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The role of protected area wetlands in waterfowl habitat conservation: Implications for protected area network design

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ABSTRACT

The principal goal of protected area networks is biodiversity preservation, but efficacy of such networks is directly linked to animal movement within and outside area boundaries. We examined wetland selection patterns of mallards (*Anas platyrhynchos*) during non-breeding periods from 2010 to 2012 to evaluate the utility of protected areas to migratory waterfowl in North America. We tracked 33 adult females using global positioning system (GPS) satellite transmitters and implemented a use-availability resource selection design to examine mallard use of wetlands under varying degrees of protection. Specifically, we examined effects of proximities to National Wildlife Refuges, private land, state wildlife management areas, Wetland Reserve Program easements (WRP), and waterfowl sanctuaries on mallard wetland selection. In addition, we included landscape-level variables that measured areas of sanctuary and WRP within the surrounding landscape of each used and available wetland. We developed 8 wetland selection models according to season (autumn migration, winter, spring migration), hunting season (present, absent), and time period (diurnal, nocturnal). Model averaged parameter estimates indicated wetland selection patterns varied across seasons and time periods, but ducks consistently selected wetlands with greater areas of sanctuary and WRP in the surrounding landscape. Consequently, WRP has the potential to supplement protected area networks in the midcontinent region. Additionally, seasonal variation in wetland selection patterns indicated considering the effects of habitat management and anthropogenic disturbances on migratory waterfowl during the non-breeding period is essential in designing protected area networks.

1. Introduction

Conservation practitioners use protected areas as primary and effective tools to preserve biodiversity, and a diverse array of ecosystem types is included in the global protected area network (Rodrigues et al., 2004; Scott et al., 2001). However, global, regional, and local environmental drivers such as climate change, land use change, and anthropogenic disturbance have the potential to drastically alter surrounding landscapes (Faleiro et al., 2013; Groom et al., 2006; Hannah et al., 2007; Mantyka-Pringle et al., 2012). As a result, the effectiveness of protected areas can be limited if sites are isolated and/or if the surrounding landscape is not considered in area design (Margules and Pressey, 2000; Newmark, 1996).

To mitigate effects of protected area isolation, conservationists develop networks of protected areas that collectively account for landscape composition, structure, and function to spatially distribute risk and address life history needs of highly mobile organisms (Margules and Pressey, 2000). Protected areas and protected area networks also often encompass properties owned by multiple conservation groups with disparate goals. Consequently, many protected area networks balance biodiversity preservation with other working economic uses. For example, conservation planners may have to address conflicts among publicly owned protected areas and other conservation areas managed by private individuals or organizations (Hannah, 2010; Knight, 1999; Rissman et al., 2007).

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In mid-continent North America, protected wetlands provide an excellent example of a functional protected area network. Wetlands provide a variety of cultural, economic, and ecological benefits, including flood control, pollution mitigation, recreation opportunities, and wildlife habitat (Costanza et al., 1997; Zedler and Kercher, 2005). However, wetlands have declined in the contiguous United States by approximately 53% since European settlement, and wetlands currently exist within a fragmented patchwork landscape, often with reduced capacities to provide vital ecosystem services (Dahl, 2011; Mitsch and Gosselink, 2007; Zedler and Kercher, 2005). To mitigate effects of wetland loss and degradation, federal and state agencies in the United States have opportunistically acquired and protected wetlands through various conservation initiatives (Curtin, 1993; Scott et al., 2004). The U.S. Fish and Wildlife National Wildlife Refuge (NWR) System and state wildlife management areas (WMA) were among the first functional protected area networks in the world, establishing protected areas beginning in 1903, although these areas are often managed independently of one another (Curtin, 1993).

In recent years, public conservation agencies and non-governmental organizations (NGOs) have emphasized the importance of incorporating private and working lands into wetland protected area networks in the midcontinent region (King et al., 2006; Knight, 1999; North American Waterfowl Management Plan Committee, 2012). Conservation easement programs are one mechanism used by conservation planners to preserve biodiversity on privately owned lands (King et al., 2006; Schoenholtz et al., 2001). The largest public conservation easement program specifically targeted to conserving wetland habitat for wildlife is the Natural Resources Conservation Service Wetlands Reserve Program (WRP), which was first authorized in the Food, Agriculture, Conservation, and Trade Act of 1990 (i.e. Farm Bill) (United States Congress, 1990). Along with other conservation easements held by land trusts (e.g. Wetlands America Trust), WRP has significantly contributed to wetland habitat and conservation goals throughout North America (Kaminski et al., 2006; King et al., 2006; Schoenholtz et al., 2001). However, WRP and other conservation easement programs may provide limited benefits to wildlife due to minimal management and/or anthropogenic activities.

Waterfowl populations are among the fauna that may benefit from the network of protected wetlands in North America. In the midcontinent region, waterfowl hunting is a prominent and traditional recreational activity, and as such, protected wetlands have been managed by numerous conservation entities with a broad range of interests (Jenkins et al., 2010). However, the relative role of various types of protected areas in migratory waterfowl conservation remains unclear (Olmstead et al., 2013; Rissman et al., 2007; Waddle et al., 2013). Although recent research has evaluated waterfowl abundance on private conservation easements and WMAs, abundance studies often do not account for wetland availability (Evans-Peters et al., 2012; Kaminski et al., 2006; Lancaster, 2013; Olmstead et al., 2013; Tapp, 2013). Research on wetland selection accounts for wetland availability and assumes that waterfowl are choosing from a suite of wetlands within a defined area (McDonald et al., 2012). Relatively few studies have compared waterfowl wetland selection patterns among private conservation easements, federally managed wetlands, state managed wetlands, or wetlands on working lands. Thus, our objective was to examine the utility of protected area wetlands to migratory waterfowl during the non-breeding period within the framework of a use-availability resource selection design. To meet this objective, we tracked adult female mallards (*Anas platyrhynchos*) using global positioning system (GPS) satellite transmitters and developed multinomial discrete choice models that accounted for variance in wetland type. We used the mallard because it is a generalist waterfowl species that is the focus of extensive wetland protection, restoration, and management throughout North America (Drilling et al., 2002; Johnson et al., 1997). Under the Federal Water Pollution Control Act of 1972 (33 USC 1251), many wetlands on private land have some measure of jurisdictional protection in the United States. However, we did not consider wetlands on private land (except those enrolled in conservation easement programs) to be within the protected area network because these wetlands have greater potential to be influenced by changing land use trends, variation in regulation and enforcement measures, and fluctuating economic conditions (Dahl, 2011).

2. Materials and methods

2.1. Capture and GPS telemetry

Adult female mallards (after hatch year) were captured in two separate groups in 2010 and 2011 (Beatty et al., 2013). The first group was captured near Yorkton, Saskatchewan, Canada (51°13′N 102°28′E) in late September 2010 whereas the second group was captured at multiple locations in Arkansas, USA in February 2011 under federal banding permit 06569 (Five Oaks Duck Lodge at 34°20′N, 91°36′E; Bayou Meto Wildlife Management Area at 34°13′N, 91°31′E; Black River Wildlife Management Area at 36°03′N, 91°09′E) (Beatty et al., 2013). Reasonable efforts were made by Arkansas Game and Fish Commission and Ducks Unlimited Canada field personnel to minimize animal stress, and capture and handling procedures were initially described in Beatty et al. (2013). Briefly, we captured adult female mallards with rocket nets or swim-in traps and fit captured birds with a Teflon-ribbon harness equipped with a solar-powered global positioning system (GPS) satellite transmitter (Argos/GPS PTT 100, Microwave Telemetry, Inc., Columbia, Maryland, USA; ±18 m accuracy) programmed to obtain four GPS fixes (i.e. locations) per day. We attached transmitters with a harness design based on Malecki et al. (2001). For all birds captured in Arkansas, combined transmitter and harness accounted for <4% of body mass, and <3% of body mass in 18 of 20 individuals. Marked birds were monitored until transmitters failed or were immobile for at least one day (Beatty et al., 2013). Because waterfowl spend relatively small proportions of time in flight, we assumed all GPS locations were obtained when birds were on the ground (Pearse et al., 2011).

2.2. Delineating seasons and spatial scale

Public wildlife management areas, private lands, and conservation easements spatially and temporally vary in habitat condition (i.e. flooding) and food availability (De Steven and Gramling, 2012; Evans-Peters et al., 2012; Olmstead et al., 2013). In addition, mallard wetland use may differ across the non-breeding period in accordance with nutritional and energetic requirements of annual cycle events (Drilling et al., 2002). We separated the non-breeding portion of the annual cycle into three seasons (autumn migration, winter, spring migration) according to methods outlined in Beatty et al. (2013). Briefly, we modeled an empirical movement metric (net displacement) using single and double sigmoid functions to estimate timing of autumn and spring migrations for individual birds (Beatty et al., 2013). A subset of ducks ($n = 14$) did not have sufficient data to be included in migration models; therefore we used mean migration dates according to year to delineate seasons for those individuals (Beatty et al., 2013, 2014).

Resource selection patterns may vary due to differences in the distribution of resources across spatial scales (Johnson, 1980; McDonald et al., 2012). To specifically identify a behaviorally relevant spatial scale for wetland selection, we examined movement patterns from individual birds throughout the non-breeding