FACTORS INFLUENCING AGE RATIOS OF MALE MALLARDS HARVESTED IN EASTERN SOUTH DAKOTA

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ABSTRACT

We analyzed harvest age ratios (immatures:adult) for male mallards (Anas platyrhynchos) (n = 185) shot by waterfowl hunters during September - November 1996 from 10 counties in eastern South Dakota. Our objectives were to evaluate within-year temporal trends in male mallard age ratios and to determine if hunting method, area hunted, and hunter effort influenced these age ratios. Chi-square goodness-of-fit tests were used to determine age-specific differences in male mallards harvested within and among the 3 sample periods (Period 1 = 28 Sept. - 13 Oct., Period 2 = 14 - 30 Oct., Period 3 = 31 Oct. - 16 Nov.). Goodness-of-fit tests also were used to determine influence of hunting method on age of harvested male mallards and differences in hunter effort by area. There was no difference (P = 0.2) in the number of harvested adult male mallards across sample periods, however, a significant (P < 0.01) sample period effect was documented for immature male mallards. Over twice as many adult than immature male mallards were harvested during the last sample period. Male mallard age ratios declined (1.19, 0.83, 0.48) across the 3 sample periods defined for this study. More male mallards of both age classes were harvested using decoys over-water than any other method. Participants in this study spent more time hunting on private than on public land. Although we recognize that immature waterfowl are considered more susceptible to harvest, other factors may contribute to differences in age-specific harvests at a smaller spatial scale.

INTRODUCTION

Duck harvest regulations were historically driven by mallard population indices (Martin et al., 1979) and more recently are derived from a matrix incorporating number of May ponds and mallard population indices (i.e., adaptive harvest management; Johnson et al., 1993; Nichols et al., 1995). A variety of factors influence annual mallard production including breeding population size, age and breeding experience, body condition, nesting cover, wetland conditions, local weather patterns, and predation (Johnson et al., 1992). One method of assessing mallard recruitment is to determine the proportion of juveniles from the harvest (March and Hunt, 1978; Kaminski and Gluesing, 1987; Raveling and Heitmeyer, 1989). Estimates of harvest age ratios are obtained
annually from duck wings sent in by a random sample of waterfowl hunters (Geissler, 1990). Annual estimates (1961 - 95) of male mallard age ratios in the Central Flyway averaged 0.66 immatures:adult, the lowest ratio among the four flyways. Within the Central Flyway, South Dakota had the second highest male mallard age ratio (0.93 immatures:adult) during this same period (Sharp, 1997). The low harvest age ratio obtained for male mallards in the Central Flyway is an interesting phenomena considering the Prairie Pothole Region is an important breeding area for continental duck populations (Smith et al., 1964).

Data obtained from waterfowl hunters are commonly used in waterfowl ecology studies and for management of waterfowl populations. However, data from hunter-killed birds may be biased due to differential vulnerability attributed to age (Martin et al., 1979) and sex (Olson, 1965), flock size (Olson, 1965; Dufour and Ankney, 1995), species (Stott and Olson, 1972), brightness of plumage (Metz and Ankney, 1991), and body condition (Greenwood et al., 1986; Reinecke and Shaiffer, 1988; Dufour et al., 1993; Heitmeyer et al., 1993). Hunter selectivity likely plays an important role accounting for some of the differential vulnerability of hunted waterfowl (Metz and Ankney, 1991; Gleason and Jenks, 1997). Our objectives were to evaluate within year temporal trends in male mallard harvest age ratios in relation to hunting method, area hunted, and hunter effort. We predicted that male mallard age ratios would differ throughout the season with more immatures harvested early compared to late season. We further predicted that hunting method also would influence age ratios with a higher proportion of immatures harvested over decoys compared to other hunting methods.

STUDY AREA

The study area included mallards collected from 10 counties in eastern South Dakota. Wetland demography in eastern South Dakota is characteristic of the glaciated prairie pothole region with a relatively large number of permanent lakes, and semi-permanent, seasonal, and temporary wetlands (Brewster et al., 1976; Johnson and Higgins, 1997). Waterfowl distribution on the study area has been relatively consistent from year-to-year depending on wetland conditions and local weather patterns. Early in the hunting season individuals, pairs, late broods, and small flocks are scattered across the study area using seasonal and semipermanent wetlands (Gleason pers. obs.). As the season progresses, harvest pressure (Kirby et al., 1989) and low temperatures (Rakowicz et al., 1996) force the birds off smaller wetlands onto larger, open water lakes and rivers.

South Dakota hunters are regulated by a daily-bag system with restrictions on certain species and sexes. During the 1996 - 97 waterfowl season, the daily bag limit was 5 ducks of which no more than 1 could be a female mallard. In South Dakota, there was a 60-d regular season (i.e., ducks) and opening date for the north zone occurred on 28 September. Most hunters participating in this study hunted in the middle zone with the season opening on 5 October and closing on 3 December. Daily shooting times for all waterfowl species in South Dakota was one-half hour before sunrise (CST) to sunset.
METHODS

Mallard wings were collected opportunistically from hunters in eastern South Dakota (28 September - 16 November). Ages of male mallards were determined by cloacal examination (Hochbaum, 1942) if the whole carcass was obtained or by wing plumage (Carney, 1992). Mallard wings were aged based on the color, shape, and wear of the tertails, scapulars, and coverts (Carney, 1992). The greater tertial coverts are a good indicator of age for both sexes to at least 1 March (Hopper and Funk, 1970). Since collection for this study was completed by mid-November, we considered our aging techniques to be accurate for this study. Mallards were assigned to one of three periods: early (28 Sept. - 13 Oct.), mid (14 Oct. - 30 Oct.), and late (31 Oct. - 16 Nov.) depending on when they were shot (Rakowicz et al., 1996). Time periods were defined at the end of the study with the late period occurring after the first freeze on 30 October.

Harvest age ratios were calculated for the three periods by dividing the number of immatures by the number of adults. We also separated the harvest by hunting method (i.e., decoying over water, decoying over land, pass shooting, jump shooting) and area hunted (i.e., public vs. private) and documented temporal and between-area differences in hunter effort. For this study, hunter effort was defined as the amount of time spent in pursuit of waterfowl on a specified area or during a specified time period. Kill rate was determined for the three sample periods and the two hunting areas. For this study, kill rate was the number of mallards harvested divided by the number of hours hunted. Chi-square goodness-of-fit tests (Wilkinson, 1990) were used to determine age-specific differences in male mallards harvested within and among the three sample periods, to determine influence of hunting method on age of harvested male mallards and differences in hunter effort by area. Chi-square Goodness-of-fit tests also were used to evaluate temporal and spatial influences on the number of male mallards harvested by method.

RESULTS

A total of 185 (85 immatures, 100 adults; overall age ratio = 0.85) male mallards were collected during the early (38 immatures, 32 adults), mid (34 immatures, 41 adults), and late (13 immatures, 27 adults) seasons (Fig. 1). Age ratios declined (1.19, 0.83, 0.48) across the three sample periods. There was no difference ($\chi^2 = 3.02, df = 2, P = 0.2$) in the number of adult males harvested during the three periods, however, there was a significant ($\chi^2 = 12.73, df = 2, P = 0.002$) temporal difference in the number of immature males harvested. Within a sample period, age ratios differed only for the late period when significantly ($\chi^2 = 4.90, df = 2, P = 0.03$) more adults were shot. For this study, the majority of male mallards were shot in Brookings and Kingsbury counties (Table 1) with mallard harvest increasing on weekends (Fig. 2).

A large proportion (85.95%) of males were collected by decoying over-water (n = 92) and land (n = 67). In contrast, pass shooting and jump shooting accounted for only 21 and 5 male mallards, respectively. For both age class-
Figure 1. Number and age of male mallards harvested during the 3 sample periods defined for this study.

Table 1. Distribution of male mallards harvested by waterfowl hunters participating in this study, 1996.

<table>
<thead>
<tr>
<th>County</th>
<th>Number Harvested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brookings</td>
<td>55</td>
</tr>
<tr>
<td>Brown</td>
<td>7*</td>
</tr>
<tr>
<td>Clark</td>
<td>2</td>
</tr>
<tr>
<td>Hamlin</td>
<td>3</td>
</tr>
<tr>
<td>Hand</td>
<td>2</td>
</tr>
<tr>
<td>Kingsbury</td>
<td>86</td>
</tr>
<tr>
<td>Lake</td>
<td>6</td>
</tr>
<tr>
<td>Marshall</td>
<td>18</td>
</tr>
<tr>
<td>McPherson</td>
<td>1*</td>
</tr>
<tr>
<td>Moody</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>185</strong></td>
</tr>
</tbody>
</table>

* A total of 8 male mallards was harvested in the north zone, of which 3 occurred on opening weekend (28 - 29 September).
es, significantly \( P < 0.01 \) more mallards were harvested by decoying over-water than by other methods. Age ratios for the four hunting methods averaged across time periods were 0.70 (decoys over-water), 1.03 (decoys over-land), 0.75 (pass shooting), and 4.00 (jump shooting), respectively. However, no age differences \( P > 0.09 \) were detected when comparing male mallards collected using the four hunting methods. Harvest age ratios for the two decoy methods combined was 0.87, which was similar to the overall age ratio of 0.85. Early period age ratios obtained using decoys over-land was 2.33 compared to 0.43 during the late period (Table 2). Neither pass nor jump shooting provided sufficient sample sizes for determining age ratios by period. Similarly, data were not sufficient to determine temporal differences in area-by-method age ratios.

Hunters participating in this study spent a total of 33 days afield; 20 weekdays and 13 weekend days. The highest single day harvest \( n = 20 \), 9 adults and 11 immatures) for male mallards occurred on opening day of the middle zone (October 5). Daily totals (all hunters combined) for adult and immature male mallards were 3.0 \pm 0.51 \text{(SE)} and 2.6 \pm 0.48 \text{(SE)/day}, respectively. Approximately 55\% (\( n = 102 \)) of the total male mallard harvest occurred on weekends. Hunter effort was relatively constant for the first and second periods (66.5 and 72.5 hrs.), but declined considerably during the last period (45 hrs.). Total effort of waterfowl hunters on both private and public lands was 184 hours. Eighty-two percent (151.5 hours, period \( x = 50.5 \text{ hrs.} \)) of the total hunting effort occurred on private land, compared to 18\% (32.5 hours, period \( x = 70.83 \)) on public land (Table 3). More time \( P < 0.01 \) was spent hunting on private than on public land irrespective of the sample period hunted. No difference \( \chi^2 = 1.96, \text{df} = 2, \ P = 0.38 \) was detected in hunter effort by sample.
Table 2. Number and age ratio of male mallards harvested during the 3 sample periods (1 = 28 September - 13 October, 2 = 14 October - 30 October, 3 = 31 October - 16 November) using the 4 hunting methods (1A = decoys over-water, 2B = decoys over-land, 3C = pass shooting, 4D = jump shooting) defined for this study.

<table>
<thead>
<tr>
<th>Sample Period</th>
<th>Number Harvested</th>
<th>Age Ratio</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47</td>
<td>0.88</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>1.33</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0*</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>2.00</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>1.18</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>0.70</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>1.07</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>0.50</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0*</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>0.22</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>0.43</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>1.25</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0*</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>0.48</td>
<td></td>
</tr>
</tbody>
</table>

A Age ratio obtained by decoying over-water = 0.70, B Age ratio obtained by decoying in the field = 1.03, C Age ratio obtained by pass shooting = 0.75, D Age ratio obtained by jump shooting = 4.00

* Unable to determine age ratios from this sample.

Table 3. Hunter effort (in hours) by area (1 = Public land, 2 = Private land) for the 3 sample periods (1 = 28 September - 13 October, 2 = 14 October - 30 October, 3 = 31 October - 16 November) defined for this study.

<table>
<thead>
<tr>
<th>Sample Period</th>
<th>Hunter Effort</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>51.5</td>
<td>2</td>
</tr>
<tr>
<td>Total*</td>
<td>66.5</td>
<td>Combined</td>
</tr>
<tr>
<td>2</td>
<td>15.5</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>57.0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>72.5</td>
<td>Combined</td>
</tr>
<tr>
<td>3</td>
<td>2.0</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>43.0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>Combined</td>
</tr>
</tbody>
</table>

Overall 184

* A total of 3 male mallards were harvested in the north zone on opening weekend (28 - 29 September).
period for individuals on private land, however, less time ($\chi^2 = 10.563, \text{df} = 2, \ P = 0.005$) was spent hunting on public land during the late period.

Overall, kill rate ($\#$ mallards shot/hr.) declined slightly across the three sample periods (Period 1 = 1.05, Period 2 = 1.03, Period 3 = 0.88). Kill rates (+ SE, all four methods combined) varied by area hunted with the highest average harvest (1.08 + 0.11) occurring on private land. In comparison, kill rate on public land averaged 0.85 + 0.33. No temporal differences ($\chi^2 = 2.947, \text{df} = 2, \ P = 0.229$) were found for male mallards collected on public areas, however, a significant ($\chi^2 = 9.554, \text{df} = 2, \ P = 0.008$) sample period affect was documented for male mallards shot on private land. Temporal differences ($\ P < 0.0001$) existed in number of male mallards collected on private and public lands.

**DISCUSSION**

**Temporal Differences in Age Ratios**

Our results indicate a consistent temporal pattern of harvest for male mallards shot by hunters in eastern South Dakota. As predicted, age ratios obtained for this study declined (1.19, 0.83, 0.48) (Table 2) during the 1996 - 97 waterfowl season. Analogous to our results, harvest data obtained from the Harvest Surveys Section of the U. S. Fish and Wildlife Service (USFWS) resulted in age ratios of 1.32 (72 males), 1.25 (81 males), and 0.86 (65 males) for the same periods and counties defined for this study. Sample sizes for our data and the USFWS were relatively similar, however, the sample of wings obtained by the USFWS is a random and representative sample of waterfowl hunters (Geissler, 1990). Conversely, hunters participating in our study likely represent a small contingent of South Dakota’s serious waterfowl hunters. The number of males harvested by period were relatively similar for the first two sample periods, but declined during the late period (Figure 1). Similarly, age ratios were not different for the first two sample periods, but significant differences occurred during the late period with a greater number of adults than immatures being shot (Table 2). For this study, kill rate declined across the three sample periods with the lowest take occurring during the late period when age ratios were also the lowest.

It is well established that immature waterfowl are more vulnerable to hunting than are adults (Bellrose et al., 1961; Geis, 1972; Munro and Kimball, 1982) and in some cases, males are more vulnerable to hunting than are females (Anderson, 1975; Burnham et al., 1984; Nichols et al., 1990; Metz and Ankney, 1991). Trost et al., (1987) found that waterfowl harvest is a direct function of both hunter numbers and hunter success. At the same time, there exists a relationship between waterfowl abundance and subsequent harvest (Trost et al., 1987). Taking into account age-specific differences in vulnerability, the age ratio for a target population is simply the proportion of immatures in that population. In our case, locally raised immature males are more available and hence more likely to be shot early in the season than later (Jessen, 1970; March and
Two reasons may explain why age ratios obtained later in the season were lower. First, local weather patterns (Nichols et al., 1983; Jorde et al. 1984; Nichols and Hines, 1987) and hunting pressure (Jessen, 1970; March and Hunt, 1978) may have forced the majority of locally hatched immatures to disperse or migrate from natal marshes. Second, an influx of migratory mallards with lower age ratios occurred later in the season (March and Hunt; 1978). During this study, a cold front occurred on 31 October, causing a reduction in the availability of open water. This likely caused a movement of immature male mallards off the study area. However, large flocks of field-feeding mallards (presumably adults), remained on the study area until the last week of November (Gleason pers. obs.).

Hunting Method as an Influence on Age Ratios

For this study, over 85% of male mallards were harvested using decoys, both over-water and in the field (Table 2). Age ratios obtained by averaging both decoying methods (0.87) was similar to the overall age ratio (0.85). Age ratios averaged across time periods for these two methods were 0.70 and 1.03. In comparison, age ratios averaged across time periods for pass shooting and jump shooting were 0.75 and 4.00. Our results do not support the prediction that a greater proportion of immatures would be harvested using decoys compared to other methods. However, the similar or higher age ratios obtained from males shot by pass and jump shooting is likely an artifact of small sample sizes. Very few mallards were shot using these two hunting methods. We believe that given adequate and representative samples of male mallards collected from the various hunting methods, results would support our prediction that male mallard age ratios shot over decoys would be higher than those obtained from other hunting methods.

Gleason and Jenks (1997) documented the importance of decoying as a favored method among South Dakota natural resource agency personnel participating in waterfowl hunting. Similarly, Humburg et al., (1988) identified decoying birds over water as the preferred method of waterfowl hunters responding to a survey in Missouri. On a continental basis, more waterfowl are likely shot over decoys than by any other method. Age ratios obtained from ducks shot over decoys may overestimate local recruitment in hunted waterfowl populations. Conversely, using harvest age ratios as an index to recruitment on a large geographic scale (i.e., flyway level) may in fact underestimate actual age ratios in the population (see Rakowicz et al., 1996). It has been documented that the use of decoys to entice birds within shooting range may evoke a feeding response by passing ducks (Weatherhead and Ankney, 1984). Because immature ducks are subordinate (Hepp, 1989) and possibly in poorer condition (see Table 1, Dufour et al., 1993), they must spend more time searching for food and unoccupied foraging habitats, thus increasing their exposure to hunters (Bain, 1980; Munro and Kimball, 1982; Weatherhead and Ankney, 1985). A condition bias from hunter-shot waterfowl was first established by Bain (1980) for canvasbacks (Aythya valisineria) and redheads (Aythya amer-
icana). Recent studies on mallards were consistent with these results supporting the assertion that mallards shot by hunters using decoys were in poorer condition (i.e., less mass or mass/wing length) than mallards collected by other means (Greenwood et al., 1986; Hepp et al., 1986; Reinecke and Shaiffer, 1988; Dufour et al., 1993; Heitmeyer et al., 1993).

Hunting Effort as an Influence on Age Ratios

During the season, waterfowl hunters participating in this study spent more time hunting on weekdays than on weekends. However, approximately 55% of all male mallards harvested during this study were shot on weekends (Fig 2). Of the total mallards shot during this study, 19% were shot on opening weekend of the middle zone. This higher harvest may reflect the fact that hunter numbers for the entire hunting public increased on weekends (Fig. 1; Gleason and Jenks, 1997) forcing ducks to spend more time flying in search of secluded marshes away from hunting pressure. Most of the ducks collected during this study were shot during the first 30 days of the season. This result is important considering that early in the season immature male mallards are likely more available to be shot. Similar to our results, Martin and Carney (1977) documented that a major portion of waterfowl harvested during their study occurred during the early part of the hunting season and attributed this high early season harvest to relatively mild weather conditions and high hunter numbers. Gleason and Jenks (1997) demonstrated that approximately 50% of hunter effort occurred during the first month of the season and that effort declined through time.

Hunter effort differed depending on the period and area hunted (Table 3). Nearly 82% of the total time was spent hunting on private land. Conversely, Gleason and Jenks (1997) determined that public land was the most frequently hunted area (56.3%) for waterfowl hunters participating in their survey. Average kill rates were higher for male mallards collected on private versus public lands. A temporal effect was documented when comparing numbers of male mallards shot on private versus public lands. The results we obtained likely reflects a willingness of participants in this study to seek permission to hunt waterfowl on private lands. Waterfowl use of private lands on the study area likely increased during the hunting season. Possible reasons for this shift in waterfowl distribution include, 1) an increase in hunting pressure or disturbance on public areas and subsequent dispersal to secluded marches on private land, 2) a decrease in availability of natural aquatic plants and seeds consumed by waterfowl on public areas, or 3) a dietary shift in foods consumed by waterfowl (Jorde et al., 1983; 1984). One of the highest single period age ratios (2.33) obtained during this study was for mallards collected in the first sample period using decoys over-land. Male mallards shot using this method were likely responding to decoys placed on a food source such as corn or millet.

A variety of factors can influence the harvest of waterfowl (Trost et al., 1987) and understanding biases associated with hunter-shot birds is important.
Our results indicate a decline in numbers of immature male mallards harvested throughout the season. Similarly, we found that the number of adults and immatures harvested differed by hunting methods and area hunted. We agree with Rakowicz et al. (1996) that caution should be used when interpreting harvest age ratios as an index to recruitment. Hunter numbers and a differential availability of ages and sexes during the season directly influence mallard harvest. This understanding is critical since information on mallards continues to be used as the foundation for managing duck populations in North America.

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LITERATURE CITED


