawdown as a management activity will vary. For many projects, the only cost will be the time or resources necessary to adjust or operate an outlet structure to manipulate wetland water levels. For other projects, additional activities that will be conducted as part of this management strategy will affect overall time and cost. These can include, but are not limited to the following items:

- Drawdown of water levels to allow pre-flooding vegetation management (cutting/spraying/fire)
- Herbicide treatment – pre and post flooding
- Mowing – pre flooding
- Fire – pre flooding
- Acquisition of temporary flowage easements
- Seeding/Planting

ADDITIONAL REFERENCES

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