Research Article

Energetic Carrying Capacity of Actively and Passively Managed Wetlands for Migrating Ducks in Ohio

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ABSTRACT Habitat conservation strategies of the North American Waterfowl Management Plan (NAWMP) are guided by current understanding of factors that limit growth of waterfowl populations. The 1998 implementation plan of the Upper Mississippi River and Great Lakes Region Joint Venture (UMR and GLRJV) assumed that availability of foraging resources during autumn in wetlands actively managed for waterfowl was the primary limiting factor for duck populations during the nonbreeding season. We used multistage sampling during autumn and spring 2001–2004 to estimate energetic carrying capacity (ECC) of actively and passively managed wetlands in Ohio, USA, and examine this assumption. Energetic carrying capacity during autumn was similar between actively and passively managed wetlands each year. Averaged across years, energetic carrying capacity was 3,446 and 2,047 duck energy-days (DED)/ha for actively and passively managed wetlands, respectively. These estimates exceeded the UMR and GLRJV assumption that 1,236 DED/ha were provided by managed wetland habitats. Energetic carrying capacity declined each year by >80% between autumn and spring migration. Consequently, ECC of actively and passively managed wetlands was low during spring ($\bar{x}$ = 66–242 DED/ha). These results suggested that duck foraging resources in actively and passively managed wetland habitats are abundant during autumn, but overwinter declines may create food-limiting environments during spring.
(JOURNAL OF WILDLIFE MANAGEMENT 71(8):2532–2541; 2007)

DOI: 10.2193/2006-401

KEY WORDS active management, duck energy-days, energetic carrying capacity, migration, Ohio, passive management, waterfowl, wetland restoration.

Conservation and management of waterfowl populations in North America have been guided since 1986 by goals and objectives of the North American Waterfowl Management Plan (NAWMP). Success of the NAWMP is predicated on identifying factors limiting population growth, and mitigating their effect through landscape-scale habitat conservation and management (Williams et al. 1999). Diet quality and wetland habitat conditions may affect waterfowl body condition, survival, and subsequent recruitment (Heitmeyer and Fredrickson 1981, Delnicki and Reinecke 1986, Reinecke et al. 1987). Consequently, the Upper Mississippi River and Great Lakes Region Joint Venture (UMR and GLRJV) assumed that availability of foraging resources was the factor during migration and winter most likely to limit waterfowl populations. The UMR and GLRJV thus established habitat objectives for migrating and wintering waterfowl from bioenergetic models that estimate quantities of habitats necessary to satisfy seasonal energy demands of waterfowl (NAWMP Plan Committee 2004).

A hallmark of the NAMWP is its recognition that conservation objectives and strategies should be based on existing knowledge of waterfowl ecology and refined subsequently with contemporary science. The 1998 NAWMP update (NAWMP Plan Committee 1998) advocated explicitly for evaluations of biological foundations. This stimulated several examinations of the assumptions and parameter values of Joint Venture bioenergetic models (e.g., Naylor 2002, Olson 2003, Penny 2003, Greer 2004, Rutka 2004). We designed this study to evaluate selected assumptions of a bioenergetics model for the UMR and GLRJV.

Habitat objectives of the UMR and GLRJV were derived under the following assumptions: 1) average energetic carrying capacity (ECC) of nonagricultural, managed wetlands equals 1,236 duck energy-days (DED)/ha, where 1 DED represents the daily energy requirement of a mallard-sized duck (*Anas platyrhynchos*; Prince 1979, Reinecke et al. 1989); 2) ducks satisfy energy demands principally from wetlands managed for waterfowl; 3) availability of foraging resources is more limiting during autumn than spring; and 4) meeting habitat objectives to support waterfowl during autumn migration is sufficient to support waterfowl during spring migration (UMR and GLRJV Management Board 1998). The UMR and GLRJV implicitly assumed that unmanaged or passively managed wetlands on private land would not contribute substantially to meeting energy demands of migrating waterfowl. However, wetland restoration and creation in the United States have been promoted successfully through federal and state conservation programs (Heard et al. 2000). Many restoration and creation efforts occur on private land, and management activities may be infrequent, nonexistent, or inconsistent with traditional waterfowl management practices (e.g., moist-soil management [Fredrickson and Taylor 1982]). Yet few attempts have been made to document the potential for restored and

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