A Guide to Wetland Habitat Management in the Central Valley

A Cooperative Effort

California Department Fish and Game
California Waterfowl Association

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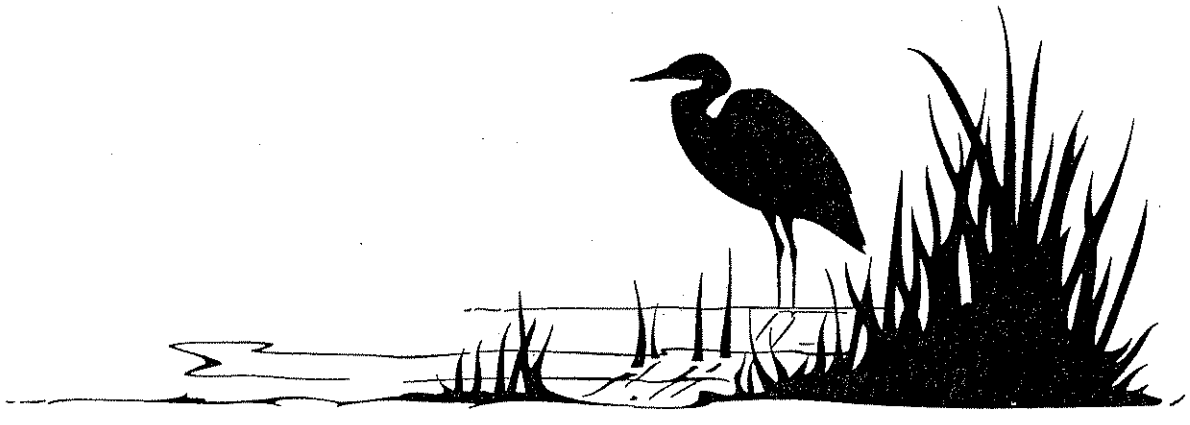

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FOREWORD

The California Department of Fish and Game (CDFG) and the California Waterfowl Association (CWA) cooperatively prepared the wetland management information contained in this handout. Beginning in 1991, CDFG and CWA began developing written materials for Central Valley wetland managers. The intent of this project was to prepare an overview of Central Valley wetland management and six easily-followed, 2-3 page habitat management guides for landowners enrolling in CDFG's California Waterfowl Habitat Program (CWHP). These guides, which are included in all CWHP management plans, describe management practices that can be used to provide a variety of productive wetland habitats.

The theoretical principles of "moist-soil management" (i.e. managing seasonally flooded wetlands for wildlife) were developed primarily by researchers and wetland managers at Mingo National Wildlife Refuge in southeast Missouri. These principles have been field-tested by wetland managers in the Central Valley for the last 20 years and refinements have been made to adapt these ecological principles to the Central Valley. In recent years, CDFG has also developed several techniques for integrating summer wetlands into moist-soil management programs. Thus, the information contained in this handout is a general review of our knowledge of Central Valley wetland management at the present time.

Although this information was intended primarily for use with the CWHP, CDFG and CWA have received numerous requests for this material from agencies, organizations, and landowners involved with wetland management. In response to this demand, CDFG is in the process of expanding the scope of its written materials on Central Valley wetland management to include information on wetland construction, water distribution and delivery systems, water control structures, and vegetation management. This information will ultimately be presented in a Central Valley Wetland Management Handbook that will be published by the CDFG in 1994. This handout, in its current form, was developed specifically for the "Managing Farmlands to Bring Back Game Birds and Wildlife to the Central Valley" workshop on February 19, 1994.

ACKNOWLEDGEMENTS

This wetland habitat management information could not have been compiled without the generous contribution of knowledge from wetland managers throughout the Central Valley. Although small amounts of the information concerning Central Valley wetland management are found in the published literature, the majority of the knowledge exists in the minds of those who spend a large portion of their lives in the marsh. We extend special thanks to J. Beam, D. Becker, P. Blake, S. Brueggeman, C. Dennis, E. Edwards, G. Gerstenberg, B. Huddleston, P. Hofmann, L. Howard, G. Kerhoulas, G. Kramer, R. Lewis, G. Mensik, J. Miller, N. Nelson, T. Poole, R. Riviere, B. Reno, R. Reno, E. Smith, M. Womack, and D. Yparraguirre. Tom Blankenship assisted with earlier drafts of the wetland habitat management guides.

We thank the staff of the California Waterfowl Association for their superb technical support. J. Lee and C. Miglino deserve substantial credit for their patience. C. Isola and R. Shinn assisted with the wetland habitat management guides. We extend thanks to Dr. Robert McLandress for his guidance throughout all phases of the project.

PRINCIPLES OF CENTRAL VALLEY WETLAND MANAGEMENT

Wetland management can best be described as the active manipulation of wetland habitat. Wetlands evolved as dynamic ecosystems, constantly changing due the physical and chemical processes associated with floods, drought, and fire. Today, most of California's rivers have been contained and the majority of the Central Valley's wetlands seldom experience natural seasonal flooding. Most wetlands are now enclosed by levees and flooded with water from irrigation district conveyance systems, rivers and sloughs, and/or deep wells. Whereas natural wetland hydrology was very dynamic, flooding cycles now used for managed wetlands are often very predictable. It is the task of the modern wetland manager to emulate natural hydrology and re-create a dynamic, productive wetland system. With only 5% of the Central Valley's original wetlands remaining, it is also imperative that the remaining wetlands are managed such that they support the maximum abundance and diversity of wildlife. The Central Valley supports the single largest concentration of wintering waterfowl in North America, thus Central Valley wetland managers have an enormous responsibility to provide optimum habitat conditions for wintering waterfowl. However, wetland management can be conducted in such a manner that shorebirds, wading birds, breeding ducks, and other wetland-dependent wildlife also realize maximum benefits.

The management of productive wetland habitat requires dynamic water management, as well as periodic soil and vegetation disturbances. An adequate water conveyance system is essential for meeting water management objectives, thus pumps, delivery ditches, water control structures, and drainage systems must be maintained in functional condition. Discing, mowing, and burning can be used to interrupt the natural evolution of wetland habitat and to stabilize the marsh vegetation at a point which is the most productive of those elements required by waterfowl and other wetland-dependent species. The attached wetland habitat management guides were designed to inform landowners of a variety of management practices that can be used to produce a diversity of productive wetland habitats.

Moist-soil Management (Seasonal Wetlands)

Seasonal wetlands are flooded in the fall, with standing water maintained continuously throughout the winter until drawdown occurs in the spring. A variety of annual plants germinate on the exposed mudflats of seasonal wetlands when surface water is drained during spring and summer. These plants are collectively known as "moist-soil plants". Some of these plants produce seeds, browse, and/or tubers that are important foods for waterfowl. A combination of moist-soil plants and robust emergent vegetation (typically cattails and/or tules) usually results from management practices in Central Valley seasonal wetlands. A primary goal of "moist-soil management" (seasonal wetland management) is to provide an abundance and diversity of seeds, aquatic invertebrates, and other moist-soil foods for wintering waterfowl. Although agricultural grains (e.g. rice, corn) supplement the diets of waterfowl in winter, these foods lack many of the vitamins, minerals, and proteins essential for survival and subsequent reproductive success. The seeds of moist-soil plants provide waterfowl with the essential nutritional balance lacking in grains. Invertebrates are protein-rich by-products of moist-soil management that serve as an important food source for ducks during late winter and spring. Shorebirds are also highly dependent on seasonal wetlands and the invertebrate foods they supply, particularly during spring migration.

Wildlife Values of Various Moist-soil Plants

The wildlife value of a moist-soil plant species is generally based on its seed production capability, the nutritional quality of its seeds, and the invertebrate habitat the plant provides. Management practices that encourage a diversity of highly valuable moist-soil plants are considered most effective. Watergrass, swamp timothy, and smartweed are the most important moist-soil plants in the Central Valley due to their documented value as a food source for wintering waterfowl. Seeds of these three plants, in aggregate, provide waterfowl and other seed-eating wildlife with a relatively nutritionally balanced diet. However, a variety of other wetland plants are needed to provide additional nutrition, cover, and thermal protection. Some moist-soil plants are not good seed producers or produce seeds with modest nutritional value, but have a complex leaf structure and harbor rich invertebrate communities, thus are valuable to wildlife.

Moist-soil plants with exceptional value to wildlife include watergrass, smartweed, swamp timothy, sprangletop, ammannia, chufa, burhead, beggarticks, annual atriplex, goosefoot, and brass buttons. Spikerush, pricklegrass, alkali heath, alkali weed, bermuda grass, aster, and alkali bulrush are moist-soil plants that are believed to be only moderately valuable to wildlife, but may be important in localized areas. Cocklebur, sweet clover, river bulrush, tuberous bulrush, baltic rush, jointgrass, dock, and salt grass are generally invasive and undesirable wetland plants.

Timing of Drawdown and Soil Disturbance

Important moist-soil waterfowl food plants such as swamp timothy, smartweed, and watergrass are easily propagated on most seasonal wetland sites through effective water management and soil disturbance. The primary factors that affect the type and abundance of moist-soil plants that are found in a seasonal wetland are 1) the timing of spring drawdown, and 2) the "successional stage" of the wetland (length of time since soil disturbance). The seeds of each plant species germinate best at a specific soil temperature under specific successional conditions. Therefore, as plants compete for dominance, wetland managers can favor specific plants (or groups of plants) by 1) timing drawdowns to coincide with optimum germination conditions (primarily soil temperature) and 2) discing periodically to maintain the successional stage required by the target vegetation. Although climatic conditions vary by year and location, the drawdown dates listed in the habitat management guides will generally induce germination of the target waterfowl food plant. The management strategies described in these leaflets have been successfully implemented by wetland managers throughout the Central Valley, but are by no means the **only** way to achieve these desired habitat types. Soil type and water quality also influence plant growth, so modification of these general recommendations may be necessary based on local knowledge and weather patterns for specific sites.

Rate of Drawdown

The rate of pond drawdown affects moist-soil plant composition, seed production, soil-salt levels, and the duration of food availability to waterfowl. Slow drawdowns (2-3 weeks) cause invertebrates to become concentrated in the shallow water and allow waterfowl optimum foraging conditions for a prolonged period. Slow drawdowns also typically result in high vegetation diversity and, if executed during mid to late spring, may enhance seed production. However, they may concentrate salts near the soil surface in systems with brackish or saline water. Rapid drawdowns (3-5 days) are desirable if a soil-salt problem exists, as was quite often the case in the San Joaquin Valley in the past. The Grasslands Water District now provides water that appears to be of sufficient quality for managers to execute slow drawdowns without adversely affecting vegetation. However, further research is needed to determine the long-term relationship between slow drawdowns and

alkaline soils. Rapid drawdowns may produce extensive stands of waterfowl food plants if timed correctly, but "rob" wildlife of the extended shallow water habitat associated with slow drawdowns. Rapid drawdowns late in the growing season should be followed by a summer irrigation to insure a good seed crop. Although slow drawdowns are generally better for wildlife, there is no "right" or "wrong" way to drain a seasonal wetland. The rate of drawdown should be based on site-specific knowledge.

Irrigations

Spring and summer irrigations are very important in Central Valley moist-soil management. Most waterfowl food plants will not attain maximum seed production without at least one irrigation. The San Joaquin Valley receives less rainfall than the Sacramento Valley, and therefore the soils dry out faster and irrigations are more often a necessity. Swamp timothy is the only waterfowl food plant that may be grown successfully without an irrigation in the San Joaquin Valley, however, irrigations greatly enhance seed production if timed correctly. Irrigation schedules for smartweed and watergrass vary with annual weather patterns. These plants can be observed for signs of wilting to determine proper irrigation dates.

Fall Flooding

The timing of fall flooding is typically based on water delivery dates. Early fall flooding (August and September) is particularly important for locally-raised mallards and early migrant pintails and is highly recommended if feasible. Generally, most wetland units should be flooded prior to October 15. Since irrigation districts typically cease water deliveries by mid-December and do not resume deliveries until April, wetland managers must devise ways to maintain water in their ponds until spring drawdown. This problem is easily solved on those properties which can simply pump groundwater from deep wells to overcome the effects of evapo-transpiration and seepage (percolation). Wetland properties which do not enjoy access to wells can close all of their drainage structures and rely on rainfall to maintain pond levels. In extreme cases, it may be possible to maintain pond levels by purchasing water from nearby properties that have wells.

Water Depth

Water depth is extremely important in Central Valley moist-soil management. Dabbling ducks (e.g. mallards, pintails, green-winged teal) cannot effectively feed on the seeds and invertebrates found on pond-bottoms if the water is deeper than 12 inches. Water depths of 4-10" are preferred for feeding. Therefore, in order to provide feeding habitat for dabbling ducks, shallow water must be maintained! Shallow water habitat management is valuable to many other wildlife species, as well. In Missouri, only 5 of 54 bird species that use seasonal marshes can effectively forage in water deeper than 10 inches. Shorebirds are particularly dependent on shallow water and seldom use habitats in which the water is deeper than 6 inches.

Summer Wetlands

The Central Valley's resident wetland wildlife are highly dependent on semi-permanent and permanent wetlands during the late spring and summer when seasonal wetlands are dry. Basically, the two primary habitat requirements of wetland wildlife during this time period are: 1) sufficient cover and protection from predators, and 2) an abundant food supply of aquatic invertebrates. Such invertebrates are the primary source of dietary protein for ducks and other wetland birds during the breeding season. Most species of wetland wildlife are dependent upon invertebrates as a direct or indirect food source during the spring and summer. For example, breeding ducks and shorebirds eat invertebrates almost exclusively, but herons eat other direct consumers of invertebrates such as fish,

reptiles, and amphibians. Both semi-permanent and permanent wetlands provide ample protection from predators, however semi-permanent wetlands usually supply a much greater abundance of invertebrates. Invertebrate populations decline with prolonged flooding, thus a dry period of at least 2 months each year is essential for maintaining abundant populations of invertebrates.

Semi-permanent Wetlands

Semi-permanent wetlands, commonly referred to as "brood ponds", are flooded during the spring and summer, but experience a 2-6 month dry period each year. Semi-permanent wetlands provide breeding ducks, ducklings, and other wetland wildlife with protection from predators and abundant invertebrate food supplies. Water depths of 6-12" are necessary to allow wildlife access to invertebrate foods, however deeper areas (e.g. channels, borrow ditches) are also important in that they provide open water. Well managed semi-permanent wetlands require periodic discing to prevent the vegetation from becoming too dense. In order to maximize habitat values without incurring major discing costs, it is recommended that semi-permanent wetlands be relatively small in size (2-10 acres). Various techniques have been developed for integrating semi-permanent wetlands into a moist-soil management program. Specific management practices are described in the attached management guides.

Permanent Marshes

Permanent marshes are wetlands that remain flooded throughout the year. Due to year-round flooding, permanent marshes support a diverse, but usually not abundant, population of invertebrates. However, submerged aquatic vegetation such as sago pondweed, horned pondweed, and water hyssops may occur if adequate water clarity exists. The leaves and/or nutlets of these aquatic plants are commonly consumed by waterfowl, particularly gadwalls, ring-necks, redheads, and canvasbacks. Carp and other rough fish may reduce water clarity and prohibit the growth of these desirable plants. Permanent marshes are important to resident waterfowl in mid- to late summer when local ducks are molting their flight feathers; the deep water and dense cover provide protection from predators.

Habitat Diversity

It is unlikely that wetland managers will be able to produce a monoculture of any one plant in an established wetland, particularly if pond bottoms are of uneven topography. Furthermore, a wetland with diverse habitats is valuable to a wider variety of waterfowl and other wildlife species and will better resist the devastating effects of plant diseases, insect pests, and bird depredation. Diversified habitats also provide a variety of waterfowl foods throughout the fall and winter. Even though some moist-soil plants are poor seed producers, when flooded they may support excellent assemblages of invertebrates. Waterfowl also utilize other plants (e.g. cattails and "tules") for cover. An ideal Central Valley seasonal wetland is dominated by waterfowl food plants, contains other moist-soil plants, and provides waterfowl with substantial cover.

Vegetation Control

Some plants reduce the value of a wetland to waterfowl if they become overly abundant. Tules and/or cattails can eventually "fill in" a pond and eliminate open water. Dense stands of tules and cattails should not occupy more than 60% of a pond. The primary tools for tule/cattail control are discing, mowing, and burning. Mowing and burning are only effective when followed by discing and 2-3 months of exposure to the sun, which is necessary in order to dry out and kill the tubers and

rhizomes. Discing tules and cattails also disturbs the soil and provides favorable conditions for invasion by valuable moist-soil waterfowl food plants.

Discing is typically accomplished with either a "stubble disc" or a "finish disc". The depth of discing varies with soil structure, soil moisture, implement weight, tractor size, and tractor speed. Most stubble discs have blades that range from 26-36" in diameter; these make cuts that are 7-10" deep. Stubble discs are necessary for most types of pond-bottom discing, however, a finish disc and ring-roller can be used afterward to break up dirt clods and make walking easier under flooded conditions. Deep stubble discing can adversely affect the water-holding capacity of a wetland if the disc breaks through the shallow clay pond bottom and into the underlying sandy soil. Although very uncommon, this unfortunate situation can be avoided be contacting the local Soil Conservation Service (SCS) office prior to initiating a deep-discing or excavation project.

Finish discs, which typically have blades that range from 18-24" in diameter, usually make cuts that are 4-6" deep. Finish discs often suffice for discing low-growing vegetation such as pricklegrass and swamp timothy, but have proven totally ineffective for controlling cattails, tules, river bulrush, baltic rush, or other robust wetland plants.

Summer irrigations occasionally cause watergrass, smartweed, sprangletop, and other valuable moist soil plants to occur in very dense stands. Waterfowl use of these areas may be impeded unless openings are created prior to fall flooding. With the use of a finish disc, managers can create strips, channels, and potholes in the otherwise dense vegetation. The appropriate time to create such openings is in July or August.

Wetland Management - An Art

Wetland management is an art, not a science. Wetland management practices are continually being improved as a result of research and experimental management. The results of these learning efforts are disseminated to interested parties by the agencies and organizations involved in waterfowl management. However, it is to the advantage of all wetland managers to keep accurate records of habitat manipulations (e.g. dates of flooding, irrigation, drawdown, discing). Managers should eventually be able to predict how the vegetation on their property will respond to specific management practices, this in turn will allow them to consistently provide high-quality waterfowl habitat.

WETLAND HABITAT MANAGEMENT GUIDE #1

SEASONAL WETLAND

Target Waterfowl Food Plant: Smartweed

Timing of Spring Drawdown:

March 1 - 20. Sacramento Valley
February 20 - March 10. San Joaquin Valley

Moist-soil Plant Community: In addition to smartweed, other desirable wetland plants that may occur under the following water management and soil disturbance schedule include but are not limited to tule, cattail, spikerush, chufa, fat-hen, alkali bulrush, and watergrass.

Potential Problem Plants: Some wetland plants are undesirable if they become overly abundant or create dense stands. These include but are not limited to tule, cattail, asters, cocklebur, salt grass, bermuda grass, and baltic rush.

Value to Waterfowl: A moist-soil plant community dominated by smartweed, but including various other wetland plants, is an important component of a diversified marsh management program. Also referred to as "redweed", smartweed provides ducks with a quality food source throughout the fall and winter. Smartweed produces seeds that contain balanced proportions of essential vitamins, protein, minerals, and carbohydrates. In addition, it has a complex leaf structure, which supports excellent assemblages of aquatic invertebrates when flooded. Recent research in the Midwest shows high invertebrate abundance and diversity in association with smartweed. Tules, cattails, and other emergent plants add structural diversity to the marsh and provide ducks with cover. Wetland units having dominant stands of smartweed in association with these cover plants become an integral part of the wetland complex and receive heavy usage by dabbling ducks, particularly mallards. Smartweed may also occur in combination with watergrass, which has even greater seed value.

Management Strategy: Two important factors that influence smartweed growth are (1) the timing of spring drawdown and (2) the stage of succession (number of years since the area was last disturbed through discing or plowing). Smartweed requires cool soil temperatures and relatively high soil moisture for germination, and therefore, is usually found in wetlands that undergo early spring drawdowns. Smartweed can be maintained in seasonal wetlands for several years if water management coincides with its growth requirements. Periodic soil disturbance is usually essential to the maintenance of smartweed stands. Smartweed is considered a "pioneer" or "invader" plant species because it colonizes recently disturbed wetland sites. Eventually, competition from other

wetland plants, particularly cattails and tules, will eliminate smartweed from the community. Discing should occur when smartweed abundance decreases substantially.

Establishment: Smartweed seeds are present in the soils of most wetlands, ricefields, and set-aside lands, which eliminates the need for any type of planting. If undesirable vegetation is dominant, the area must be disced, preferably during summer. Discing reduces plant competition and prepares the seedbed for improved smartweed production the following spring. Discing dense stands of cattails and tules in early summer is the most effective way to reduce competition and create conditions suitable for smartweed colonization. This method exposes cattail/tule rhizomes and tubers to the sun and kills them, thus preventing their re-growth during fall flooding. Water should be maintained on these areas throughout the winter. Smartweed will usually "invade" the disced areas if an early spring drawdown occurs.

Spring Drawdown: Managers must do everything possible within the constraints imposed by water districts to maintain water until the early-spring drawdown that will typically encourage smartweed development. Coincidentally, the retention of pond water through February assures the availability of protein-rich invertebrates to pre-breeding ducks. Appropriate drawdown dates are listed above. Smartweed seeds should begin to germinate within 2 weeks of drawdown. Rapid drawdowns (3-5 days) typically produce extensive stands of moist-soil vegetation, consisting of relatively few plant species. Slow drawdowns (2-3 weeks) maximize the foraging opportunity for waterfowl and other wetland birds and result in greater diversity of vegetation. Invertebrates, in particular, become concentrated and readily available to ducks.

Irrigation: An irrigation will be needed if smartweed plants show signs of stunting (i.e. halted growth and "yellowing"). This usually occurs 4-6 weeks after germination when plants are generally 3-12" high. Irrigation should occur as soon as possible, but may be delayed until mid-summer if water availability is a problem. A second irrigation is necessary if plants appear stunted before seed development occurs. Summer irrigations encourage the expansion of cattail and tule stands, as well as sprangletop and watergrass development. Smartweed may achieve full development without an irrigation, particularly if a high water table is present, late rains occur, or water seeps in from surrounding wetlands or ricefields.

Fall Flooding: Flooding should coincide with the arrival of migratory waterfowl. Pintails begin arriving in the Central Valley in mid-August, and peak numbers of wintering waterfowl are usually present during December and January. The flooding of individual units should be staggered to match the habitat requirements of arriving waterfowl, if possible. For example, fall flooding should begin on sites suitable for pintails, such as areas dominated by swamp timothy. Smartweed units are typically used by mallards, many of which are raised locally, therefore flooding can occur anytime between August and October. The timing of water delivery plays a major role in the determination of flooding schedules, however. Many marsh managers simply execute their fall flooding when irrigation districts make water available. Marsh units should be gradually flooded to allow ducks maximum accessibility to seeds and invertebrates.

Discing: Periodic soil disturbance is vital to most marsh management programs, particularly those involving smartweed production. It reduces potential problem plants and creates conditions suitable

for smartweed establishment. Discing should be employed when it is obvious that smartweed is no longer dominant and is being replaced by undesirable species. This normally occurs 3-6 years after establishment. However, discing the entire field at one time would eliminate all food and cover from the area for one season and should be discouraged. This practice would also return the marsh to a monoculture of smartweed the following year. Marsh plant diversity is desirable, and discing 30-40% of the pond bottom in a random pattern will create a "mosaic" of smartweed and dense emergent vegetation. Following discing, smartweed will colonize areas previously occupied by cattails, tules and other non-target species.

Note: Occasionally, stands of smartweed develop a fungal infection called "smut", which reduces seed production. Little is known about smut, although it appears most prevalent when too much water is applied during the growing season. Managers should not be overly concerned with the disease because it usually only affects a portion of the smartweed seed source, and not the invertebrate habitat the plant provides. However, the threat of the disease further emphasizes the need for habitat diversity. If, in a given year, a smartweed seed crop fails in a diverse wetland complex, other waterfowl food plants will help supply necessary seeds for wintering waterfowl.

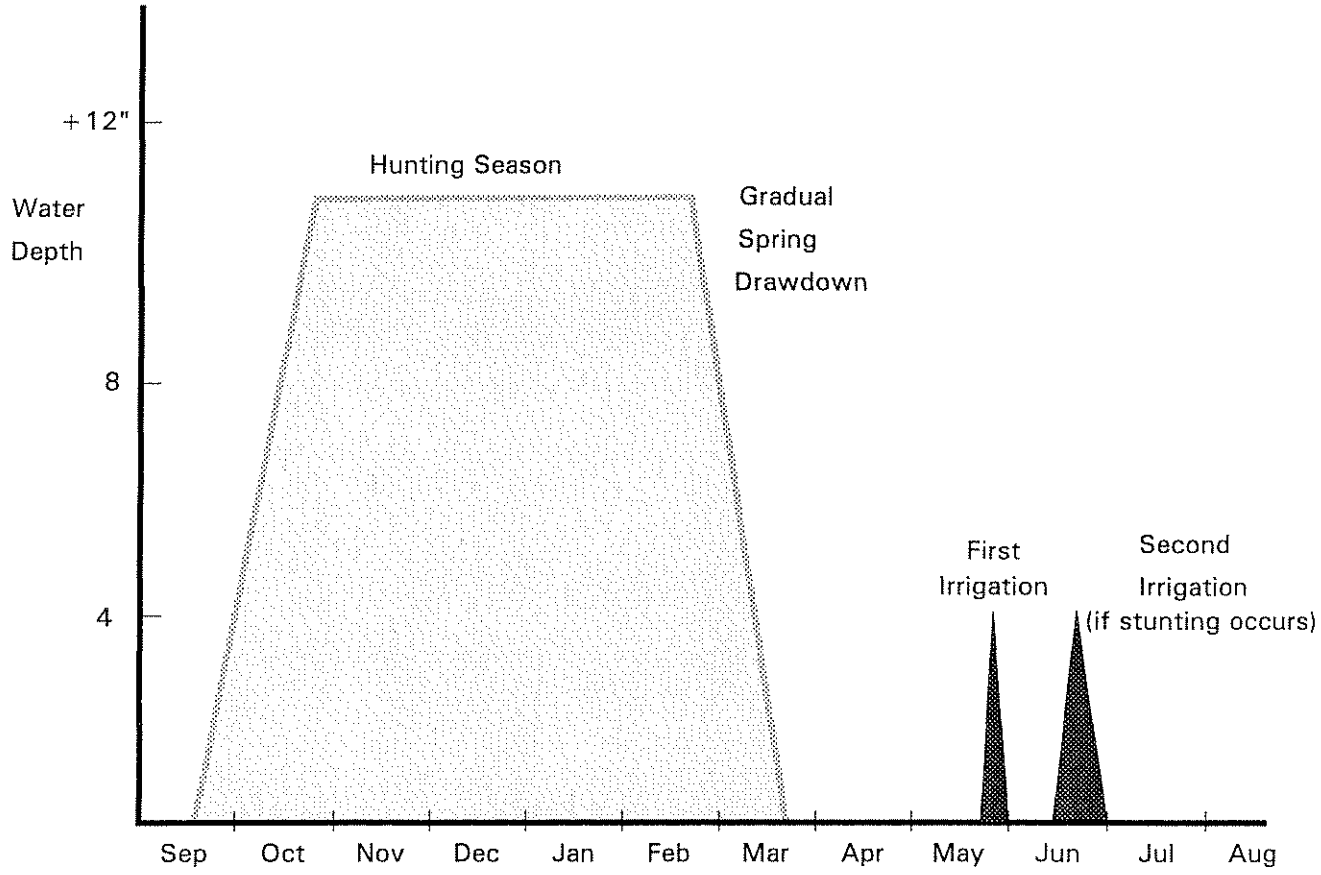

Figure 1. Water management schedule for smartweed in the Sacramento Valley.

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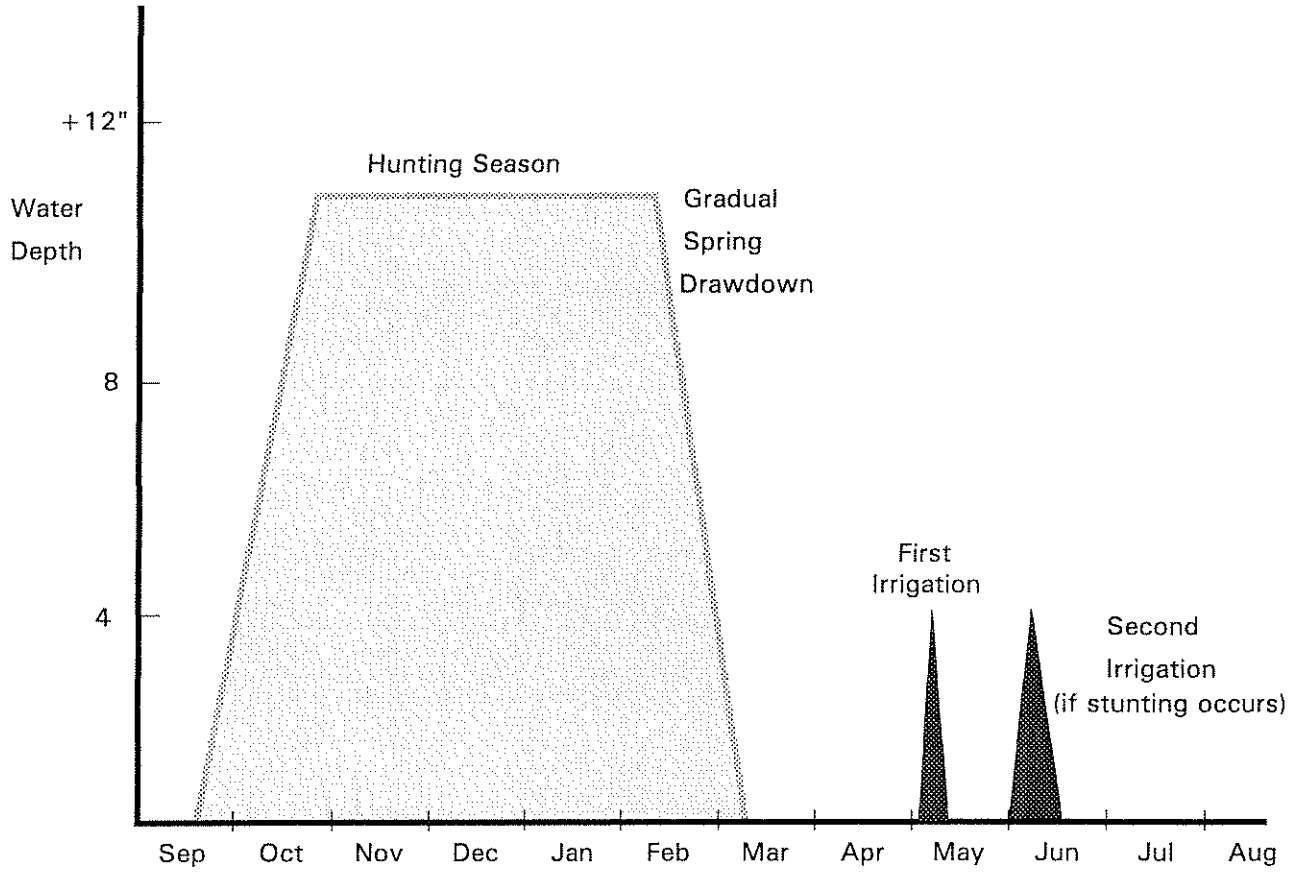

Figure 2. Water management schedule for smartweed in the San Joaquin Valley.

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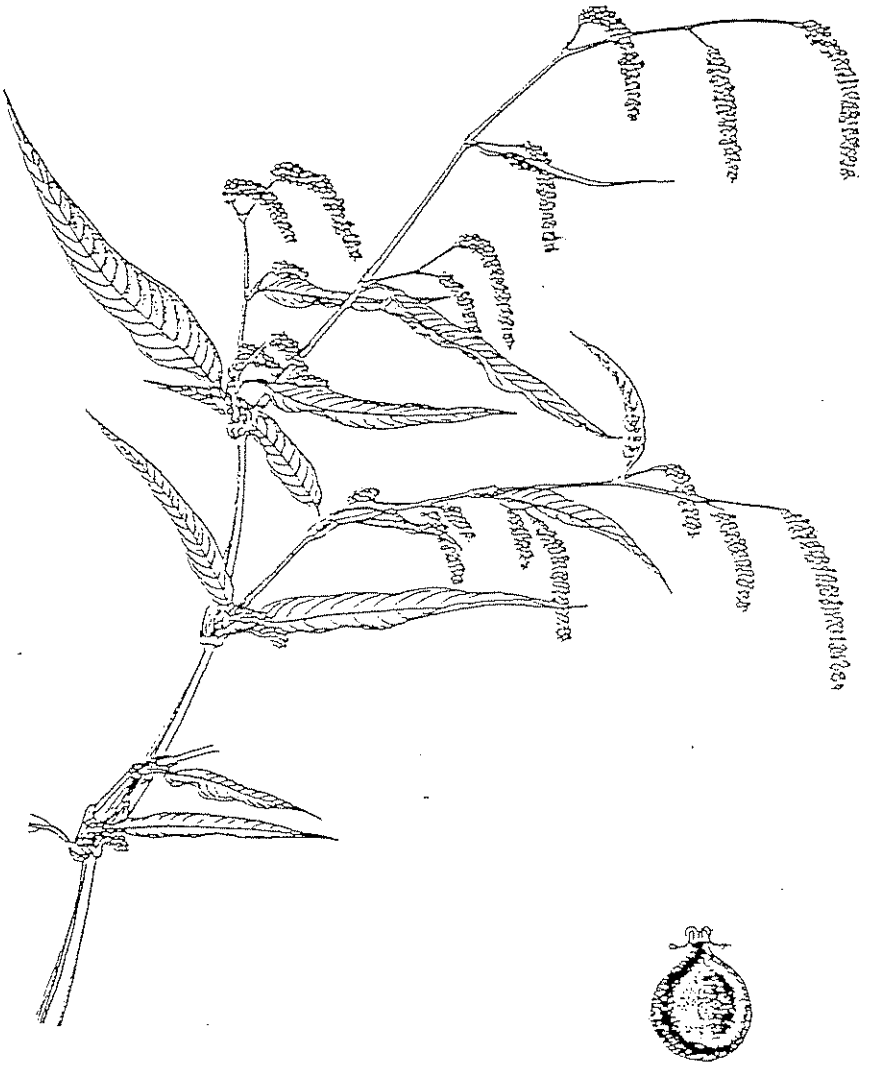

Figure 3 Smartweed
Reprinted from Mason
A Flora of the Marshes of California
University of California Press

WETLAND HABITAT MANAGEMENT GUIDE #2

SEASONAL WETLAND

Target Waterfowl Food Plant: Swamp timothy

Timing of Spring Drawdown:

April 15 - 30. Sacramento Valley
March 20 - April 10. San Joaquin Valley

Drawdown should be slightly later on sites with sandy soils.

Moist-soil Plant Community: In addition to swamp timothy, other desirable wetland plants that may occur under the following water management and soil disturbance schedule include but are not limited to tules, cattails, pricklegrass, watergrass, beggarticks, fat-hen, and alkali bulrush.

Potential Problem Plants: Some wetland plants are undesirable if they become overly abundant or create dense stands. These include but are not limited to tule, cattail, cocklebur, salt grass, bermuda grass, aster, dock, jointgrass, and baltic rush.

Value to Waterfowl: A moist-soil plant community dominated by swamp timothy, but including various other wetland plants, can be an important component of a diversified marsh management program. Seasonal wetlands dominated by swamp timothy are very attractive to wintering waterfowl. Swamp timothy is a low-growing (2-10"), seed-producing, moist-soil plant that provides sheet-water habitats when flooded. Water should be maintained at depths of 4-12" to allow optimum foraging conditions for dabbling ducks. This plant is naturally occurring on bare, poorly drained sites, but can be grown under a variety of circumstances. Conditions that favor swamp timothy germination and growth were examined in the 1970's and propagation techniques have been refined in recent years. Many San Joaquin Valley wetlands that were once dominated by jointgrass and other low-quality moist-soil plants now support excellent stands of swamp timothy.

Pintails and green-winged teal, in particular, prefer wetland habitats dominated by swamp timothy. Swamp timothy seeds are important to ducks arriving in early fall (August and September) as they facilitate the accumulation of fat reserves and the restoration of nutrients expended during molt and migration. As wetland seed resources are depleted during winter, many invertebrate populations reach maximum densities and are readily available in the shallow water of swamp timothy stands. Studies indicate that midge larvae (the worm-like larvae of the midge fly) are heavily utilized by dabbling ducks in swamp timothy habitats during late winter. In addition, these shallow, open-water habitats provide excellent sites for loafing and courtship.

Management Strategy: Swamp timothy is a drought-adapted plant that germinates with a mid-spring drawdown and will achieve seed production without summer irrigation. Swamp timothy management is commonly practiced on areas that lack a reliable source of summer water, but growth and seed formation may be enhanced through irrigation. However, summer irrigations and periodic discing have differing effects on swamp timothy stands at different locations in the Central Valley. For example, irrigations enhance plant growth and seed production in the San Joaquin Valley, but apparently have little impact on seed production in the western Sacramento Valley. The periodic discing of pond bottoms (every 3-7 years) has also resulted in increased plant vigor and seed production in the San Joaquin Valley, although managers in the western Sacramento Valley have maintained productive timothy stands for many years without discing. In general, if the vigor of timothy stands declines significantly over time, regardless of location, discing is strongly recommended.

Establishment: Swamp timothy seeds are present in most Central Valley wetland soils, thus planting is generally unnecessary. Discing may be required to position seeds near the surface if recent soil disturbance has not occurred. Impounding water throughout the fall and winter will create ideal conditions for germination the following spring.

Spring Drawdown: Managers must do everything possible within the constraints imposed by water districts to maintain water until the mid-spring drawdown that will typically encourage swamp timothy development. Coincidentally, the retention of pond water through March assures the availability of protein-rich invertebrates to pre-breeding and breeding ducks. Appropriate drawdown dates are listed above. Swamp timothy seeds should begin to germinate within 2 weeks of drawdown. Rapid drawdowns (3-5 days) typically produce extensive stands of moist-soil vegetation, consisting of relatively few plant species. Slow drawdowns (2-3 weeks) maximize the foraging opportunity for waterfowl and other wetland birds and result in greater diversity of vegetation. Invertebrates, in particular, become concentrated and readily available to ducks.

Irrigations: A shallow "flash" irrigation may be given to swamp timothy stands approximately one month after germination. Extreme care must be taken in this process, however. Maturing plants will not survive flooding which overtops them for more than 10 days, nor will they tolerate flooding once they have produced a seed head. Rainfall may eliminate the need for irrigation in the Sacramento Valley, however San Joaquin Valley wetlands usually require at least one irrigation for optimal swamp timothy development.

Fall Flooding: Flooding should coincide with the arrival of migratory waterfowl. Pintails begin arriving in the Central Valley in mid-August, and peak numbers of wintering waterfowl are usually present during December and January. The flooding of individual units should be staggered to match the habitat requirements of arriving waterfowl, if possible. For example, fall flooding should begin on sites suitable for pintails, such as areas dominated by swamp timothy. The timing of water delivery plays a major role in the determination of flooding schedules, however. Many marsh managers simply execute their fall flooding when irrigation districts make water available. Marsh units should be gradually flooded to allow ducks maximum accessibility to seeds and invertebrates.

Notes: Proper water manipulation may be needed for 1-3 years after initial discing to achieve a robust stand of swamp timothy. If at least a few plants produce a seed crop the first year, ground cover will increase each of the following years due to increased seed production and distribution. Swamp timothy ponds should have 10-35% cattail or tule interspersion to provide cover for loafing waterfowl.

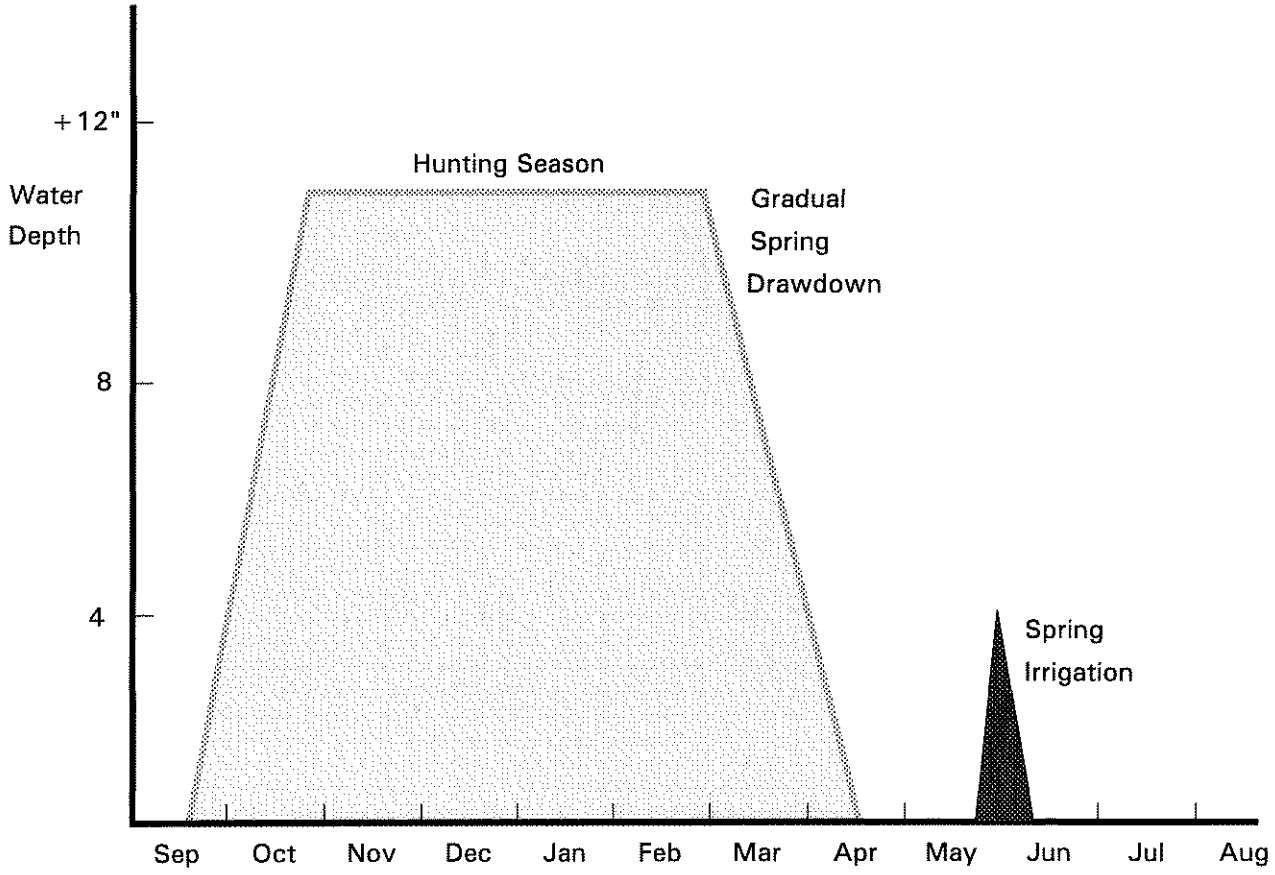

Figure 4. Water management schedule for swamp timothy in the Sacramento Valley.

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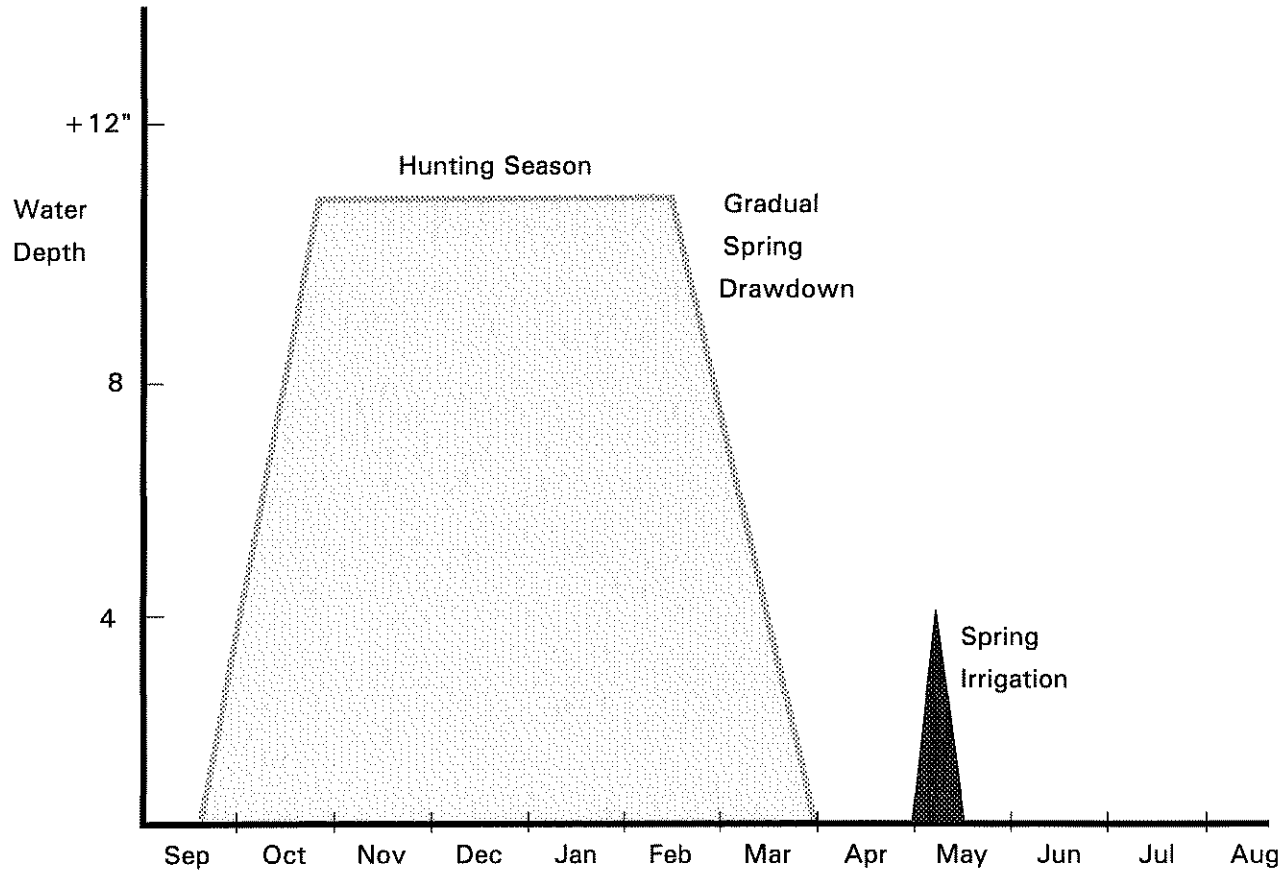

Figure 5. Water management schedule for swamp timothy in the San Joaquin Valley

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Figure 6 Swamp Timothy
Reprinted from Mason
A Flora of the Marshes of California
University of California Press

WETLAND HABITAT MANAGEMENT GUIDE #3

SEASONAL WETLAND

Target Waterfowl Food Plant: Watergrass

Timing of Spring Drawdown:

May 1 -31. Sacramento Valley.
April 15 - May 15. San Joaquin Valley

Moist-soil Plant Community: In addition to watergrass, other desirable wetland plants that may occur under the following water management and soil disturbance schedule include, but are not limited to tules, cattails, sprangletop, ammannia, fat-hen, beggarticks, and smartweed.

Potential Problem Plants: Some wetland plants are undesirable if they become overly abundant or create dense stands. These include but are not limited to tule, cattail, cocklebur, salt grass, bermuda grass, dock, jointgrass, and baltic rush.

Value to Waterfowl: A moist-soil plant community dominated by watergrass is an important component of a diversified marsh management program. Watergrass, also referred to as millet, is an important and very abundant waterfowl food plant in the Central Valley. It is highly attractive to pintails, mallards, and other dabbling ducks, presumably due to its combination of seed production, invertebrate habitat, and thermal cover. Watergrass is a weed that grows in dense stands and may produce in excess of 2,000 lb. of seed/acre. It has substantial stem mass, which provides ducks with thermal cover and protection from predators. Through flooding and waterfowl activity, the stems eventually become matted and serve as excellent substrate for invertebrate production.

Watergrass seeds provide greater balance in nutritive quality than the high-energy, low-protein cereal grains, (e.g. corn, rice). They are especially high in essential minerals. Marsh units dominated by watergrass typically receive heavy duck usage throughout the season. Sprangletop seeds provide waterfowl with a lesser, but still valuable, food source. Ammannia is a plant species that benefits waterfowl, but does not occur in great abundance.

Management Strategy: Watergrass requires more water than other waterfowl food plants, but is an easily propagated wetland plant species. Although an initial seeding may be required, a stand can be sustained for several years with proper water management, which involves late-spring drawdowns and summer irrigations. Unlike other waterfowl food plants, watergrass is commonly propagated in a monoculture. These watergrass units resemble unharvested rice fields in appearance. This management practice maximizes food production at the expense of habitat diversity. However, units can be strategically located so that diverse wetland habitats are nearby. Watergrass is also produced in conjunction with other moist-soil plants in diverse wetland units.

Watergrass and rice have very similar growth requirements. Maximum growth occurs during hot days and warm nights. The establishment (i.e. aerial seeding) of rice can even be used as a local estimate for determining the proper drawdown date for watergrass. Watergrass seed maturation takes approximately 45-80 days, but less time may be required under ideal soil and temperature conditions. Although crops can be established as late as August, seed production is limited due to the cold nights at the end of the growing season. Sprangletop germination generally occurs with late June or July drawdowns. Watergrass grows best in heavy clay or loam soils and will tolerate mildly saline conditions.

Establishment: The introduction of watergrass to a seasonal wetland through seeding usually promotes rapid establishment. Optimal establishment occurs either by: 1) discing, broadcasting the seed, treating the soil with a cultipacker (ring-roller), then flooding for 3-5 days, or 2) through aerial application on saturated soils. The subsequent drawdown should be executed within the time frame in which watergrass locally germinates best (listed under "Timing of Spring Drawdown"). Seeds should begin to germinate within 2 weeks. If germination has not occurred 3 weeks after drawdown, an irrigation will be needed. Irrigation schedules are listed below. Discing prior to seeding reduces plant competition and need not occur if the ground is sparsely vegetated. It may be necessary to repeat the discing process several times to remove dense or robust vegetation. It is important to remember that watergrass is a weed and that drilling or covering the seed is unnecessary. The seed will not germinate if it is buried too deeply in the soil. "Rice cleanings" can be obtained from rice mills and should be applied at 50-100 lb./acre. Though only 10-40% watergrass seed, these have proven quite satisfactory. "Pure" watergrass can be purchased from seed distributors and only requires 15-40 lb./acre.

Spring Drawdown: Managers must do everything possible within the constraints imposed by water districts to maintain water until the late-spring drawdown that will typically encourage watergrass development. Coincidentally, the retention of pond water through April assures the availability of protein-rich invertebrates to breeding ducks. Appropriate drawdown dates are listed above. Watergrass seeds should begin to germinate within 2 weeks of drawdown. Rapid drawdowns (3-5 days) typically produce extensive stands of moist-soil vegetation, consisting of relatively few plant species. Slow drawdowns (2-3 weeks) maximize the foraging opportunity for waterfowl and other wetland birds and result in greater diversity of vegetation. Invertebrates, in particular, become concentrated and readily available to ducks.

Irrigation: Watergrass and other millets are water-dependent plants that require one or two summer irrigations for seed development to occur. Watergrass plants typically show signs of "redness" when soil moisture becomes limiting and the plants are "stressed". Plants will usually be 3-6" high when this condition occurs. At this point the marsh manager may elect to employ either of two strategies. They are as follows:

a) Irrigate Immediately: This method is the most reliable way to produce a highly productive stand of watergrass. The first irrigation should occur when the majority of the plants are turning red, which is generally 4-6 weeks after drawdown. A subsequent irrigation is crucial if plants show redness again. This procedure generally produces a robust stand of watergrass with good seed development. Although ducks may initially have problems utilizing excessively tall

watergrass, weather and feeding activity eventually create openings and facilitate access. Stems serve as an excellent substrate for invertebrates when they become "matted" in the water, therefore, tall watergrass provides good invertebrate habitat.

b) Delay Irrigation Until August: If irrigation water is unavailable until August or if a more open and shorter watergrass stand is desired, then irrigation can be delayed until August. However, under this scenario, high soil moisture must be maintained throughout the remainder of the growing season. This can be accomplished through repeated irrigations or continuous flooding. Early fall flooding (August) can serve as this irrigation. This form of watergrass management is not normally recommended because vegetation response is variable and, therefore, seed production is unreliable.

Fall Flooding: Flooding should coincide with the arrival of migratory waterfowl. Pintails begin arriving in the Central Valley in mid-August, and peak numbers of wintering waterfowl are usually present during December and January. Watergrass units should be flooded between August and October, but the delayed flooding (late November - early December) of an individual unit can make a "new" food source available to wintering waterfowl. The timing of water delivery plays a major role in the determination of flooding schedules, however. Many marsh managers simply execute their fall flooding when irrigation districts make water available. Marsh units should be gradually flooded to allow ducks maximum accessibility to seeds and invertebrates.

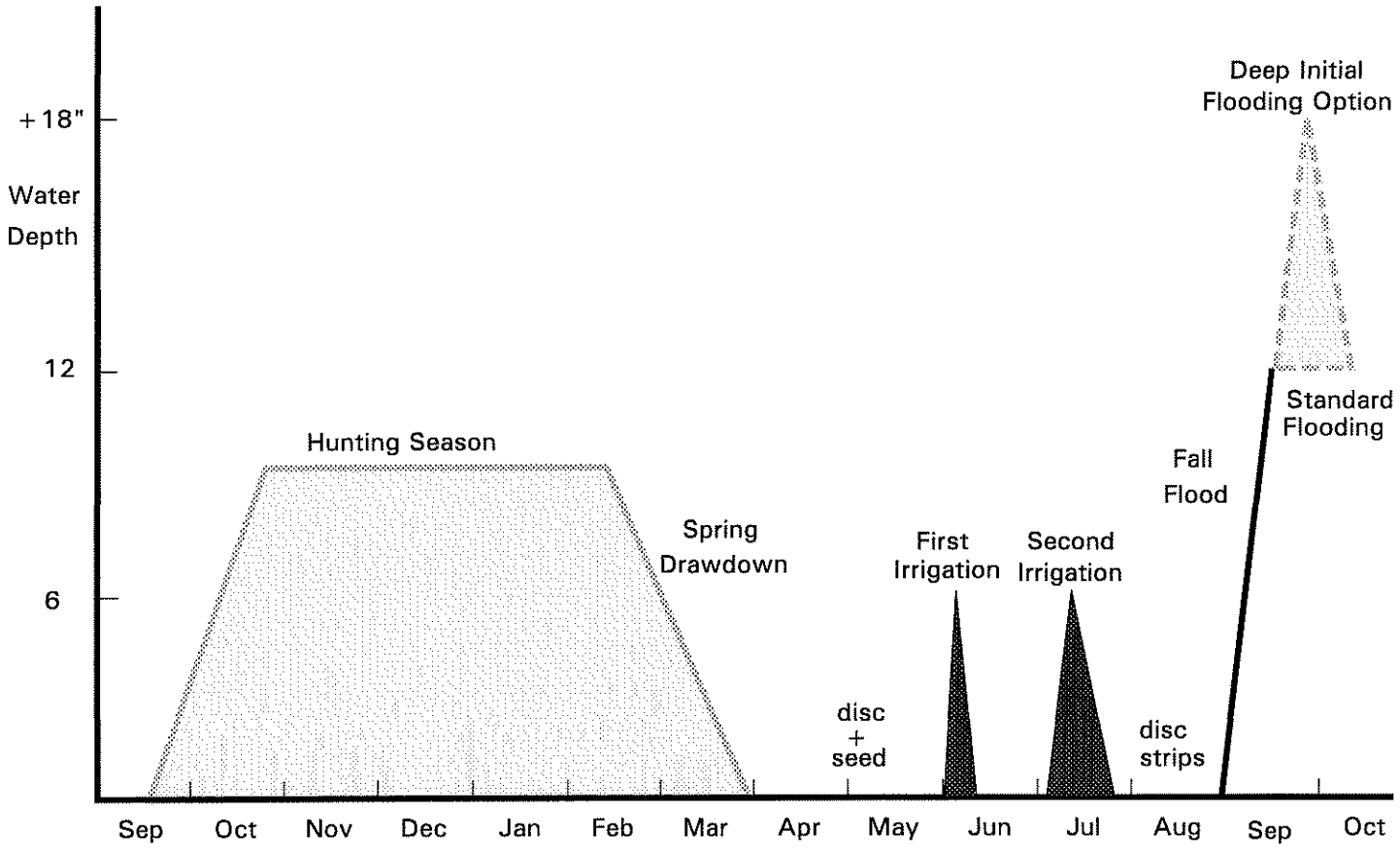

Figure 7. Water management schedule for the initial establishment of watergrass

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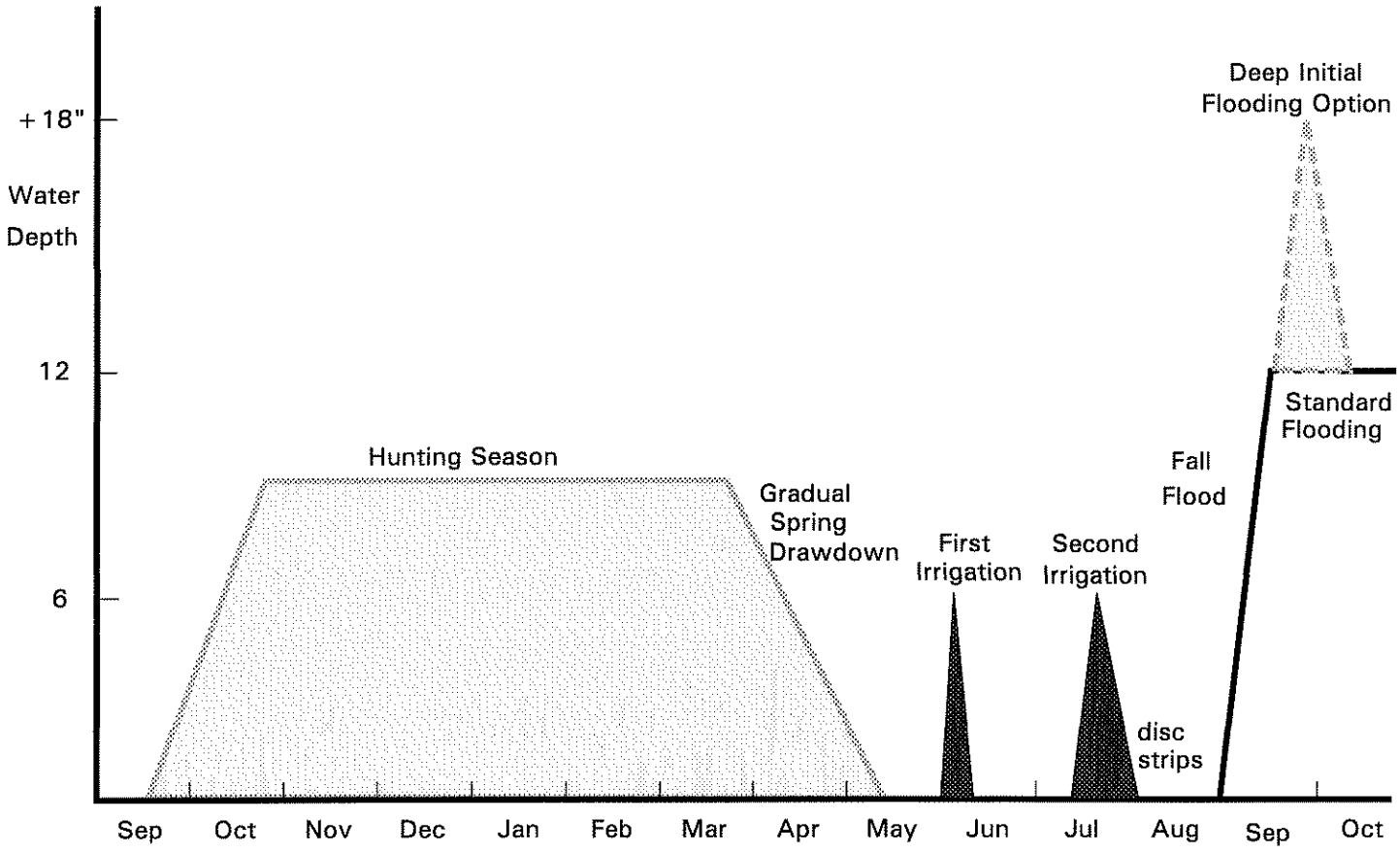

Figure 8. Water management schedule for maintaining stand of watergrass.

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Figure 9 Watergrass

Reprinted from Mason

A Flora of the Marshes of California

University of California Press

WETLAND HABITAT MANAGEMENT GUIDE #4

PERMANENT MARSH

A permanent marsh is a wetland impoundment that incorporates a permanent, year-round flooding regime with dense emergent vegetation, aquatic vegetation, open water, and possibly small islands. These marshes provide critical habitat for wetland wildlife, particularly during the summer when seasonal wetlands are dry. Hardstem bulrush (tules) and cattails are characteristic of permanent marshes. Ideally, these plants cover approximately 50% of the water surface area and the open water area supports extensive beds of submerged aquatic vegetation. Proper management of a permanent marsh satisfies brood-rearing habitat requirements for ducks, therefore, a "brood pond" that is flooded throughout the year in most years will be considered a permanent marsh. Permanent marsh management does not allow for the production of "moist-soil" waterfowl food plants (e.g. watergrass, smartweed, swamp timothy), but does provide waterfowl with a diverse source of invertebrates and aquatic plants.

Value to Waterfowl: Ducks utilize these habitats throughout their annual cycle, but are most dependent upon them during the breeding season and flightless molting period (late spring and summer months). Permanent marshes provide ducks with habitat for brood-rearing, molting (feather replacement), loafing, foraging, and protection from predators. Nestings sites may be available for over-water nesters, such as redheads. Ideally, the pond bottom is uneven, which allows for a diversity of vegetation and optimal foraging depths for various waterfowl and other wetland birds. These habitats are crucial to breeding ducks, wading birds, pheasants, shorebirds, and certain fur-bearing mammals and songbirds due to the lack of summer wetland habitat in the Central Valley. Winter waterfowl use is primarily by gadwalls, mallards, and wood ducks, although permanent marshes are usually attractive loafing sites for a variety of waterfowl. Sago pondweed is a preferred food of many dabbling and diving ducks and typically exists in permanent marshes.

The Central Valley breeding duck population is much larger than it was believed to be in the 1950's, however the factor that ultimately limits the population may be the availability of high quality brood-rearing habitat. Permanent marshes are more productive than the relatively sterile ricefields that breeding ducks use extensively in the Sacramento Valley, thus marsh managers can benefit breeding ducks by establishing permanent marsh habitat whenever practical. Although permanent marshes are typically thought of as brood-rearing habitat, they also serve as molting habitat. Ideal molting habitat is also relatively scarce in the Central Valley. The vast permanent and semi-permanent tule marshes of the Klamath Basin and southern Oregon support large congregations of flightless molting ducks during late summer. Mallards that breed in the Central Valley are known to migrate northward in search of suitable molting habitat and it is possible that other species do as well.

Management Strategy: Permanent marshes are usually maintained at constant water depths, with the circulation of water an important factor in maintaining marsh productivity. Circulation can be achieved with water controls set to provide a "slow flow-through" to offset the effect of evapo-

transpiration. Complete drawdown should occur every 5-7 years to recycle nutrients and control dense emergent vegetation. Overall pond vegetation will increase annually and should be reduced by discing when coverage exceeds 80% of the pond.

Establishment: The construction of a permanent marsh involves establishing uneven topography on the pond bottoms, creating small islands, and the placement of a water distribution and drainage system that allows adequate circulation and complete drainage. Different plants will become established at different water depths.

♦**Size and Location:** Permanent marshes can be of any size, but should be near suitable nesting habitat for ducks to utilize it as brood-rearing habitat. The creation of numerous ponds 5-25 acres in size, scattered throughout a block of wetland habitat generally produces optimum benefits for breeding waterfowl. Generally, such ponds should total no more than 10% of the overall marsh area. The amount and location of permanent marshes on surrounding lands should be taken into consideration when designing a wetland complex.

♦**Gradient:** Pond bottoms of uneven topography tend to develop an interspersion of emergent cover and open water. A water regime that involves the maintenance of water throughout the summer months results in the growth of dense emergent vegetation. Emergent vegetation will become established rapidly in areas where the water depth is less than 2.5 feet. Deeper areas will remain open. Thus, it is important to design a pattern of channels, potholes, and small islands that create a mosaic of open water, dense emergent vegetation, and loafing sites. Potholes and channels should be interconnected and sloped from the inlet to the outlet. This design allows for complete drainage of the pond, which is occasionally necessary for habitat revitalization and the maintenance of water control structures.

♦**Vegetation:** Tules and/or cattails are generally the dominant vegetation in a permanent marsh. Submerged, emergent and floating aquatic vegetation, such as sago pondweed, arrowhead, and duckweed are also common. The position of cover and open water in a permanent marsh is not critical, but consideration should be given to the fact that vegetation serves to protect duck broods from predators. Trees are not generally encouraged in brood-rearing areas because they provide a perch for avian predators, such as hawks and owls. Most managers maintain permanent marshes for the purpose of raising ducks broods. Thus, if it is the manager's intent to maximize duck brood survival, then the establishment of nearby trees is not recommended. However, trees provide outstanding habitat in seasonal wetlands for many species of wintering waterfowl, particularly mallards and wood ducks.

♦**Islands**: The presence of islands in a permanent marsh increases the benefits to waterfowl and other wildlife. They are not essential, but provide additional habitat diversity. Islands can provide important loafing habitats during the wintering, molting, and brood-rearing periods. Ducks prefer barren loafing areas in the fall, thus a late summer burn can be used to provide them with a "clean" site. Winter rains and pond edge moisture will insure that cover is available for duck broods the following spring. Historically, small mounds were naturally created by physical processes such as erosion and silt deposition and were probably low and gently sloping. Man-made mounds should emulate these natural formations. Gentle

slopes will also result in a large "band" of vegetation around the island, creating more emergent cover and diversity.

WETLAND HABITAT MANAGEMENT GUIDE #5

BROOD POND

Flooding Schedule

Fall Flooding: October 1 preferred
Summer Drawdown: July 15 - August 1

A semi-permanent marsh is a wetland impoundment that incorporates a semi-permanent flooding regime with dense emergent vegetation, aquatic vegetation, moist-soil plants, open water, and possibly small islands. In the Central Valley, they are typically flooded from fall until mid-summer to meet the brood-rearing habitat requirements of local waterfowl. For this reason, semi-permanent marshes are often referred to as "**brood ponds**". They provide critical habitat for wetland wildlife, particularly during the summer when seasonal wetlands are dry. Hardstem bulrush (tules) and cattails are characteristic of brood ponds. Brood pond management limits the growth of "moist-soil" waterfowl food plants (e.g. smartweed, swamp timothy), but creates valuable escape cover for duck broods. Brood ponds also provide ducks with a diverse food source of invertebrates and aquatic plants.

Value to Waterfowl: Ducks utilize brood ponds throughout much of their annual cycle, but are most dependent upon them during the late spring and summer when aquatic invertebrates are their primary food source and relatively few wetland areas are flooded. Invertebrates, which are high in protein, are readily available to ducks in both seasonal and semi-permanent marshes during drawdowns. Seasonal wetlands in the Central Valley are typically dry and of little value to ducks during the summer. Although permanent marshes are flooded during the summer, invertebrates are not highly available to ducks in these deep-water marshes. Research has shown that while gadwall hens and their broods utilize permanent marshes extensively, hen mallards with broods prefer shallow seasonal or semi-permanent wetlands over permanent marshes when both habitat types are available. Thus, brood ponds (especially during drawdown) and other semi-permanent wetlands appear to be the preferred feeding habitat for Central Valley mallards during the summer.

Brood ponds typically support vigorous stands of cattails and/or tules. The maintenance of a productive brood pond generally requires periodic vegetation manipulation, however. Studies have shown that wetlands exhibiting the "hemi-marsh" 50:50 cover to open water ratio are ideal habitats for breeding ducks. Frequent discing will accomplish nutrient cycling and insure that the marsh remains in a productive state. Brood ponds also provide excellent loafing habitat for wintering waterfowl, particularly mallards and wood ducks.

Management Strategy: Brood ponds should be flooded continuously from the fall until at least July 15, but preferably August 1. The presence of summer water encourages cattail and/or tule growth in shallow areas, which provides ideal escape cover for duck broods. Discing, mowing, and

burning are methods that can be used to maintain brood ponds in the 50:50 "hemi-marsh" state. Moderate production of moist-soil vegetation may occur (e.g. watergrass), although seed development is hindered by the short period between drawdown and fall flooding, as well as competition from dense emergent vegetation.

In the Central Valley, many wetlands that remain flooded during the spring and summer months are enrolled in the USDA Water Bank Program. Landowners receive annual payments for this provision of brood habitat and may only begin draining these units on established dates between June 15 and July 15. The flightless molting period and part of the brood-rearing period may occur after some Water Bank units have been drained, thus the maintenance of water beyond the contractual calendar date may provide increased benefits to brood-rearing and molting ducks. The timing of fall flooding is not crucial because seasonal wetlands provide the majority of the habitat for early migrant waterfowl. Flooding of brood ponds should occur after maintenance work (i.e. discing, mowing) has been completed.

Note: The presence of summer water benefits ducks and other wetland wildlife, but also may produce mosquitos. Landowners should check with their local mosquito abatement district for guidelines.

WETLAND HABITAT MANAGEMENT GUIDE #6

SEASONAL WETLAND - SUMMER WATER COMBINATION

Most wetland impoundments have borrow ditches on the "inside" or "pond" side of exterior levees. Borrow areas are created during levee construction and are generally 12-24" lower than the average elevation of the pond bottom. A marsh management practice that is becoming increasingly popular in the Central Valley involves the maintenance of summer water in the borrow areas or channels that exist within otherwise drained seasonal wetlands. These flooded borrow areas/channels typically comprise less than 5% of a wetland impoundment, but can be extremely productive habitats. Without impairing the capability of a wetland unit to produce large quantities of "moist-soil" waterfowl food plants, marsh managers can provide critical summer habitat for wetland-dependent wildlife in the low areas of their seasonal wetlands. These wet summer habitats may be drained in August or maintained throughout the year. Such wetlands may be extremely important summer feeding areas for breeding and post-breeding ducks, ducklings, pheasants, wading birds, and shorebirds. These feather-edged habitats offer more upland/wetland interface, and thus a more productive feeding habitat, than do typical "brood ponds" which are generally flooded "levee-to-levee".

Value to Waterfowl: Ducks utilize these flooded borrow areas/channels during the late spring and summer when aquatic invertebrates are their primary food source and relatively few wetland areas are flooded. Invertebrates, which are high in protein, are readily available to ducks in seasonal marshes during spring drawdowns. However, seasonal wetlands in the Central Valley are typically dry and of little value to ducks during the summer. Although permanent marshes are flooded during the summer, invertebrates are not highly available to ducks in these deep-water marshes. Research has shown that while gadwall hens and their broods utilize permanent marshes extensively, hen mallards with broods prefer shallow seasonal or semi-permanent wetlands over permanent marshes when both habitat types are available. Thus, flooded borrow areas/channels within seasonal marshes and "brood ponds" would appear to be the preferred feeding habitat for Central Valley mallards during the summer.

Flooded borrow areas/channels provide some escape cover for duck broods, but function primarily as invertebrate-rich feeding areas for duck broods and other wetland wildlife. Ideally, brood ponds should be located nearby to provide ducks with optimum cover. Although these wet summer habitats are important to duckling survival, they may also be extremely important to the survival of young pheasants. Pheasant chicks are completely dependent on insects as a food source during their first 2 weeks of life; the "feather-edges" of these semi-permanent wetlands support good insect populations.

Management Strategy: The management of a seasonal wetland in combination with a flooded borrow area/channel component involves flooding the entire pond during the fall and draining the majority of the pond during the spring, while maintaining water in borrow areas/channels until at least July 15. However, managers are encouraged to maintain water in borrow areas/channels throughout the entire year at stable levels. This practice is compatible with

the interests of mosquito abatement districts because a mosquito fish population can be established and continuously maintained. These wetland areas generally encompass such small acreage that the amount of water required to maintain them is minimal. In addition to providing mosquito fish, these sites also provide a brood stock of midges. This management practice is thought to increase the production of midge larvae substantially in the pond during the following winter. The worm-like larvae of the midge fly is a major invertebrate food source for pintails and green-winged teal.

Channels or borrow areas may be constructed in wetlands that do not have existing topographic diversity. The depth of these channels may range from 6"-36". Although inexpensive to construct, shallow channels (6"-12") typically require periodic maintenance (e.g. discing) due to the invasion of tules and/or cattails that results from the presence of summer water. Deep (30"-36") channels prohibit tule/cattail growth and require minimal maintenance, but the cost of excavation can be extremely high. Generally, shallow channels are more productive than deeper areas, but either can greatly enhance the value of a seasonal wetland.

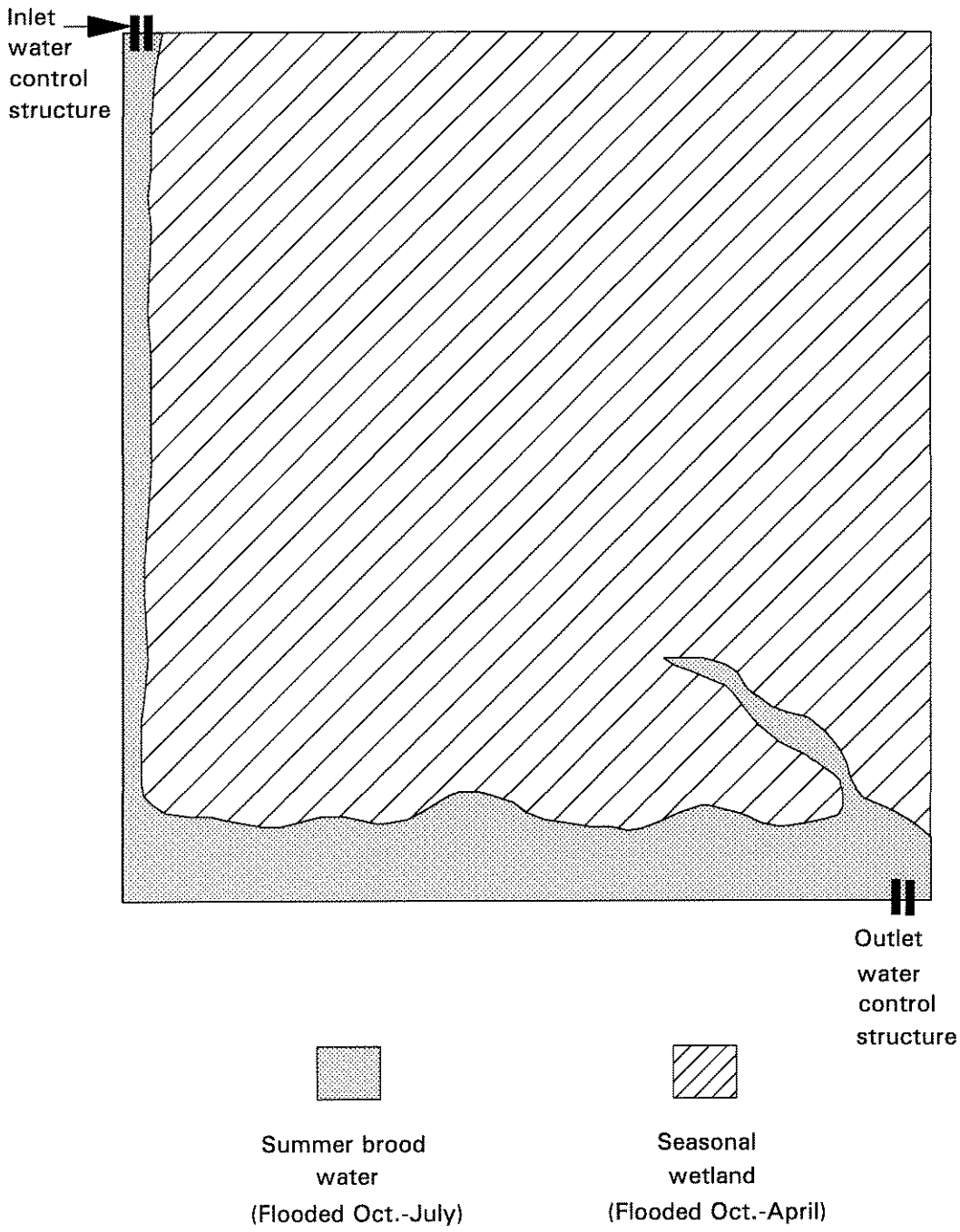

Figure 10. Seasonal Wetland - Summer Water Combination

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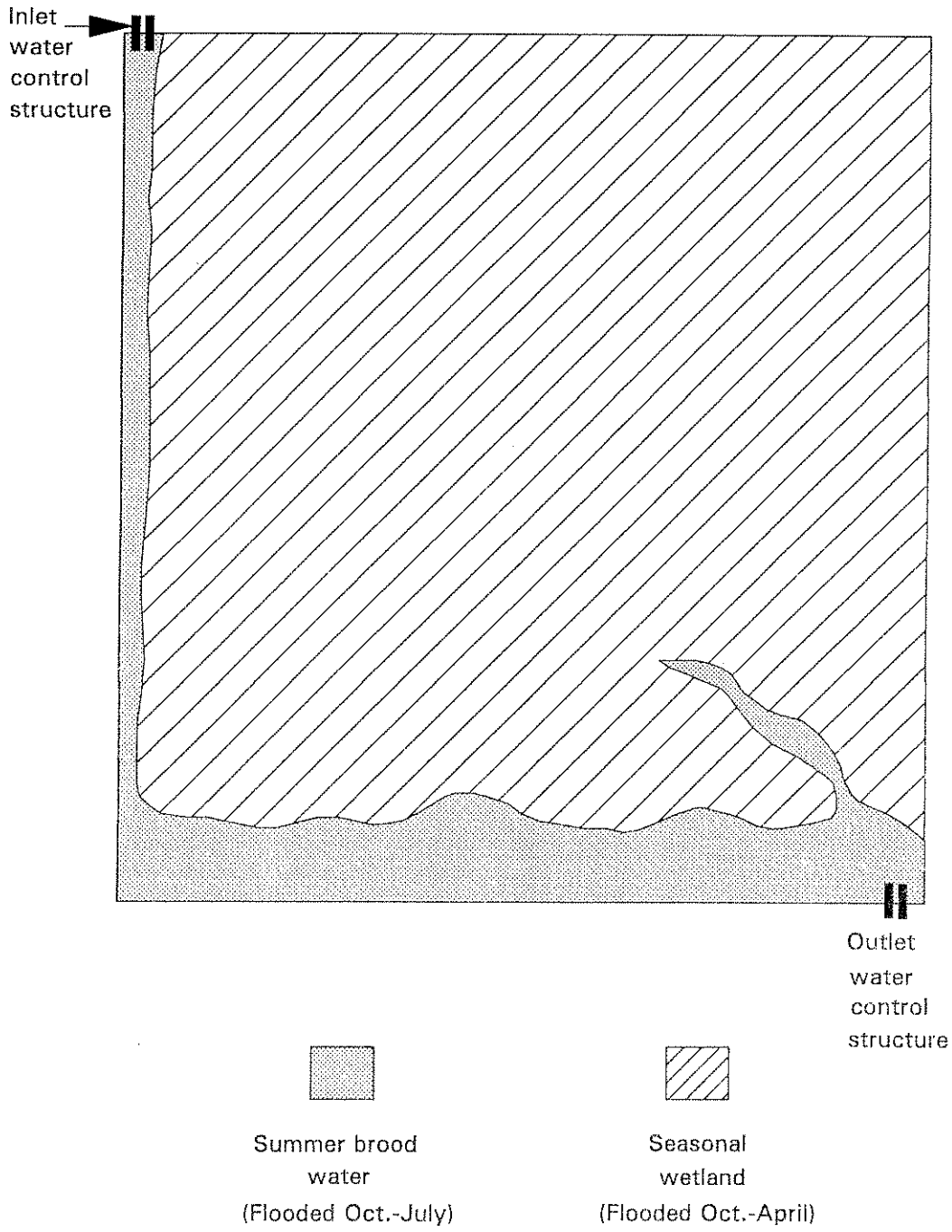

Figure 10. Seasonal Wetland - Summer Water Combination

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Appendix A. Common and scientific names of plants named in text.

PLANTS

Common Name	Scientific Name
Ammannia	Ammannia coccinea
Asters	Aster spp.
Annual atriplex or fat-hen	Atriplex spp.
Water hyssops	Bacopa spp.
Beggarticks	Bidens spp.
Goosefoot	Chenopodium spp.
Brass buttons	Cotula corinopifolia
Alkali weed	Cressa truxillensis
Pricklegrass	Crypsis niliaca
Bermuda grass	Cynodon dactylon
Chufa	Cyperus esculentus
Salt grass	Distichilis spicata
Watergrass	Echinochloa crusgalli
Burhead	Echinodorus cordifolius
Spikerushes	Eleocharis spp.
Alkali heath	Frankenia grandifolia
Swamp timothy	Heleochloa schenoides
Baltic rush	Juncus balticus
Sprangletop	Leptochloa fascicularis
Duckweeds	Lemna spp.
Jointgrass	Paspalum distichum
Sago pondweed	Potamogeton pectinatus
Smartweed	Polygonum lapathifolium
Dock	Rumex crispus
Widgeongrass	Ruppia maritima
Arrowheads	Sagitarria spp.
Tule or hardstem bulrush	Scirpus acutus
River bulrush	Scirpus fluviatilis
Alkali bulrush	Scirpus robustus
Cattails	Typha spp.
Cocklebur	Xanthium strumarium
Horned pondweed	Zannichellia palustris