



## Winter management of California's rice fields to maximize waterbird habitat and minimize water use



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### ABSTRACT

Rice agriculture provides habitat for waterbirds in California's Sacramento Valley, a region that has lost over 90% of natural wetlands. Developed as an agronomic practice, winter-flooding of rice fields also provides habitat for waterbirds but alternatives are needed with predicted declines in water availability. During the winters of 2009–2010 and 2010–2011, we compared waterbird density and water depths of Sacramento Valley rice fields in four post-harvest management treatments that varied in the amount of water used: maintenance flooding, one-time flooding, non-flooded with boards left in water control structures, and non-flooded with boards removed from water control structures. Densities of waterbirds were higher in the flooded treatments compared to non-flooded treatments. One-time flooding provided the most suitable water depths for shorebirds and long-legged waders while maintenance flooding provided the most suitable water depths for dabbling ducks. Our results confirm that the practice of winter-flooding rice fields provides waterbird habitat. However, increased habitat value and potentially less water use could be achieved using a combination of traditional and alternative flooding practices.

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### 1. Introduction

Habitat loss is one of the primary threats to wildlife throughout the world (Wilcove et al., 1998). For waterbirds, habitat has been lost as wetlands have been drained and converted to agriculture, flood plains have been disconnected from rivers and developed, and bays and lagoons have been dredged or filled (Framer et al., 1989; Finlayson and Davidson, 1999). Furthermore, waterbird habitat is projected to be vulnerable to climate change, as warming temperatures and increasing demand by people decrease water availability (Joyce et al., 2011; Gardali et al., 2012). In the face of these stressors, waterbird conservation depends on finding creative solutions to maintain habitat availability.

Rice fields provide important alternative habitat for waterbirds in many of the world's regions where natural wetlands have been degraded or altered (Remsen et al., 1991; Fasola and Ruiz, 1996; Lawler, 2001). Rice fields in the Central Valley of California are one reason the region is internationally important for waterbirds. Over

350,000 shorebirds and almost 3 million dabbling ducks use the region each year (Shuford et al., 1998; Collins et al., 2011), despite the loss of over 90% of the seasonally inundated wetlands that historically were present (Framer et al., 1989; Heitmeyer et al., 1989).

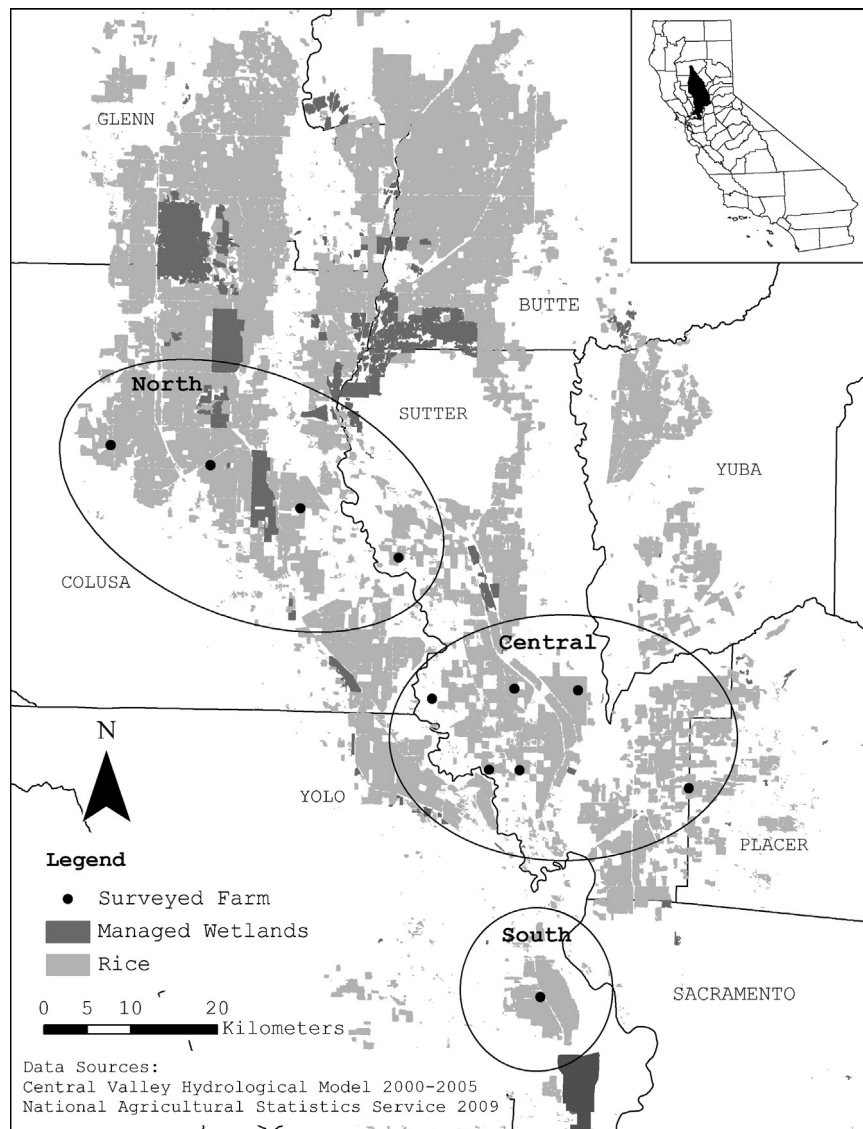
In California, 96% of all rice cultivation occurs in the Sacramento Valley (Fig. 1). Annually, over 140,000 ha (67%) of harvested rice fields in the Sacramento Valley are flooded in winter providing 85% of all flooded habitat in this region (CVJV, 2006) and supporting over 50 species of waterbirds (Day and Colwell, 1998; Elphick and Oring, 1998). California rice provides habitat for 9 species of dabbling ducks, 8 species of long-legged waders and 13 species of shorebirds (Elphick and Oring, 1998; Eadie et al., 2008), including three species of special concern in the state of California and two species of federal conservation concern (Shuford and Gardali, 2008; USFWS, 2008).

State regulations enacted in the 1990s restricting the amount of post-harvest rice stubble burning (Rice Straw Burning Act, AB 1378, 1991) resulted in an increase in the amount of rice that is winter-flooded to promote decomposition of rice stubble (crop-related plant material remaining in the field after harvest). The shift from burning to flooding for stubble decomposition had the unintended consequence of creating high value habitat for waterbirds (Fleskes et al., 2005; Miller et al., 2010) while providing agronomic benefits to farmers (Bird et al., 2000) and increasing the recreational value of rice through waterfowl hunting opportunities. Changes in water availability threaten the environmental,

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**Fig. 1.** Location of rice farms surveyed for waterbirds in the Sacramento Valley, CA, December–January 2009–2010 and 2010–2011. Farms are grouped according to region (see Section 2.4).

agronomic, and cultural benefits of winter-flooded rice fields and present an opportunity for stakeholders to work collaboratively and develop rice field management practices that provide multiple benefits. Most winter-flooding is implemented for agronomic reasons but developing a better understanding of the consequences that these flooding practices have on waterbird habitat would allow an evidence-based approach to waterbird conservation strategies in California rice (Sutherland et al., 2004).

Specific habitat requirements vary among waterbird guilds (i.e. dabbling ducks, long-legged waders, shorebirds) using winter-flooded rice fields of the Sacramento Valley and must be considered when designing new field management practices to enhance rice for waterbirds. The specialized feeding ecology of shorebirds requires water depths less than 15 cm (Elphick and Oring, 1998; Isola et al., 2000; Taft et al., 2002). Traditional water depths of winter-flooded rice fields are 20–25 cm (Elphick and Oring, 1998); these depths are appropriate for many waterfowl but do not provide habitat for shallow water obligates such as shorebirds (CVJV, 2006). In addition to specific water depths, shorebirds and dabbling ducks prefer open expanses of habitat for foraging and roosting (Helmers, 1992; Isola et al., 2000), the availability of which can be affected by post-harvest field

management. Long-legged waders have less restrictive habitat requirements and use a variety of habitat types, including vegetated and open, flooded and non-flooded (Butler, 1992; McCrimmon et al., 2001). Given the varied needs of waterbirds and the importance of winter-flooded rice, it is necessary to develop field management practices that create diversity in rice field conditions seasonally that are compatible with agriculture and waterbirds.

In the winters of 2009–10 and 2010–11, we used an experimental approach to (1) evaluate the effectiveness of four post-harvest management practices developed and designed in collaboration with rice farmers and the rice growing community, including two intentionally flooded treatments (maintenance flooding and one-time flooding) and two passively flooded treatments (boards-in and boards-out), to provide habitat for three guilds of wintering waterbirds (dabbling ducks, long-legged waders, shorebirds), (2) determine if the effectiveness of each treatment changes through the winter, (3) evaluate the effect of four habitat variables (water depth, rice stubble, dirt clods and rainfall) on bird use of each treatment, and (4) determine if leaving boards-in water control structures could provide shallow water habitat specifically for shorebirds.

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