Mallard Brood Movements and Wetland Selection in the Canadian Prairie Parklands

By

Garnet Harold Raven

A Thesis Submitted to the
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in Partial Fulfillment of the Requirements
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Abstract

Nest success is the most important determinant of population growth in prairie waterfowl, and tremendous resources have been allocated to increasing nest success as part of the North American Waterfowl Management Plan. Although brood survival is also important to mallard (*Anas platyrhynchos*) recruitment rates, knowledge of brood ecology is severely lagging relative to nest success. My study addresses this information gap by exploring mallard brood movements and wetland selection. An increased understanding of mallard brood behaviour will allow landscape management decisions to be more considerate of brood needs, and should lead to greater recruitment.

Data were collected in conjunction with the Prairie Habitat Joint Venture (PHJV) Assessment project from 15 65-km^2 study areas located throughout the Canadian prairie parklands. A total of 308 mallard broods were radio-tracked from hatch until 30-days post-hatch. Models were constructed to predict movement probability (repeated-measures logistic regression) and movement distance (ANCOVA) of broods in relation to brood age, date, and study area. A backwards-elimination procedure was used to simplify models by eliminating non-significant ($P > 0.05$) effects. Models also were constructed to predict wetland selection in relation to wetland permanence, cover type, width of flooded emergent vegetation, brood age, date, dominant vegetation, and percent of seasonal wetlands inundated with water. Information-theoretic techniques were used to select the best fitting models.

Movement probability generally decreased with age, although results varied by hatch date and study area. Later hatched broods moved farther than early hatched broods. Permanence, cover type, the width of flooded emergent vegetation, and the dominant

species of vegetation were all important predictors of wetland selection. More permanent wetlands were preferred to ephemeral wetlands, especially in the late brood-rearing season. Semipermanent wetlands dominated by bulrush (*Scirpus* spp.) were preferred, whereas semipermanent wetlands dominated by cattail (*Typha* spp.) were avoided. Seasonal wetlands dominated by sloughgrass (*Beckmannia syzigachne*) were also avoided.

Future management of habitats to enhance duck nest success should also consider brood survival. Based on my results, mallards clearly prefer wetlands with adequate water and flooded emergent cover. These habitat requirements can most easily be met by providing upland nesting habitat in landscapes that already contain an abundance and diversity of natural wetland habitats. Where such wetlands are unprotected and vulnerable to drainage, additional management efforts aimed at wetland protection should be encouraged. Finally, where upland nesting cover and duck populations are abundant, but suitable brood habitat is limiting, restoration or management of more permanent wetlands may be necessary to meet the habitat requirements of ducklings.

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CHAPTER 1: INTRODUCTION

The Prairie Pothole Region and Waterfowl Production

Abundant small wetlands in the prairie landscape of south-central Canada and the north-central United States were formed from melting ice following the last ice age. This wetland-pocketed landscape is known as the Prairie Pothole Region (PPR), and historically it has been the most important duck breeding area in North America, supporting 50-80% of the continent's surveyed duck population in any given year (Batt et al. 1989). The Canadian prairie parklands comprise the northern section of the PPR, a transitional zone dominated by increasing coverage of aspen trees (*Populus tremuloides*) that separates the (historically) treeless southern prairies from the northern boreal forest.

Historically, the plant communities of the PPR were influenced primarily by wild fires and grazing by bison (*Bison bison*), but these factors ceased to be important following European settlement, leading to invasion by aspen and other woody vegetation. Modern agriculture, however, has had the greatest impact on the prairie landscape since settlement. Cattle have replaced bison on most of the prairies, and many studies show that cattle are detrimental to the native flora, especially around wetlands (Hamilton 1996, Biondini et al. 1999, Knapp et al. 1999). In addition, ranchers often have replaced native plant species with introduced (and often invasive) species such as smooth brome (*Bromus inermis*), crested wheat grass (*Agropyron cristatum*), and alfalfa (*Medicago sativa*). Even more importantly, vast areas of native vegetation have been converted to annual crops, with losses exceeding 80% in many areas of the PPR (Turner et al. 1987). Agriculture also has had a tremendous impact on the wetland community of the PPR; up to 70% of wetlands in prairie Canada have been drained or tilled for crop production (Lands

Directorate 1986, National Wetlands Working Group 1988). Shallow wetlands often are targeted for these operations, resulting in a disproportionate decrease in the number of temporary and seasonal wetlands on the landscape.

The wildlife community of the prairies has changed in concert with the landscape changes and other human influences. Gray wolves (*Canis lupus*) and plains grizzly bears (*Ursus horribilis*), once the dominant predators of the prairies, have been extirpated and replaced by mesocarnivores such as red foxes (*Vulpes vulpes*) and raccoons (*Procyon lotor*), whose smaller size may make them more efficient as waterfowl predators (Sargeant and Raveling 1992). The construction of stock-watering ponds has allowed mink (*Mustela vison*), an efficient predator of ducks and ducklings (Krapu et al. 2000), to colonize areas where insufficient permanent water previously precluded them. Additionally, increasing aspen has resulted in an increased number of perch and nesting sites for avian predators such as great horned owls (*Bubo virginianus*), Swainson's and red-tailed hawks (*Buteo swainsonii* and *B. jamaicensis*), and American crows (*Corvus brachyrhynchos*).

This altered landscape may have rendered duck populations more susceptible to environmental influences. By the mid 1980's a prolonged dry spell on the prairies had exacerbated the effects of a changing landscape, and duck populations declined to levels well below those seen in the previous decade (Canadian Wildlife Service and U.S. Fish & Wildlife Service 1986). Hatching rates and brood survival are important for maintaining duck populations (Johnson et al. 1987, Hoekman et al. 2002), and hence the losses of upland nesting habitats and brood-rearing wetlands to agriculture were believed to be the dominant factors contributing to population decreases in the Canadian parklands (Clark and Nudds 1991, Beauchamp et al. 1996).

In an effort to reverse continental declines in duck populations, the governments of Canada and the United States formed the North American Waterfowl Management Plan (NAWMP) in 1985 (Mexico joined the partnership in 1994). The goals of NAWMP focus on creating landscapes that can support self-sustaining duck populations representative of average population levels recorded during the 1970's.

Numerous government and non-government organizations have formed regional partnerships to accomplish the goals of NAWMP. The largest of these partnerships, or joint ventures, is the Prairie Habitat Joint Venture (PHJV), which focuses on the Canadian PPR (Prairie Habitat Joint Venture 1986). Although Alberta, Saskatchewan, and Manitoba each developed separate plans for addressing waterfowl production problems within their respective provinces, all three provincial plans focused on low nesting success as a result of loss and fragmentation of upland nesting habitat. Upland habitat programs included purchase or lease of annually cultivated cropland and replacing the annual crops with mixtures of perennial grasses and legumes, which were believed to provide more dependable nesting cover for breeding ducks. Financial incentives also were given to landowners to modify their annual cropping practices in ways thought to benefit waterfowl (e.g., no-till and minimum till agriculture, winter versus spring wheat). Habitat programs also targeted existing perennial cover. Such programs included paying producers to delay haying operations until after 15 July, when the majority of nesting ducks have already hatched, or rotating cattle grazing schedules among multiple paddocks to increase nesting cover for waterfowl. These habitat programs were targeted to areas with historically high densities of breeding waterfowl. Ducks Unlimited Canada has been the single largest organization delivering PHJV habitat programs, but numerous other federal, provincial, and non-governmental organizations also have been involved in the PHJV.

The PHJV Assessment Project

To quantify the effectiveness of PHJV habitat programs, Ducks Unlimited Canada initiated a large-scale research project known as the Prairie Habitat Joint Venture Assessment in 1993 (Anderson et al. 1995). The PHJV Assessment focused on duck nesting patterns because low nesting success was thought to be the most important factor limiting dabbling duck production in the PPR (e.g., Cowardin and Johnson 1979, Cowardin et al. 1985). However, knowledge concerning brood ecology was severely lacking during the planning stages of the PHJV Assessment. In fact, the mallard (*Anas platyrynchos*) productivity model (Johnson et al. 1987, Cowardin et al. 1988) used to plan for delivery of PHJV habitat programs modeled duckling survival as a constant because reliable predictors of duckling survival were lacking. However, Ducks Unlimited biologists involved in Assessment planning recognized this information gap and consequently designed their study to collect brood survival data in addition to nesting information. Subsequent research has shown that duckling survival trails only nesting success and breeding female survival in affecting the annual population dynamics of prairie mallards (Hoekman et al. 2002).

The PHJV Assessment study monitored 3,618 radiomarked mallard females on 27 Assessment sites between 1993 and 2000 (typically 135-137 females per site). I was involved in the Assessment study as a Research Technician in 1997, a Research Crew

Leader in 1998 and 1999, and a Research Site Leader in 2000. Sites typically encompassed 25 legal sections (65.1 – 68.0 km^2, except one site was 55.4 km^2 and another was 80.4 km^2) and were studied for a single year. Radio-marked females were captured prior to the nesting season and were monitored daily through most of the brood-rearing period (typically until ducklings reached 30 days of age). Included with these radiotracking histories were data on duckling survival, brood movements, and wetland habitat characteristics. The extensive temporal and spatial nature of these data allowed for an unprecedented opportunity to analyze mallard brood movements and wetland habitat selection.

Mallard Brood Ecology

Mallard brood movement patterns evolved over thousands of generations in a prairie landscape that has only recently been affected by modern agricultural activities. Since settlement by immigrants began, roughly a century ago, many wetlands have been drained and native upland vegetation has been cultivated and converted to annual croplands. Understanding the factors influencing brood movements in this altered landscape is critical to ongoing waterfowl management efforts.

Overland movements by mallard broods are more frequent when the ducklings are young (Talent et al. 1982). Mortality also appears to be higher during this time (Ball et al. 1975, Talent et al. 1983, Orthmeyer and Ball 1990, Rotella and Ratti 1992a), suggesting a possible relationship between movements and survival. Discovering what factors affect the frequency or distance of movements may help explain the relationship between movements and survival.

Habitat use and availability can also influence duckling survival (Rotella and Ratti 1992a). Mallard broods do not always select the wetland nearest their nesting location (Dzubin and Gollop 1972, Cowardin et al. 1985), and they move frequently even though their previous wetland still retains water (Talent et al. 1982, Rotella and Ratti 1992b), indicating that some sort of habitat selection process is involved. It is assumed that organisms will select habitats that maximize their fitness, although tests of this assumption are rare (Clark and Shutler 1999, Morris and Davidson 2000). Understanding the selection processes that mallards use when selecting brood habitat would allow managers to make better informed decisions concerning protection or enhancement of wetland and associated upland habitats, thereby improving brood survival and overall population recruitment.

Previous studies of habitat selection by mallard broods may provide some clues as to what factors are important in the selection process. The amount or species composition of emergent vegetation may help explain patterns of brood use (Berg 1956, Lokemoen 1973, Mack and Flake 1980, Talent et al. 1982). The dominant vegetation of a wetland is related to permanence (i.e., hydroperiod, or typical depth and duration of flooding; Steward and Kantrud 1971, Grosshans 2001). However, there has been disagreement about how wetland permanence affects wetland selection by broods, with both seasonal (Talent et al. 1982, Duebbert and Frank 1984) and more permanent wetlands (Stoudt 1971) being identified as most important. The dominant vegetation of a wetland may help clarify why this discrepancy exists. Stoudt (1971) indicated that open water also may be important to wetland selection by broods, and hence habitat quality might vary according to wetland cover type (Stewart and Kantrud 1971), which describes different patterns of juxtaposition between emergent cover and open water.

In summary, the principle objective of my study was to determine key factors influencing resource-use decisions by mallard broods, which in turn are likely to influence duckling survival. Brood survival is a very important vital rate affecting rate of population change in mallards (Hoekman et al. 2002), but it is one of the least studied components of the mallard's life cycle. Despite its importance, knowledge of brood behaviour is difficult to obtain because mallard hens accompanied by ducklings are very secretive and, thus, are difficult to observe by conventional means. By increasing our understanding of brood decisions pertaining to movements and habitat selection, future landscape management can be more considerate of the habitat needs of mallards (and other related duck species) during the brood-rearing period.

Thesis Organization

The PHJV Assessment project comprised 27 different study sites between 1993 and 2000 (2 – 4 sites per year). However, only the 15 study areas completed between 1993 and 1997 were included in this study, as it was hoped to associate these analyses with concurrent analyses of brood and duckling survival being conducted by another investigator (D. Howerter, unpubl. data). Although it would have been interesting and informative to correlate patterns of movement and habitat selection with subsequent survival, such analyses could not be included in my thesis because they are included within another investigation.

Chapter 2 of my thesis deals with movement patterns exhibited by mallard broods on 15 PHJV Assessment sites located throughout the Canadian prairie parklands, whereas

Chapter 3 investigates the wetland selection process exhibited by these same broods. Finally, Chapter 4 summarizes my most important findings and provides key management recommendations.

Chapters 2 and 3 were each written as stand alone manuscripts in anticipation of submission to scientific journals. Chapter 2 is intended for the Canadian Journal of Zoology and utilizes a more traditional statistical format that involves model fitting via formal hypothesis testing, whereas Chapter 3 is intended for The Journal of Wildlife Management and utilizes a newer model-fitting approach that involves information theory (Anderson and Burnham 2002). Although this results in some methodological inconsistencies between chapters, it provided me with the opportunity to utilize and gain familiarity with both of these commonly used statistical methods. Despite the different statistical approaches to model fitting, there was complete overlap in study areas and methods of data collection, and hence there is some overlap and repetition between these two chapters, most notably in the methods sections.

CHAPTER 2: MALLARD BROOD MOVEMENTS IN THE CANADIAN PRAIRIE PARKLANDS

Introduction

Brood survival is one of the most important determinants of population growth in mallards (Cowardin and Johnson 1979, Hoekman et al. 2002). But to manage a landscape for increased brood survival, waterfowl managers must first understand the survival strategies employed by broods. The prairie parkland region of Canada has been highly modified by agriculture (Turner et al. 1987), with up to 70% of wetlands having been drained since European settlement (Lands Directorate 1986, National Wetlands Working Group 1988). Understanding how altered landscapes influence brood movement patterns and distinguishing important factors influencing these movements is important for waterfowl management within this highly modified landscape.

The majority of duckling mortality occurs during the first two weeks post-hatch (Ball et al. 1975, Talent et al. 1983, Orthmeyer and Ball 1990, Rotella and Ratti 1992a). This also is the period when most overland movement occurs (Talent et al. 1982), but it is not clear whether this is cause or effect. Movements may be a response to duckling losses (i.e., as females attempt to move their offspring to safer habitats), or alternatively, losses may occur as a result of movements (e.g., loss and separation of young ducklings, or predation during overland movements; Talent et al. 1983, Rotella and Ratti 1992a). Talent et al. (1983) found that little mortality occurred during overland moves, whereas others observed that movement distance and survival were negatively correlated (Ball et al. 1975, Rotella and Ratti 1992b). Exploring factors affecting frequency and distance of moves by mallard broods may clarify how survival is related to interwetland movements.

Several studies have found that mallard broods hatched early in the season have a greater chance of survival than late-hatched broods (Orthmeyer and Ball 1990, Rotella and Ratti 1992a, Sayler and Willms 1997, Krapu et al. 2000; but see Mauser et al. 1994a). This might occur because late-hatched broods have to move farther or more frequently because wetlands are more likely to become dry later in the season. Knowledge of how brood movements change as the season progresses may increase our understanding of these seasonal patterns in survival.

A brood's location may represent a tradeoff between safety (from predators and the elements) and food resources. If the wetland a brood currently occupies does not meet its needs and a more suitable alternative is available, then a movement may be warranted. Longer moves presumably increase the risk of predation while traveling overland (Ball et al. 1975, Rotella and Ratti 1992a), but longer moves are likely to be beneficial because they increase the number of available wetlands. If more wetlands are available, broods will have a greater selection of ponds from which to chose, hence wetlands with better brood-rearing habitat should be available. Perhaps there is a distance at which the risks incurred during a move outweigh the benefits a move typically can provide. This distance may vary according to brood age or date.

Ball et al. (1975) and Rotella and Ratti (1992b) reported a negative correlation between number of surviving ducklings and distance of overland travel, thus hinting that overland moves by ducklings were costly. However, Dzus and Clark (1997) found no correlation between length of first move and duckling mortality, or between total distance traveled over the first 14 days post-hatch and duckling mortality. Likewise, Talent et al. (1983) found that few ducklings and no entire broods were lost during overland moves.

This lack of agreement on cost of overland moves by broods suggests that other factors may be important. Duckling mortality during overland moves may be a function of vegetation and terrain (Talent et al. 1983, Rotella and Ratti 1992a). If vegetation density can help protect ducklings from the elements or predators, then it also may affect brood movements. Time of season affects density and concealment of upland vegetation and consequently may affect seasonal strategies of brood movements.

Characteristics or distribution of local wetlands may influence the frequency and distance of moves. Rotella and Ratti (1992b) found that distance of first moves increased in areas of lower wetland density. Regional moisture levels have been indexed as the percentage of seasonal wetlands holding water (Krapu et al. 2000), and this index has been shown to be positively correlated with brood survival (Rotella and Ratti 1992a, Krapu et al. 2000). Seasonal wetlands show the most variation in abundance and therefore are thought to be the best indicators of local moisture levels (Krapu et al. 1997). However, semipermanent wetlands are more likely to retain water during the brood-rearing period and may be better indicators of brood habitat (Stoudt 1971).

Based on my review of the literature, I predicted that brood age would be an important predictor of movement frequency, with younger broods moving more often than older broods. Also, I believed that broods hatched later in the season would have a lower probability of moving due to decreasing wetland availability caused by drying wetlands late in the season. However, due to decreasing wetland densities and increased upland cover, I expected moves to be longer as the season progressed and as ducklings aged. Using similar logic, I predicted that later hatched broods would move farther from the nest than early hatched broods.