# Southwest Montana Mule Deer Either-sex Management Area Summary

Post 2020 Hunting Season—Year 5

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# Executive Summary

This report summarizes either-sex harvest management of mule deer across eleven southwest Montana hunting districts in Montana Fish, Wildlife & Parks (FWP) administrative Region 3 (Figure 6: hereafter; Either-sex Management Area or EMA) following five years of implementation. These data should be considered preliminary and interpreted with caution. Given the wide range of biological and social factors that influence annual hunter-harvest and mule deer population vital rates, conclusive results may require many years of implementation. We recognize maintaining continued public dialogue, including a detailed annual summary of preliminary results, is critical to maintaining this management structure until conclusive results can be obtained.

An unlimited one-per-hunter (UOPH)-license either-sex harvest regulation was adopted for mule deer in 2016 following 40 years of mostly UOPH-license buck-only hunting. Buck-only mule deer hunting has long been desired by most hunters because it's believed it will allow populations to increase back to past peak levels by maintaining high doe survival. During the period of UOPH-license buck-only hunting, mule deer populations in southwest Montana declined and today are recruiting one-third fewer fawns per adult than during 1970–1985 (FWP unpublished data). We hypothesized this decline was primarily a product of long-term reduction in quantity and quality of browse available to mule deer. Minimal successional disturbance has allowed conifer forest to become dominant across former shrub-grasslands and deciduous-dominated forests; intense ungulate browsing has retrogressed many curl-leaf mountain mahogany plants within winter habitats; and competition from elk and white-tailed deer has increased. We further hypothesized that past peak mule deer populations could not currently be sustained given available browse and inter-specific competition for that browse. We hypothesized sustaining larger mule deer populations across southwest Montana would require measurable shifts in habitat management and productivity. Initially, this includes maintaining ungulate populations, including mule deer, within modern habitat capacity. Subsequently, habitat management needs to include enhanced forage and browse quality and quantity through periodic disturbance at a landscape scale. We aim to improve mule deer productivity through sustained antlerless harvest via either-sex management and large scale habitat management. Either-sex management is expected to improve productivity by; maintaining populations within modern habitat capacity, reducing the proportion of does in less productive older age classes, and better aligning annual antlerless harvest with winter severity. Either-sex management is also expected to improve adult buck composition by spreading harvest across antlered and antlerless deer and increase mule deer harvest on private lands.

We hypothesized that under either-sex mule deer management:

1) The level of antlerless harvest resulting from the UOPH-license would not become the primary influencer of mule deer population trend across southwest Montana. Annual browse and weather conditions, competition for resources with other ungulates, and predation would remain the primary short-term drivers. Habitat quality and quantity would remain the primary long-term driver;
2) Post-hunting season total, yearling, and adult buck: doe ratios and the proportion of older age-class bucks harvested by hunters would increase. This would result from reducing the proportion of harvest comprised of antlered deer and allowing more buck deer to survive beyond two years old;
3) Fawn recruitment would improve through reductions in intra-specific competition for resources and the proportion of does entering older, less productive age class;
4) Antlerless harvest would be higher during years when autumn snow accumulation concentrates deer on winter range in November—pairing elevated annual antlerless

harvest with the onset of severe winters, when harvest mortality is expected to be most compensatory to starvation mortality; and

5) Antlerless harvest opportunity would increase mule deer harvest on private lands. Increased harvest would better distribute hunters between public and private land and more effectively address private land game damage through the general hunting season.

We used a before–after–control design to test our hypotheses against adjacent hunting districts managed by a variety of harvest structures including; UOPH-license buck-only, limited permit buck-only, UOPH-license shortened-season (late October–November 15) buck-only, and unlimited permit buck-only. Permits validate use of the unlimited deer license in specific hunting districts. In each of the comparison districts, antlerless harvest was absent or managed by limited quotas of antlerless-only B-licenses (second deer license). Following five years of implementation, preliminary results include:

- *<u>UOPH-license antlerless harvest has not become the primary influencer of mule deer population trend</u>*. After implementation of the either-sex harvest regulation, we have not observed a decline in population growth. The mule deer population in the EMA increased 32.1%, compared to a 37.9% decrease across the control area;
- *<u>During years 4–5 following implementation of the either-sex harvest regulation, the annual average adult buck: doe ratio increased significantly. Non-statistically significant increases in total and yearling average buck: doe ratios were also observed.</u> In contrast,* non-statistically significant decreases in total, adult, and yearling buck: doe ratio were observed in the UOPH-license buck-only control area;
- *<u>During years 4–5 following implementation of the either-sex harvest regulation: the average total buck: doe ratio in the EMA was significantly higher than the control area managed by an UOPH-license buck-only harvest regulation; lower, but not significantly lower, than the control</u>*

*areas managed by limited permit buck-only harvest regulations; and higher, but not significantly higher than control areas managed by UOPH-license unlimited permit buck-only harvest regulations*;

- *Changing the UOPH-license harvest regulation in the Tobacco Root Mountains from a shortened-season buck-only to a five-week either-sex season has not reduced average post-hunting season buck: doe ratios*. *During years 4–5 following implementation of the either-sex harvest regulation, average total and adult buck: doe ratios were higher than pre-implementation averages*. The observed increase in average adult buck: doe ratio was statistically significant, while the observed increase in average total buck: doe ratio was not. The average yearling buck: doe ratio decreased slightly, and the change was not statistically significant;
- *UOPH-license either-sex harvest opportunity has not increased hunter participation in the EMA*. Since implementation of either-sex harvest management, average annual deer hunter participation increased 3.6% in the EMA and 4.3% in the control area. Neither increase was statistically significant;
- *Evidence for an increase in population productivity with UOPH-license either-sex harvest was mixed*. During years 4–5 following implementation of the either-sex harvest regulation, average annual fawn recruitment in the EMA increased 5.1% relative to the 10 years prior to implementation, based on spring fawn: adult ratios. This difference was not significant and a similar increase in average spring fawn: adult ratio was observed in the control area during the same period. During post-hunting season surveys, where does can be distinguished from bucks, observed fawn: doe ratios increased significantly (15.5%) after implementation of either-sex harvest in the EMA. Fawn: doe ratios showed no increase in the control area during this time;
- *The average annual percentage of mule deer harvested on private lands not enrolled in FWP's Block Management Program increased from 4.0% to 12.0%* in the EMA following

implementation of the either-sex harvest regulation. The increase was not statistically significant;

- *No measurable changes in age structure of hunter harvested antlered or antlerless mule deer was observed in the EMA or control area*. During years 4–5 following implementation of the either-sex harvest regulation, the proportion of harvested bucks that were 1–2 years old decreased relative to pre-implementation from 46.2% to 38.6%, while the proportion that were ≥6 years old in the EMA increased from 7.6% to 8.0%. The differences were not statistically significant.

Preliminary results suggest alignment with multiple management goals and warrant continued implementation and monitoring. Following five years of either-sex management: opportunity for hunters to harvest doe mule deer has increased; there is evidence that buck: doe ratios have increased; harvest on private land may have slightly increased; and there is no evidence mule deer population growth has been impeded. The either-sex harvest regulation will remain through the 2021 hunting season. Based on preliminary data, we recommend that the either-sex harvest regulation be maintained for the 2022 and 2023 hunting seasons. During that period, we would continue to collect data, evaluate relative to the management goals and hypotheses, and draft progress reports.

# Introduction

Mule deer (*Odocoileus hemionus)* populations across southwest Montana peaked during the mid-1950s (Allen 1967). Noticeable winter mortality was documented in the East Pioneer Mountains as early as 1949. Subsequent study determined those die-offs were caused principally by starvation, resulting from mule deer populations exceeding winter range carrying capacity (South 1957). In response, game managers recommended increased antlerless harvest to lower populations to within habitat carrying capacity. From 1955 through 1966, mule deer harvest regulations allowed all hunters to possess two deer licenses valid for either-sex harvest (Allen 1967). These two-deer seasons reduced the population, but not to the extent necessary to align populations within habitat carrying capacity. In the late-1960s, game managers stressed that future harvest regulations needed to be more liberal to bring mule deer populations in balance with their habitat. Otherwise, important browse species would retrogress from overuse and populations would experience long-term decline. However, in response to social desires to increase mule deer populations, mule deer harvest regulations across southwest Montana were restricted back to one license per hunter that was valid for either-sex harvest in 1967.

Mule deer buck harvest and population experienced significant declines across southwest Montana during the early 1970s (Figure 1). Subsequently, unlimited mule deer hunting license regulations shifted from either-sex to buck-only in 1976. Antlerless harvest was regulated by limited quotas of antlerless-only licenses. Buck-only mule deer hunting was desired by most hunters to preserve does and allow populations to increase back to peak levels observed during the 1950s and 1960s. Except for a few hunting districts (HD) that were managed with either-sex regulations for two years during the mid-1990s, unlimited one-per-hunter (UOPH)-license buck-only and limited quotas of antlerless-only licenses remained the primary mule deer harvest regulation across southwest Montana through 2015. During that period, mule deer populations fluctuated widely but experienced long-term decline (Figure 1) and today are recruiting one-third fewer fawns per adult than during 1970–1985 (FWP unpublished data).

We hypothesized long-term mule deer decline across southwest Montana is primarily a product of long-term reduction in habitat carrying capacity and that past peak mule deer populations cannot currently be sustained. More specifically, decades of intense ungulate use and forest succession has diminished the quantity of quality browse. Minimal disturbance to forest succession has allowed conifer trees to become dominant across habitats formerly dominated by shrubs, grasses, and deciduous trees (Figure 2). Simultaneously, available population and harvest trend data suggest: elk herds across southwest Montana have increased approximately six-fold since the 1970s and ten-fold since the 1950s (Figure 3); white-tailed deer across Montana Fish, Wildlife & Parks Region 3 have increased approximately six-fold since the 1960s (Figure 4); and pronghorn herds across southwest Montana have approximately doubled since the 1970s (Figure 5). We further hypothesized sustaining larger mule deer populations across southwest Montana will require measurable shifts in habitat management and productivity. Initially, a component of habitat management is maintaining ungulate populations within modern habitat capacity. Subsequently, large-scale restoration of shrub grasslands, curl-leaf mountain mahogany (*Cercocarpus ledifolius*), and deciduous-dominated forests will be needed across all seasonal habitats.

In 2016, wildlife biologists recommended a mule deer harvest management change from buck-only to either-sex with an UOPH-license across nine HDs (302, 320, 322, 325, 326, 328, 330, 331 and 333) in southwest Montana. They also recommended the UOPH-license be valid for antlerless mule deer harvest in HDs 300 and 329, where buck harvest was managed by limited and unlimited HD-specific permits, respectively (Figure 6; hereafter Either-sex Management Area or EMA). The unlimited HD-specific buck permit was removed in HD 329 in 2018 and an UOPH-license either-sex regulation was implemented. The objectives were to:

- maintain mule deer populations within declining habitat capacity to prevent further long-term impacts to habitat condition and its consequences for long-term mule deer populations;
- improve hunter-harvest opportunity through sustainable antlerless harvest;
- provide private landowners an unlimited tool to manage mule deer populations within individual tolerances; and
- increase the proportion of mule deer bucks surviving beyond two years old by spreading hunter harvest across antlered and antlerless deer (Waltee 2015).

The Montana Fish and Wildlife Commission adopted the recommended harvest changes prior to the 2016 hunting season. Either-sex mule deer seasons had not been utilized at a landscape scale across southwest Montana for any measurable length of time since 1975. Unlimited either-sex harvest of mule deer is believed by many to be unsustainable across southwest Montana. Given this uncertainty, wildlife biologists committed to monitoring population responses relative to five hypotheses:

1) The level of antlerless harvest resulting from an UOPH-license either-sex regulation would not become the primary population driver of mule deer in southwest Montana. Annual browse and weather conditions, competition for resources, and predation would remain the primary short-term drivers. Habitat quality and quantity would remain the primary long-term driver;

2) Post hunting season buck: doe ratios and the proportion of older age-class bucks harvested by hunters would increase because UOPH-license harvest would be spread across antlered and antlerless deer instead of only antlered deer;
3) Fawn recruitment would increase because of reductions in intra-specific competition for resources and the proportion of does entering older, less productive age classes;
4) Antlerless harvest would be higher during years when autumn snow accumulation concentrates deer on winter range in November—pairing higher antlerless harvest with the onset of severe winters, when it is expected to be most compensatory to starvation mortality; and
5) Antlerless harvest opportunity would increase mule deer harvest on private lands. This would better distribute hunters between public and private land and more effectively address private land game damage through the general hunting season.

This report summarizes preliminary population-level responses of mule deer to the either-sex management regulation, relative to these hypotheses, following five years of implementation.

# Methods

We used a before–after–control design to test our hypotheses against adjacent HDs managed by a variety of harvest regulations. Harvest regulations in comparison districts included: UOPH-license buck-only, HD-specific limited permit buck-only, UOPH-license shortened-season (late October–November 15) buck-only, and HD-specific unlimited permit buck-only. Permits validate use of the UOPH-license in specific HDs. In each of the comparison HDs, antlerless harvest was absent or managed by limited quotas of antlerless-only B-licenses (second deer license). We aggregated data across the EMA to analyze the hypothesized effects of either-sex management on harvest and population characteristics. The number of years of data for harvest and population characteristics prior to either-sex management varied between different metrics. Therefore, the number of years included in data analysis varied depending on the metric being evaluated. We used difference of means tests and Z-score tests to test for statistical difference at the 95% confidence level between means and proportions, respectively. For difference of means tests, we used zero as the value of no effect because all measures were absolute. We considered P-values ≤0.05 as significant.

During all study years, up to one deer license could be purchased by an unlimited number of resident and limited number of non-resident hunters. The licenses were valid for mule or white-tailed deer harvest in many HDs across the state. There was no limit on the number of licenses that could be used in the EMA. The annual hunting season included a 44-day archery-only season that initiated on the first Saturday in September and a 37-day rifle season that ended on the Sunday following the Thanksgiving holiday.

**Population**

We indexed population by the number of mule deer observed per square mile surveyed during spring. Data were collected from five survey areas in the EMA (HDs 300, 320, 325, 326, and 331) and four control surveys areas in HDs 319, 324, 360-362, and 391 (Figure 6). No survey was completed in the HD 341 survey area during spring 2021. We used deer per square mile as the population measure to account for unbalanced survey effort between the EMA and control area within year and within the EMA and control areas between years. Population surveys were aerial minimum counts of geographically defined areas using helicopters at initial spring green-up. To measure population response following implementation of the either-sex harvest regulation, we measured the percent change in population in the EMA since 2016. The geometric mean of annual population growth was used to estimate average annual growth rate since implementation of either-sex harvest. For comparison, we estimated average annual growth rate in the EMA during years of UOPH-license buck-only and limited quota antlerless harvest (1976-2016). To control for possible non-harvest regulation effects, we measured the percent change in population in the control area during the same years.

**Recruitment**

We measured recruitment as the ratio of fawns: 100 adults during spring. Recruitment surveys were completed in conjunction with aerial population surveys using helicopters at initial spring green-up. Spring recruitment surveys index the combined vital rates of doe fecundity and fawn survival through their first year (Mills 2013). We also measured the ratio of fawn: 100 does collected in post-hunting season flights. These flights are conducted in December or January while bucks retain their antlers. These flights provide fawns: doe ratios which are not subject to changes in buck: doe ratios.

However, they do not include over winter survival of fawns provided by spring recruitment surveys. Spring fawn: adult ratios were collected from five survey areas in the EMA (HDs 300, 320, 325, 326, and 331) and four control survey areas in HDs 319, 324, 360-362, and 391 (Figure 6). Post-season fawn: doe ratios were collected in the five EMA areas and control area HDs 312, 313, 319, 324, 341, 380, and 391. To measure recruitment response following implementation of the either-sex harvest regulation, we compared average annual recruitment in the EMA during years 1–3 and years 4–5 post implementation to average annual recruitment in the EMA during the 10 years prior to implementation. We compared average annual recruitment in the control area during the same time periods to control for possible effects not associated with harvest regulations.

**Hunter Harvest**

Antlered and antlerless mule deer harvest was estimated annually for each HD through Montana Fish, Wildlife & Parks (FWP) harvest survey program, which randomly surveys hunters by telephone (Lukacs et al. 2011). We used these data to estimate the number of antlered and antlerless mule deer harvested annually in the EMA and control area. HDs 311, 319, 321, 323, 327, 332, 341, 350, 360, 362 and 370 (Figure 6) were used as control areas because of their proximity to the EMA, each allowed hunters to harvest deer with and UOPH-license, and none were managed by an either-sex harvest regulation for mule deer. To measure harvest response following implementation of the either-sex harvest regulation, we compared average annual harvest of antlered and antlerless mule deer in the EMA since implementation of the either-sex harvest regulation to average annual harvest during the 10 years prior to implementation. We compared average annual antlered and antlerless harvest in the control area during the same time period to control for potential effects not associated with harvest regulations.

## Hunter Effort

Hunter effort, measured as the number of hunters that invested a minimum of one day afield hunting mule or white-tailed deer was estimated by HD through FWPs harvest survey program during 2003–2011, 2013, 2017, and 2019. We used these data to estimate the number of deer hunters in the EMA and control area. HDs 311, 319, 321, 323, 327, 332, 341, 350, 360, 362 and 370 (Figure 6) were used as control areas because of their proximity to the EMA, each allowed hunters to harvest deer with an UOPH-license, and none were managed by an either-sex harvest regulation for mule deer. To measure hunter effort response following implementation of the either-sex harvest regulation, we compared the annual average number of deer hunters in the EMA during 2017 and 2019 to the average annual number of hunters in the EMA during 2003–2013. We compared the number of hunters in the control area during the same time periods to control for potential effects not associated with harvest regulations.

## Population Age Structure

Age of harvested antlered and antlerless mule deer checked at hunter check-stations was estimated using tooth eruption and wear techniques described by Robinette et al. (1957). Data were collected from eight check-stations scattered within and around the EMA (Figure 6). Check-stations were operated during weekends during the rifle hunting season. We used these data to measure the proportion of antlered and antlerless deer by age categories in the EMA and control area. All mule deer harvested outside of the EMA and within FWP administrative Region 3 were used as controls. Antlerless age categories included: 1–3 years, 4–6 years, 7–10 years, and >10 years. Antlered age categories included: 1–2 years, 3–5 years, and ≥6 years. Age categories were used because of imprecise accuracy of eruption and wear techniques beyond two years old (Hamlin et al. 2000). Harvested antlerless deer were expected to provide a random sample from the population and reliable population age structure because most hunters are not expected to be able to identify adult antlerless deer by age. Harvested antlered deer were expected to provide a sample biased by hunter selection for the largest antlered deer in a group.

To measure antlerless deer age structure response within the EMA following implementation of the either-sex harvest regulation, we compared the proportion of aged antlerless deer within each age category during years 1–3 to years 4–5 post implementation. Pre-implementation data were insufficient for comparison, therefore the potential effects on age structure were only evaluated between control and treatment areas. To account for potential non-harvest regulation effects, we compared the proportion of antlerless deer aged in the control area during years 1–3 to years 4–5 post implementation.

To measure antlered deer age structure response within the EMA following implementation of the either-sex harvest regulation, we compared the proportion of aged antlered deer within each age category during post-implementation years 1–3 and years 4–5 to pre-implementation proportions. We tested for differences in the age distribution of harvested bucks between pre- and post-implementation with a chi-square test for homogeneity. We compared the proportion of aged antlered deer within the control area for each age category during the same time periods to control for potential effects not associated with harvest regulations. For comparison between the EMA and the control area we performed a chi-square test for homogeneity for years since either-sex implementation.

**Buck: Doe Ratios**

We measured the ratio of total, yearling, and adult (≥2 years old) bucks observed per 100 does during post-hunting season surveys. Data were collected from six survey areas in the EMA (HDs 300, 302, 320, 325, 326, and 331) and six control survey areas in HDs 312, 319, 324, 341, 380, and 391 (Figure 6). Surveys were completed aerially using helicopters following the hunting season and prior to antler drop.

To measure buck: doe ratio response following implementation of the either-sex harvest regulation, we compared average annual total, yearling, and adult buck: doe ratios in the EMA during post-implementation years 1–3 and years 4–5 to pre-implementation averages. We compared average annual total, yearling, and adult buck: doe ratios in the control area managed by an UOPH-license buck-only harvest regulation (HD 341) during the same time period to control for potential effects not associated with harvest regulations. We also compared average annual total, yearling, and adult buck: doe ratios in the EMA during years 1–3 and years 4–5 post-implementation to average annual total, yearling, and adult buck: doe ratios during the same time periods in control areas managed by:

- HD-specific unlimited buck permits (HDs 319, 380, and 391);
- HD-specific limited buck permits (HDs 312 and 324); and
- UOPH-license shortened season length (season closed on November 15: HD 313).

During 1986–1993, the mule deer population associated with the HD 320 survey area was managed by an UOPH-license buck-only 5-week season. During 1994–2015, the hunting regulation changed to an UOPH-license buck-only, shortened-season regulation. The mule deer buck season was two weeks shorter than the standard Montana deer season and ended on November 15. The objective was to reduce adult buck harvest and increase the proportion of older age class bucks in the population by removing the portion of the hunting season when bucks were believed to be most vulnerable to harvest. After 22 years of implementation, the harvest regulation failed to meet that objective (Figure 14). In 2016, the harvest regulation was changed to a five-week UOPH-license either-sex regulation. To measure buck: doe ratio response following this change, we compared the average annual total, adult, and yearling buck: doe ratios from the HD 320 survey area during years 1–3 and years 4–5 post-implementation to pre-implementation averages.

During 1994–2009, the mule deer population associated with the HD 302 survey area was managed by an UOPH-license buck-only 5-week season. During 2010–2015, the hunting regulation changed to an unlimited-permit buck-only. The objective was to reduce buck harvest by limited take to only hunters that desired to hunt mule deer bucks only in HD 302. Post hunting season surveys showed increased buck: doe ratios during the unlimited-permit buck-only regulation, relative to the UOPH-license buck-only regulation (Figure 15). In 2016, the harvest regulation changed to an UOPH either-sex license. The objective was to facilitate antlerless mule deer harvest while maintaining or further increasing buck: doe ratios observed during the unlimited-permit buck-only regulation period. To measure buck: doe ratio response following this change, we compared the average annual total, adult, and yearling buck: doe ratios from the HD 302 survey area during post-implementation years 1–3 and years 4–5 to pre-implementation averages.

**Private Land Harvest**

The landownership type was recorded as public, private enrolled in FWPs Block Management Program, or private not enrolled in FWPs Block Management Program for all mule deer checked at the Alder Check-station (Figure 6) since 2013. To measure the response of private lands mule deer harvest following implementation of the either-sex harvest regulation, we compared average annual proportion of mule deer checked at the Alder Check-station that were harvested from private lands not enrolled in FWPs Block Management Program during years 1–3 and years 4–5 post-implementation to the pre-implementation average.  We did not include private lands enrolled in FWPs Block Management Program because changes to harvest regulations do not influence hunter access to those lands.  No control data were available to asses private land harvest outside of the EMA.

# Results

## Population

During spring 2021, we surveyed 298 square miles within the EMA and observed 10.3 mule deer per-square-mile (3,067 deer), compared to 12.1 per square mile in 2020—a 14.9% decrease. After implementation of the either-sex harvest regulation, the mule deer population in the EMA increased 32.1% (Figure 7). The observed deer-per-square-mile in 2021 was 4.0% above the 1970–2020 average of 9.9 (N=48, SD=4.1, 95%CI=9.1–11.5). Between 2020 and 2021 individual survey areas in HDs 300, 320, 325, 326, and 331 showed -42%, -17%, +14%, -16% and -35% change in spring counts, respectively.

Since the implementation of either-sex harvest in the EMA (2016-2020), the geometric mean of annual population growth indicated an increase of 5.6% deer per-square-mile per year for all EMA trend areas combined (95%CI=-8.6%–21.9%). In the 40 years prior to implementation of either-sex harvest, when mule deer were primarily managed with UOPH-license buck-only and limited quota antlerless harvest (1976-2016), the mean annual population growth was 1.1% deer per-square-mile per year (95%CI=-6.5%–12.9%) (Figure 8).

During spring 2021, wildlife biologists surveyed 660 square miles within control survey areas and observed 2.3 mule deer per square mile (1,516 deer), compared to 2.6 per square mile in 2020—an 11.6% decrease. Since 2016, the mule deer population in the control area decreased 37.9% (Figure 7). The observed deer per square mile in 2020 was 58.2% below the 1975–2019 average of 5.5 (N=47, SD=2.9, 95%CI=4.7–6.3). Mean annual population growth in the control areas since 2016 indicated a decrease of -9.1% deer per-square-mile per year for all control survey areas combined (95%CI=-11.4%–-6.7%).

**Recruitment**

During spring 2021, we classified 2,254 mule deer in the EMA as 1,560 adults and 694 fawns. The observed fawns: 100 adults ratio was 44.5 (95% CI=42.0–46.7) (Figure 9). This compares to 38.0 in 2020 and the 1970–2020 average of 46.1 (N=46, SD=11.9, 95% CI=42.7–49.5). During the ten most recent years that mule deer recruitment data were collected prior to implementation of the either-sex harvest regulation (2006–2016), annual fawns: 100 adults ratios averaged 39.2 (N=10, SD=7.2, 95% CI=34.5–43.5) across the EMA. During years 1–3 following implementation of the either-sex harvest regulation, annual fawns: 100 adults ratios averaged 43.0 (N=3, SD=2.2, 95% CI=40.5–45.5) across the EMA. The average fawns: 100 adults ratio during years 1–3 post-implementation increased 9.7%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=3.8, 95% CI=-5.7–13.3, P=0.40). During years 4–5 following implementation of the either-sex harvest regulation, annual fawns: 100 adults ratios averaged 41.2 (N=2, SD=4.6, 95% CI=34.8–47.6) across the EMA. The average fawns: 100 adults ratio during years 4–5 post-implementation increased 5.1% compared to the pre-implementation average. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=2.0, 95% CI=-10.1–14.1, P=0.72).

During spring 2021, wildlife biologists classified 1,167 mule deer as 884 adults and 283 fawns in the control area. The observed fawns: 100 adults ratio was 32.0 (95% CI=29.0–35.2) (Figure 9). This compares to 35.6 in 2020 and the 1975–2020 average of 39.1 (N=46, SD=12.9, 95% CI=35.4–42.8). During 2007–2016, annual fawns: 100 adults ratios averaged 31.4 (N=10, SD=4.5, 95% CI=28.6–34.2) across the control area. During 2017–2019, annual fawns: 100 adults ratios averaged 33.7 (N=3, SD=4.0, 95% CI=29.2–38.2) across the control area. The average fawns: 100 adults ratio during 2017–2019 increased 7.3% relative to 2007–2016. The difference between means was not significant at the 95%

confidence level ($\mu_1$-$\mu_2$=2.3, 95% CI=-7.4–12.0, P=0.54). During 2020–2021, annual fawns: 100 adults ratios averaged 33.8 (N=2, SD=2.5, 95% CI=30.3–37.3) across the control area. The average fawns: 100 adults ratio during 2020–2021 increased 7.6% relative to 2007–2016. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=2.4, 95% CI=-9.1–13.9, P=0.55).

During post-2020 hunting season, we classified 1,229 mule deer as 805 does and 424 fawns in the EMA. The observed fawns: 100 does ratio was 52.7 (95% CI=49.5–56.5). Since implementation of either-sex management, annual fawns: 100 does ratios averaged 58.7 (N=5, SD=4.5, 95% CI=53.1–64.3) across the EMA. This compared to 50.8 (N=10, SD=5.7, 95% CI=46.7–54.9) in the 10 years prior to implementation. Since implementation of either-sex management, the average has increased by 15.5% and the difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=7.9, 95% CI=-1.3–14.4, P=0.01). The increase in fawn: doe ratios were especially high in the first three years following implementation. The average during that period was 61.8 fawns: 100 does (N=3, SD=2.9, 95% CI=54.7–68.9). This was 21.6% higher than the pre-implementation ratios and significant at the 95% confidence level ($\mu_1$-$\mu_2$=11.0, 95% CI=3.2–18.8, P=0.007). During years 4–5 following implementation, the fawn: 100 does ratio was 54.0 (N=2, SD=1.4, 95% CI=41.8–66.3) which is 6.3% higher than the pre-implementation average, but the difference was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=3.2, 95% CI -6.1–12.5, P=0.24).

During post-2020 hunting season, biologists classified 874 mule deer as 612 does and 264 fawns in the control area. The observed fawns: 100 does ratio was 43.1 (95% CI=39.1–47.1). During 2006–2015, the average fawns: 100 does ratio was 47.2 (N=10, SD=10.0, 95%CI=40.0–54.4) in the control area. Since 2016, the average post-season fawns: 100 does ratio was 2.3% higher at 48.3 (N=5, SD=7.2, 95% CI=39.4–57.2). The difference was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=1.1, 95% CI=-10.2–12.4, P=0.84). During 2016–2018, post-season fawns: 100 does ratios averaged 53.8 (N=3, SD=2.0, 95% CI=48.0–58.6). This was 14.0% higher than 2005–2015 but this difference was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=6.6, 95% CI=-1.0–14.1, P=0.32). The average post-season fawns: 100 does ratio during 2019–2020 was 40.1 (N=2, SD=3.1, 95%CI=12.4–67.7). This was 7.1% lower than 2006–2015 but the difference was not significant at the 95% confidence level ($\mu_1$-$\mu_2$= -7.1, 95% CI=-23.5–9.2, P=0.18).

## Harvest

### *Antlered*

An estimated 1,662 antlered mule deer were harvested in the EMA in 2020 (Figure 10). This compares to 1,539 in 2019 (8.0% increase) and the 1986–2020 average of 1,825 (N=35, SD=674, 95% CI=1,602–2,048). During the ten years prior to implementation of the either-sex harvest regulation, hunters annually harvested an average of 1,246 (N=10, SD=290, 95% CI=1,066-1,426) antlered mule deer in the EMA. Since implementation of the either-sex harvest regulation, hunters annually harvested an average of 1,608 (N=5, SD=138, 95% CI=1,487–1,729) antlered mule deer in the EMA. After implementation of the either-sex harvest regulation, average annual antlered mule deer harvest in the EMA increased 29.1%. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=362, 95% CI=66–658, P=0.02).

An estimated 1,099 antlered mule deer were harvested in the control area in 2020 (Figure 11), compared to 1,084 in 2019 (1.4% increase) and the 2004–2020 average of 1,254 (N=17, SD=245, 95% CI=1,138–1,370). During 2006–2015, hunters annually harvested an average of 1,203 (N=10, SD=263, 95% CI=1,040–1,366) antlered mule deer. During 2016–2020, hunters annually harvested an average of 1,214 (N=5, SD=150, 95% CI=1,083–1,344). Since 2016, average annual antlered mule deer harvest in the control area increased 0.9%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=11.0, 95% CI=-266–288, P=0.93).

*Antlerless*

An estimated 511 antlerless mule deer were harvested in the EMA in 2020 (Figure 10). This compares to 490 in 2019 (4.3% increase) and the 1986–2020 average of 974 (N=35, SD=764, 95% CI=722–1,226). During 2006–2015, hunters annually harvested and average of 606 (N=10, SD=519, 95% CI=284–928) antlerless mule deer in the EMA. Since implementation of the either-sex harvest regulation, hunters annually harvested and average of 582 (N=5, SD=103, 95% CI=491–673) antlerless mule deer. After implementation of the either-sex harvest regulation, average annual antlerless mule deer harvest in the EMA decreased 4.0%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-24, 95% CI=-610–562, P=0.93).

An estimated 292 antlerless mule deer were harvested in the control area in 2020 (Figure 11). This compares to 325 in 2019 (10.2% decrease) and the 2004–2020 average of 333 (N=17, SD=168, 95% CI=253–413). During 2006–2015, hunters annually harvested and average of 306 (N=10, SD=174, 95% CI=180–396) antlerless mule deer in the control area. During 2016–2020, hunters annually harvested and average of 309 (N=5, SD=43, 95% CI=267–345). Since 2016, average annual antlerless mule deer harvest in the control area increased 0.01%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=3.0, 95% CI=-116–122, P=0.96).

**Hunter Effort**

No deer hunter effort data were collected in 2020. An estimated 11,053 hunters pursued deer (mule or white-tailed) in the EMA in 2019, compared to 10,854 in 2017 and the 1974–2017 average of 10,494 (N=39, SD=2,115, 95%CI=9,830–11,158). During 2016–2019, the annual average number of deer hunters in the EMA was 10,964 (N=2, SD=127, 95%CI=10,789–11,139). This compares to a 2003–2013 average of 10,583 (N=10, SD=889, 90% CI=10,032–11,134). After implementation of the either-sex harvest regulation, the average number of deer hunters in the EMA increased 3.6%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=381, 95% CI=-1,076.2–1,838.2, P=0.57).

An estimated 9,417 hunters pursued deer (mule or white-tailed) in the control area in 2019, compared to 9,677 in 2017 and the 2004–2017 average of 9,208 (N=10, SD=341, 95%CI=7,097–9,419). During 2016–2019, the annual average number of deer hunters in the control area was 9,547 (N=2, SD=184, 95%CI=9,292–9,802), compared to an 2003–2013 average of 9,156 (N=9, SD=316, 95% CI=8,949–9,363). Since 2016, the annual average number of deer hunters in the control area increased 4.3%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=391, 95% CI=-146.9–928.9, P=0.13).

## **Population Age Structure**

### *Antlered—Either-sex Management and Control Areas: 2020*

Ages were collected from 31 and 2 antlered mule deer harvested in the EMA (Table 1) and control area (Table 2) in 2020, respectively. Of those from the EMA, 32% were 1–2, 61% were 3–5, and 6% were ≥6 years old. Of those from the control area, one was 1–2 years old and one was 3–5 years old.

*Antlered—Either-sex Management Area: Pre and Post-Implementation*

During 2013–2015, prior to implementation of the either-sex harvest regulation, wildlife biologist aged 106 antlered mule deer in the EMA. Of those, 46.2% (95% CI=36.5–56.2) were 1–2 years old, 47.2% (95% CI=37.4–57.1) were 3–5 years old, and 7.6% (95% CI=3.3–14.3) were ≥6 years old. During years 1–3 following implementation of the either-sex harvest regulation (2016–2018), wildlife biologists aged 241 antlered mule deer in the EMA. Of those, 48.9% (95% CI=42.5–55.3) were 1–2 years old, 46.5% (95% CI=40.2–52.8) were 3-5 years old, and 4.6% (95% CI=1.9–7.2) were ≥6 years old. During years 4–5 following implementation of the either-sex harvest regulation (2019–2020), wildlife biologists aged 88 antlered mule deer in the EMA. Of those, 38.6% (95% CI=28.5–48.8) were 1–2 years old, 53.4% (95% CI=43.0–63.8) were 3-5 years old, and 8.0% (95% CI=2.3–13.6) were ≥6 years old (Table 1).

Relative to pre-implementation, the proportion of antlered deer aged during years 1–3 post-implementation that were:

- 1–2 years old increased 5.6%, but the difference was not significant at the 95% level ($z$=-0.46, $P$=0.65);
- 3–5 years old increased 1.5%, but the difference was not significant at the 95% level ($z$=0.12, $P$=0.90); and
- ≥6 years old decreased 34.8%, but the difference was not significant at the 95% level ($z$=1.13, $P$=0.26).

Relative to pre-implementation, the proportion of antlered deer aged during years 4–5 post-implementation that were:

- 1–2 years old decreased 19.7%, but the difference was not significant at the 95% level ($z$=1.07, $P$=0.28);

- 3–5 years old increased 11.7%, but the difference was not significant at the 95% level (z=-0.86, P=0.39); and
- ≥6 years old increased 5.2%, but the difference was not significant at the 95% level (z=-0.10, P=0.92).

Pooling the total number of antlered deer from each age class for pre-implementation, years 1–3 post-implementation, and years 4–5 post-implementation, a chi-square test showed no difference in the age distribution of harvested antlered deer between management regimes or post-implementation time periods ($\chi^2$=2.47, P=0.65).

*Antlered—Control Area: Pre and Post-Implementation*

During 2013–2015, wildlife biologist aged 193 antlered mule deer in the control. Of those, 49.2% (95% CI=42.0–56.5) were 1–2 years old, 45.1% (95% CI=37.9–52.4) were 3–5 years old, and 5.7% (95% CI=2.9–10.0), were ≥6 years old. During 2016–2018, wildlife biologists aged 210 antlered mule deer in the control area. Of those, 53.3% (95% CI=46.3–60.2) were 1–2 years old, 42.9% (95% CI=36.1–49.8) were 3-5 years old, and 3.8% (95% CI=1.7–7.4) were ≥6 years old. During 2019–2020, wildlife biologists aged 46 antlered mule deer in the control area. Of those, 52.2% (95% CI=28.5–48.8) were 1–2 years old, 39.1% (95% CI=43.0–63.8) were 3-5 years old, and 8.7% (95% CI=2.4–20.8) were ≥6 years old.

Relative to 2013–2015, the proportion of antlered deer aged during years 2016–2018 that were:

- 1–2 years old increased 8.3%, but the difference was not significant at the 95% level (z=-0.82, P=0.41);

- 3–5 years old decreased 5.1%, but the difference was not significant at the 95% level ($z=0.44$, $P=0.66$); and
- ≥6 years old decreased 33.4%, but the difference was not significant at the 95% level ($z=0.90$, $P = 0.37$).

Relative to 2013–2015, the proportion of antlered deer aged during years 2019–2020 that were:

- 1–2 years old increased 5.8%, but the difference was not significant at the 95% level ($z=-0.37$, $P=0.71$);
- 3–5 years old decreased 15.3%, but the difference was not significant at the 95% level ($z=0.73$, $P=0.46$); and
- ≥6 years old increased 34.5%, but the difference was not significant at the 95% level ($z=-0.75$, $P=0.45$).

Pooling the total number of antlered deer from each age class for time periods 2013–2015, 2016–2018, and 2019–2020, a chi-square test showed no difference in the age distribution of harvested antlered deer between time periods ($\chi^2=2.61$, $P=0.62$).

*Antlered—Either-sex Management Area versus Control Area: Post-implementation*

During years 1–3 following implementation of the either-sex harvest regulation:

- 48.9% (95% CI=42.5–55.3) and 53.3% (95% CI=46.3–60.2) of antlered deer aged from the EMA and control areas, respectively**,** were 1–2 years old. The difference was not significant at the 95% level ($z=-0.93$, $P=0.35$);
- 46.5% (95% CI=40.2–52.8) and 42.9% (95% CI=36.1–49.8) of antlered deer aged from the EMA and control areas, respectively**,** were 3–5 years old. The difference was not significant at the 95% level ($z=0.77$, $P=0.44$); and

- 4.6% (95% CI=1.9–7.2) and 3.8% (95% CI=1.7–7.4) of antlered deer aged from the EMA and control areas, respectively, were ≥6 years old. The difference was not significant at the 95% level (z=0.42, P=0.67);

During years 4–5 following implementation of the either-sex harvest regulation:

- 38.6% (95% CI=28.5–48.8) and 52.2% (95% CI=28.5–48.8) of antlered deer aged from the EMA and control areas, respectively, were 1–2 years old. The difference was not significant at the 95% level (z=-1.47, P=0.14);
- 53.4% (95% CI=43.0–63.8) and 39.1% (95% CI=43.0–63.8) of antlered deer aged from the EMA and control areas, respectively, were 3–5 years old. The difference was not significant at the 95% level (z=1.57, P=0.12); and
- 8.0% (95% CI=2.3–13.6) and 8.7% (95% CI=2.4–20.8) of antlered deer aged from the EMA and control areas, respectively, were ≥6 years old. The difference was not significant at the 95% level (z=-0.14, P=0.89).

Pooling the total number of animals checked in each age class for both the EMA and control area from time periods 2016–2018 and 2019–2020, a chi-square test showed no difference in the age distribution of harvested antlered deer between management regimes or time periods ($\chi^2$ =2.61, P=0.62) ($\chi^2$=7.52, P=0.28).

*Antlerless—Either-sex Management and Control Areas: 2020*

Ages were collected from six and zero antlerless mule deer ≥1.5 years old from the EMA (Table 1) and control area (Table 2) in 2020, respectively. Of those from the EMA, 33% were 1–3, 50% were 4–6, 17% were 7–10, and 0% were >10 years old.

*Antlerless—Either-sex Management Area versus Control Area: Post-Implementation*

During years 1–3 following implementation of the either-sex harvest regulation, wildlife biologist aged 129 antlerless mule deer from the EMA and 53 antlerless mule deer from the control area. Of those from the EMA, 44.2% (95% CI=35.5–53.2) were 1–3 years old, 31.0% (95% CI=23.2–39.8) were 4–6 years old, 21.7% (95% CI=14.9–29.8) were 7–10 years old, and 3.1% (95% CI=0.9–7.8) were >10 years old (Table 1). Of those from the control area, 52.8% (95% CI=38.6–66.7) were 1–3 years old, 45.3% (95% CI=31.6–59.6) were 4–6 years old, 1.2% (95% CI=0.0–10.1) were 7–10 years old, and 0.0% (95% CI=0.0–6.7) >10 years old (Table 2).

Relative to the control area, the proportion of antlerless deer from the EMA aged during years 1–3 post implementation that were:

- 1–3 years old was 16.3% lower, but the difference was not significant at the 95% confidence level (z=-1.06, P=0.29);
- 4–6 years old was 31.6% lower, but the difference was not significant at the 95% confidence level (z=-1.84, P=0.66);
- 7–10 years old was 94.5% higher and the difference was significant at the 95% confidence level (z=3.45, P=0.00056); and
- >10 years old was higher but the difference was not significant at the 95% confidence level (z=1.30, P=0.19).

During years 4–5 following implementation of the either-sex harvest regulation, wildlife biologist aged 53 and 13 antlerless mule deer from the EMA and control area, respectively. Of those from the EMA, 39.5% (95% CI=24.0–56.6) were 1–3 years old, 52.6% (95% CI=35.8–69.0) were 4–6 years old, 7.9% (95% CI=1.7–21.4) were 7–10 years old, and 0.0% (95% CI=0.0–9.3) were >10 years old (Table 1). Of those from the control area, 76.9% (95% CI=46.2–95.0) were 1–3 years old, 23.1% (95%

CI=5.0–53.4) were 4–6 years old, 0.0% (95% CI=0.0–24.7) were 7–10 years old, and 0.0% (95% CI=0.0–24.7) >10 years old (Table 2).

Relative to the control area, the proportion of antlerless deer from the EMA aged during years 4–5 post implementation that were:

- 1–3 years old was 48.7% lower, and the difference was significant at the 95% confidence level ($z=-2.42$, $P=0.02$);
- 4–6 years old was 127.7% higher, but the difference was not significant at the 95% confidence level ($z=1.91$, $P=0.06$);
- 7–10 years old was higher but the difference was not significant at the 95% confidence level ($z=1.05$, $P=0.29$); and
- no antlerless deer >10 years old were detected in either area.

Table 1. Age structure of antlered and antlerless mule deer harvested in the Either-sex Management Area, 2013-2020.

| Year | Antlerless Age Structure | | | | | Antlered Age Structure | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number Aged | %1-3yrs | %4-6yrs | %7-10yrs | %≥10yrs | Number Aged | %1-2yrs | %3-5yrs | %≥6yrs |
| **Pre Either-sex Regulation (2013–2015)** | **15** | **60.0** (32.3–83.7) | **26.7** (7.8–55.1) | **13.3** (1.7–40.5) | **0.0** (0.0–21.8) | **106** | **46.2** (36.5–56.2) | **47.2** (37.4–57.1) | **7.6** (3.3–14.3) |
| **Post Either-sex Regulation Implementation Years 1–3 (2016–2018)** | **129** | **44.2** (35.5–53.2) | **31.0** (23.2–39.8) | **21.7** (14.9–29.8) | **3.1** (0.9–7.8) | **241** | **48.9** (42.5–55.3) | **46.5** (40.2–52.8) | **4.6** (1.9–7.2) |
| **Post Either-sex Regulation Implementation Years 4–5 (2019–2020)** | **38** | **39.5** (24.0–56.6) | **52.6** (35.8–69.0) | **7.9** (1.7–21.4) | **0.0** (0.0–9.3) | **88** | **38.6** (28.5–48.8) | **53.4** (43.0–63.8) | **8.0** (2.3–13.6) |

Note: 95% Confidence Intervals reported in parentheses;

Table 2. Age structure of antlered and antlerless mule deer harvested in the control area, 2013-2020.

| Year | Antlerless Age Structure | | | | | Antlered Age Structure | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number Aged | %1-3yrs | %4-6yrs | %7-10yrs | %≥10yrs | Number Aged | %1-2yrs | %3-5yrs | %≥6yrs |
| **Years 2013–2015** | **25** | **52.0** (31.3–72.2) | **42.0** (21.1–61.3) | **8.0** (1.0–26.0) | **0.0** (0.0–13.7) | **193** | **49.2** (42.0–56.5) | **45.1** (37.9–52.4) | **5.7** (2.9–10.0) |
| **Years 2016–2018** | **53** | **52.8** (38.6–66.7) | **45.3** (31.6–59.6) | **1.2** (0.0–10.1) | **0.0** (0.0–6.7) | **210** | **53.3** (46.3–60.2) | **42.9** (36.1–49.8) | **3.8** (1.7–7.4) |
| **Years 2019–2020** | **13** | **76.9** (46.2–95.0) | **23.1** (5.0–53.4) | **0.0** (0.0–24.7) | **0.0** (0.0–24.7) | **46** | **52.2** (36.9–67.1) | **39.1** (25.1–54.6) | **8.7** (2.4–20.8) |

Note: 95% Confidence Intervals reported in parentheses;

**Buck: Doe Ratio**

*Either-sex Management Area: Pre and Post-Implementation*

Following the 2020 hunting season, we classified 1,403 mule deer in the EMA. The observed total, adult, and yearling buck: 100 does ratios were 21.5, 13.9, and 7.6, respectively (Figure 12).

*Total Buck: Doe Ratio*

Prior to implementation of the either-sex harvest regulation, the annual average total buck: 100 does ratio was 16.5 (N=31, SD=4.7, 95% CI=14.8–18.2). During years 1–3 following implementation, the annual average total buck: 100 does ratio was 19.0 (N=3, SD=3.5, 95% CI=15.0–23.0). Relative to pre-implementation, the annual average total buck: 100 does ratio increased 15.2%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=2.5, 95% CI=-3.2–8.2, P=0.38). During years 4–5 following implementation, the annual average total buck: 100 does ratio was 22.7 (N=2, SD=1.7, 95% CI=20.3–25.1). Relative to pre-implementation, the average total buck: 100 does ratio increased 37.8%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=6.2, 95% CI=-0.7–13.1, P=0.08).

*Adult Buck: Doe Ratio*

Prior to implementation of the either-sex harvest regulation, the annual average adult buck: 100 does ratio was 6.7 (N=31, SD=2.8, 95% CI=5.7–7.7). During years 1–3 following implementation, the annual average adult buck: 100 does ratio was 9.1 (N=3, SD=2.6, 95% CI=6.1–12.1). Relative to pre-implementation, the annual average adult buck: 100 does ratio increased 35.9%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=2.4, 95% CI=-1.0–5.8, P=0.16). During years 4–5 following implementation, the annual average adult buck: 100 does ratio was 12.7 (N=2, SD=1.7, 95% CI=10.3–15.1). Relative to pre-implementation, the annual average adult buck: 100 does ratio increased 89.6%. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=6.0, 95% CI=1.9–10.1, P=0.0057).

*Yearling Buck: Doe Ratio*

Prior to implementation of the either-sex harvest regulation, the annual average yearling buck: 100 does ratio was 9.7 (N=31, SD=3.3, 95% CI=8.5–10.9). During years 1–3 following implementation, the annual average yearling buck: 100 does ratio was 10.0 (N=3, SD=1.2, 95% CI=8.7–11.3). Relative to pre-implementation, the annual average yearling buck: 100 does ratio increased 3.0%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=0.3, 95% CI=-3.7–4.3, P=0.88). During years 4–5 following implementation, the annual average yearling buck: 100 does ratio was 10.0 (N=2, SD=3.4, 95% CI=5.2–14.8). Relative to pre-implementation, the annual average yearling buck: 100 does ratio increased 3.0%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=0.3, 95% CI=-4.6–5.2, P=0.90).

*Control Area (Unlimited-License Buck-only): Pre and Post-Implementation*

Following the 2020 hunting season, wildlife biologists classified 144 mule deer in the control area managed by an UOPH-license buck-only regulation. The observed total, adult, and yearling buck: 100 does ratios were 8.0, 4.0, and 4.0.

*Total Buck: Doe Ratio*

During 1976–2015, the annual average total buck: 100 does ratio was 14.1 (N=37, SD=7.1, 95% CI=11.8–16.4). During 2016–2018, the annual average total buck: 100 does ratio was 11.7 (N=3, SD=4.0, 95% CI=7.1–16.3). Relative to pre-implementation, the annual average total buck: 100 does ratio decreased 20.5%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.4, 95% CI=-10.9–6.1, P=0.57). During 2019–2020, the annual average total buck: 100 does ratio was 9.0 (N=2, SD=1.4, 95% CI=7.0–11.0). Relative to pre-implementation, the annual average total buck: 100 does ratio decreased 43.4%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-5.6, 95% CI=-15.3–5.3, P=0.33).

*Adult Buck: Doe Ratio*

During 1977–2015, the annual average adult buck: 100 does ratio was 7.3 (N=34, SD=3.7, 95% CI=6.9–7.7). During 2016–2018, the annual average adult buck: 100 does ratio was 3.0 (N=3, SD=1.7, 95% CI=1.0–5.0). Relative to pre-implementation, the annual average adult buck: 100 does ratio decreased 58.9%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-4.3, 95% CI=-8.7–0.1, P=0.06). During 2019–2020, the annual average adult buck: 100 does ratio was 4.5 (N=2, SD=0.7, 95% CI=3.5–5.5). Relative to pre-implementation, the annual average adult buck: 100 does ratio decreased 39.4%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.8, 95% CI=-8.2–2.6, P=0.30).

*Yearling Buck: Doe Ratio*

During 1976–2015, the annual average yearling buck: 100 does ratio was 6.3 (N=34, SD=3.6, 95% CI=5.0–7.6). During 2016–2018, the annual average yearling buck: 100 does ratio was 8.7 (N=3, SD=2.5, 95% CI=5.2–12.2). Relative to pre-implementation, the annual average yearling buck: 100 does ratio increased 38.1%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.4, 95% CI=-1.9–6.7, P=0.27). During 2019–2020, the annual average yearling buck: 100 does ratio was 4.5 (N=2, SD=0.7, 95% CI=3.5–5.5). Relative to pre-implementation, the annual average yearling buck: 100 does ratio decreased 28.6%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-1.8, 95% CI=-7.0–3.4, P=0.49).

*Either-sex Management Area versus Control Area (Unlimited-License Buck-only): Post-Implementation*

During years 1–3 following implementation of the either-sex harvest regulation, the annual average:

- total buck: 100 does ratio was 62.3% higher in the EMA than in the unlimited license buck-only control area. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-7.3, 95% CI=-15.8–1.2, P=0.08);
- adult buck: 100 does ratio in the EMA was 203% higher than in the unlimited license buck-only control area. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=-6.1, 95% CI=-11.1–-1.1, P=0.03); and
- yearling buck: 100 does ratio in the EMA was 14.9% higher than in the unlimited license buck-only control area. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-1.3, 95% CI=-5.7–3.1, P=0.46).

During years 4–5 following implementation of the either-sex harvest regulation, the annual average:

- total buck: 100 does ratio was 152.2% higher in the EMA than in the unlimited license buck-only control area. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=-13.7, 95% CI=-20.4–-7.0, P=0.01);

- adult buck: 100 does ratio in the EMA was 182.2% higher than in the unlimited license buck-only control area. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=-8.2, 95% CI=-13.8–-2.6, P=0.02); and
- yearling buck: 100 does ratio in the EMA was 122.2% higher than in the unlimited license buck-only control area. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-5.5, 95% CI=-16.1–5.1, P=0.15).

*Either-sex Management Area versus Control Area (Restrictive Buck-only Harvest Regulations): Post Implementation*

*Total Buck: Doe Ratio*

During years 1–3 following implementation of the either-sex harvest regulation, the annual average total buck: 100 does ratio in the EMA was:

- 56.8% lower than the annual average total buck: 100 does ratio of 44.0 (N=3, SD=1.2, 95% CI=42.6–45.4) in control areas managed by limited-permit buck-only regulations. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=25.0, 95% CI=19.1–30.9, P=0.0003);
- equal to the annual average total buck: 100 does ratio of 19.0 (N=3, SD=2.6, 95% CI=16.0–22.0) in the control area managed by a shortened-season buck-only regulation. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=0.0, 95% CI=-7.0–7.0, P=1.0); and
- 7.3% higher than the annual average total buck: 100 does ratio of 17.7 (N=3, SD=3.7, 95% CI=13.5–21.9) in the control areas managed by unlimited-permit buck-only regulations. The

difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=1.3, 95% CI=-9.5–6.9, P=0.68).

During years 4–5 following implementation of the either-sex harvest regulation, the annual average total buck: 100 does ratio in the EMA was:

- 25.6% lower than the annual average total buck: 100 does ratio of 30.5 (N=2, SD=17.1, 95% CI=6.8–54.0) in control areas managed by limited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=7.8, 95% CI=-44.5–60.1, P=0.59); and
- 74.6% higher than the annual average total buck: 100 does ratio of 13.0 (N=2, SD=3.8, 95% CI=7.7–18.3) in the control areas managed by unlimited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-9.7, 95% CI=-22.4–3.0, P=0.08).

*Adult Buck: Doe Ratio*

During years 1–3 following implementation of the either-sex harvest regulation, the annual average adult buck: 100 does ratio in the EMA was:

- 73.3% lower than the annual average adult buck: 100 does ratio of 34.1 (N=3, SD=0.9, 95% CI=33.1–35.1) in the control areas managed by limited permit buck-only regulations. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=25.0, 95% CI=-16.6–33.4, P=0.006);
- 17.3% lower than the annual average adult buck: 100 does ratio of 11.0 (N=3, SD=2.0, 95% CI=8.7–13.3) in the control area managed by a shortened-season buck-only regulation. The

difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=1.9, 95% CI=-8.1–11.9, P=0.50); and

- 18.8% lower than the annual average adult buck: 100 does ratio of 11.2 (N=3, SD=3.0, 95% CI=7.8–14.6) in the control areas managed by unlimited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=2.1, 95% CI=-10.0–14.2, P=0.53).

During years 4–5 following implementation of the either-sex harvest regulation, the annual average adult buck: 100 does ratio in the EMA was:

- 40.4% lower than the annual average adult buck: 100 does ratio of 21.3 (N=2, SD=10.1, 95% CI=7.3–37.3) in control areas managed by limited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=8.6, 95% CI=-22.6–39.8, P=0.36); and
- 36.6% higher than the annual average adult buck: 100 does ratio of 9.3 (N=2, SD=4.5, 95% CI=3.0–15.6) in the control areas managed by unlimited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-3.4, 95% CI=-18.0–11.2, P=0.42).

*Yearling Buck: Doe Ratio*

During years 1–3 following implementation of the either-sex harvest regulation, the annual average yearling buck: 100 does ratio in the EMA was:

- equal to the annual average yearling buck: 100 does ratio of 10.0 (N=3, SD=1.4, 95% CI=8.6–11.4) in the control areas managed by limited permit buck-only regulations. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=0.0, 95% CI=-3.0–3.0, P=1.0);

- 20.0% higher than the annual average yearling buck: 100 does ratio of 8.0 (N=3, SD=1.7, 95% CI=6.0–10.0) in the control area managed by a shortened-season buck-only regulation. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.0, 95% CI=-5.3–1.3, P=0.17); and
- 53.8% higher than the annual average yearling buck: 100 does ratio of 6.5 (N=3, SD=1.9, 95% CI=4.3–8.7) in the control areas managed by unlimited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-3.5, 95% CI=-7.1–0.1, P=0.054).

During years 4–5 following implementation of the either-sex harvest regulation, the annual average yearling buck: 100 does ratio in the EMA was:

- 8.7% higher than the annual average yearling buck: 100 does ratio of 9.2 (N=2, SD=7.1, 95% CI=0.0–18.9) in control areas managed by limited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-0.8, 95% CI=-17.9–16.3, P=0.86); and
- 170.3% higher than the annual average yearling buck: 100 does ratio of 3.7 (N=2, SD=0.7, 95% CI=2.8–4.6) in the control areas managed by unlimited-permit buck-only regulations. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-6.3, 95% CI=-16.9–4.3, P=0.12).

*Shortened Season Length (Hunting District 320 Survey Area): Pre and Post-Implementation*

*Total Buck: Doe Ratio*

During the period of three-week shorted seasons (1994–2015), the annual average total buck: 100 does ratio was 24.8 (N=20, SD=6.8, 95% CI=21.8–27.8). During years 1–3 following implementation of the either-sex harvest regulation, the annual average total buck: 100 does ratio was 29.4 (N=3, SD=1.6, 95% CI=27.6–31.2). Relative to 1994–2015, the annual average total buck: 100 does ratio increased 18.5%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-4.6, 95% CI=-15.8–6.6, P=0.32). During years 4–5 following implementation of the either-sex harvest regulation, the annual average total buck: 100 does ratio was 29.4 (N=2, SD=1.9, 95% CI=26.8–32.0). Relative to 1994–2015, the annual average total buck: 100 does ratio increased 18.5%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=0.0, 95% CI = -4.0–4.0, P=1.0).

*Adult Buck: Doe Ratio*

During the period of three-week shorted seasons (1994–2015), the annual average adult buck: 100 does ratio was 10.7 (N=20, SD=4.8, 95% CI=8.6–12.8). During years 1–3 following implementation of the either-sex harvest regulation, the annual average adult buck: 100 does ratio was 15.1 (N=3, SD=0.9, 95% CI=14.1–16.1). Relative to 1994–2015, the annual average adult buck: 100 does ratio increased 41.1%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=4.4, 95% CI=-1.5–10.3, P=0.14). During years 4–5 following implementation of the either-sex harvest regulation, the annual average adult buck: 100 does ratio was 18.7 (N=2, SD=4.1, 95% CI=13.1–24.3). Relative to 1994–2015, the annual average adult buck: 100 does ratio increased 74.8%. The difference between means was significant at the 95% confidence level ($\mu_1$-$\mu_2$=8.0, 95% CI=1.9–14.1, P=0.01).

*Yearling Buck: Doe Ratio*

During the period of three-week shorted seasons (1994–2015), the annual average yearling buck: 100 does ratio was 13.7 (N=20, SD=3.9, 95% CI=12.0–15.4). During years 1–3 following implementation of the either-sex harvest regulation, the annual average yearling buck: 100 does ratio was 14.3 (N=3, SD=2.1, 95% CI=12.0–16.6). Relative to 1994–2015, the annual average yearling buck:

100 does ratio increased 4.1%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=0.6, 95% CI=-4.2–5.4, P=0.80). During years 4–5 following implementation of the either-sex harvest regulation, the annual average yearling buck: 100 does ratio was 10.8 (N=2, SD=2.2, 95% CI=7.8–13.8). Relative to 1994–2015, the annual average yearling buck: 100 does ratio decreased 21.2%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.9, 95% CI=-8.8–3.0, P=0.32).

*Unlimited Buck Permit Area (Hunting District 302 Survey Area): Pre and Post-Implementation*

*Total Buck: Doe Ratio*

During the period of unlimited buck permit regulation (2010–2015), the annual average total buck: 100 does ratio was 21.8 (N=6, SD=4.9, 95%CI=17.9–25.8). During years 1–3 following implementation of the either-sex harvest regulation, the annual average total buck: 100 does ratio was 19.4 (N=3, SD=4.6, 95% CI=14.9–23.9). Relative to 2010–2015, the annual average total buck: 100 does ratio decreased 11.1%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.4, 95% CI=-10.5–5.7, P=0.50). During years 4–5 following implementation of the either-sex harvest regulation, the annual average total buck: 100 does ratio was 17.5 (N=2, SD=7.8, 95% CI=6.7–28.3). Relative to 2010–2015, the annual average total buck: 100 does ratio decreased 19.8%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-4.3, 95% CI=-15.3–6.7, P=37).

*Adult Buck: Doe Ratio*

During the period of unlimited buck permit regulation (2010–2015), the annual average adult buck: 100 does ratio was 12.2 (N=6, SD=4.8, 95%CI=8.3–16.0). During years 1–3 following implementation of the either-sex harvest regulation, the annual average adult buck: 100 does ratio was 9.5 (N=3, SD=3.0, 95% CI=6.5–12.5). Relative to 2010–2015, the annual average adult buck: 100 does ratio decreased 22.2%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.7, 95% CI=-10.0–4.6, P=0.41). During years 4–5 following implementation of the either-sex harvest regulation, the annual average adult buck: 100 does ratio was 9.4 (N=2, SD=2.2, 95% CI=6.4–12.4). Relative to 2010–2015, the annual average total buck: 100 does ratio decreased 23.0%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.7, 95% CI=-11.7–6.1, P=47).

*Yearling Buck: Doe Ratio*

During the period of unlimited buck permit regulation (2010–2015), the annual average yearling buck: 100 does ratio was 9.8 (N=6, SD=2.4, 95%CI=7.9–11.7). During years 1–3 following implementation of the either-sex harvest regulation, the annual average yearling buck: 100 does ratio was 9.9 (N=3, SD=5.5, 95% CI=4.5–15.3). Relative to 2010–2015, the annual average yearling buck: 100 does ratio increased 1.0%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=0.1, 95% CI=-5.9–6.1, P=0.97). During years 4–5 following implementation of the either-sex harvest regulation, the annual average yearling buck: 100 does ratio was 7.7 (N=2, SD=9.9, 95% CI=0.0–21.4). Relative to 2010–2015, the average total buck: 100 does ratio decreased 21.4%. The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=-2.1, 95% CI=-11.3–7.1, P=60).

**Private Land Harvest**

During 2013–2015, an annual average of 4.0% ($N=3$, $SD=3.5$, 95%CI=0.1–7.9) of mule deer checked at the Alder Check Station were harvested on private lands not enrolled in Fish, Wildlife & Park's Block Management Program. Since implementation of the either-sex harvest regulation, an annual average of 12.0% ($N=5$, $SD=9.8$, 95% CI=3.4–20.6). The difference between means was not significant at the 95% confidence level ($\mu_1$-$\mu_2$=8.0, 95% CI=-6.7–22.7, $P=0.23$).

# Conclusion

Measuring conclusive biological and social responses to the either-sex harvest regulation will require more than five years of implementation. With this understanding, preliminary results relative to our hypotheses after five years include:

*Hypothesis 1*—The level of antlerless harvest resulting from the UOPH-license either-sex regulation would not become the primary influencer of mule deer population trend. Preliminary data supports this hypothesis. Following five years of implementation, the mule deer population in the EMA increased 32.1%, compared to a 37.9% decrease in the control area.

Year-over-year population reductions of 11.1% and 14.9% were observed in the EMA between 2018–2019 and 2020–2021, respectively. We believe these reductions were not caused by the either-sex harvest regulation, for two reasons:

1. Similar reductions in mule deer population were observed in the control area during the same years; and
2. Antlered and antlerless mule deer harvest in the EMA, prior to each observed reduction, was similar to harvest during the prior year when population increases were observed.

We believe the 2018–2019 population reduction in the EMA was real and most influenced by starvation mortality resulting from extended deep snow and cold temperatures during late-February–April 2019. Harvesting fewer deer during the 2018 hunting season may have increased starvation mortality during early 2019. This year-over-year reduction was followed by an observed 24.7% population increase between 2019 and 2020, during more favorable winter conditions. We suspect the observed reduction between 2020 and 2021 is more reflective of sampling issues associated with a mild winter and difficult survey conditions than changes in mule deer populations. Little snow accumulation occurred during winter 2020–2021 and we suspect a portion of mule deer never migrated to traditional winter range, where population trend surveys occur. While completing late-winter elk surveys, we observed mule deer that remained distributed across traditional summer and fall range. Spring green-up in 2021 was also atypical and could have reduced deer observability. Spring 2021 green-up initiated early and was subsequently followed by relatively cold and dry conditions, which stunted green-up progression. Because of slow green-up progression, it is possible deer remained in a late-winter feeding pattern after population trend surveys were initiated.

Since implementation of either-sex harvest, densities of mule deer in the EMA survey areas have increased an average of 5.8% per year (95%CI= -8.6%–21.9%). This growth rate is slightly higher than the average 1.5% annual growth during the 40 proceeding years of general license buck-only harvest (95%CI =-6.5%–12.9%) (Figure 8). There is no evidence that control areas have experienced similar increases in mule deer density. The average annual growth rate in the control survey area during 2016–2021 shows a decline of 9.1% per year (95%CI =-11.4%– -6.7%).

<u>*Hypothesis 2*</u>—Post-hunting season total, yearling, and adult buck: doe ratios would increase, as would the percentage of older age-class bucks in the harvest. Preliminary results suggest possible support for Hypothesis 2. During years 4–5 post-implementation, we observed statistically non-significant increases in average annual total and yearling buck: doe ratios and a statistically significant increase in annual average adult buck: doe ratio in the EMA, relative to pre-implementation averages. During the same period, the UOPH-license buck-only control area showed statistically non-significant decreases in total, adult, and yearling buck: doe ratios.

Since changing HD 320 from a three-week buck-only to five-week either-sex regulation, the average annual total and adult buck: doe ratios increased relative to pre-implementation averages. The observed increases in average total buck: doe ratio was not statistically significant, while the increase in average adult buck: doe ratio was significant. The average annual post-implementation yearling buck: doe ratio decreased slightly (Figure 14).

Hunting regulations for HD 302 were changed from an UOPH buck-only license to an unlimited buck-only permit during 2010–2015, in part to increase relative buck composition. After this change, increased buck: 100 does ratios were apparent in post-season surveys (Figure 15). Regulations were changed again in 2016 to an UOPH either-sex license. Since implementing either-sex harvest in HD 302, observed buck: 100 doe ratios were comparable to those observed during the unlimited buck-only permit regulation period and significantly greater than those observed during the UOPH buck-only regulation period (Figure 15).

Except for the limited-permit regulation, which produced significantly higher total and adult buck: doe ratios, preliminary data shows the either-sex harvest regulation produced post-season total, adult, and yearling buck: doe ratios that are higher than or comparable to more restrictive regulations implemented to increase buck survival (Figure 13).

To date, no significant changes in age structure of harvested antlered deer in the EMA or between the EMA and control area have been observed.

*Hypothesis 3*—Fawn recruitment would increase because of reductions of resource competition and the proportion of does entering older, less productive age classes. Evidence was ambiguous for Hypothesis 3 in our preliminary data. During years 4–5 following implementation of the either-sex harvest regulation, annual average fawn recruitment in the EMA increased 5.1% relative to the 10 years prior to implementation, but the difference was not significant. A similar increase was observed in the control area, suggesting factors other than harvest regulation had a greater influence on the increase. In mule deer and other ungulates, recruitment of young is known to be subject to a wide range of environmental factors and highly variable from year-to-year (Gaillard et al. 1998; Monteith et al. 2013). It’s likely population vital rates of mule deer across southwest Montana have been determined by important environmental factors such as forage nutrient content (Hamlin and Mackie 1989, Wood et al. 1989), the diversity and abundance of prey available to coyotes (Hamlin and Mackie 1989, Wood et al.

1989), precipitation (Hamlin and Mackie 1989, Wood et al. 1989, Peek et al. 2002, Lawrence et al. 2004, Pojar and Bowden 2004), plant productivity (Lomas and Bender 2006, Bender et al. 2007), nutrition (Tollefson et al. 2010, Tollefson et al. 2011), winter severity (Bartmann et al. 1992, Hurley et al. 2011, Ciuti et al. 2015), and habitat quality (Bishop et al. 2009) and the interactions between these factors. The environmental stochasticity in recruitment likely swamped any effects of implementing EMA; especially given the lack of measurable effect EMA has had on population growth.

Interpretation of fawn: adult ratios in spring counts are further complicated because they include potential changes in yearling and adult buck and doe survival. In general, the combination of highly variable juvenile survival and relatively constant adult survival in ungulates allow juvenile: adult ratios to reasonably index recruitment (Mills 2013). However, changes in fall harvest and adult survival could influence spring fawn: adult ratios. For example, a larger proportion of bucks in the spring counts could reduce observed recruitment rates.

To account for the increase in buck: doe ratios, we compared fawn: doe ratios from early winter, post-hunting season surveys where we could reliably distinguish bucks from does. In the EMA, we observed a 15.5% increase in fawn: doe ratios since implementation of either-sex harvest management. There was no similar increase observed in the control area. While the increase in fawn: doe ratios within the EMA was statistically significant, more years of data will be required to evaluate this hypothesis. The observed increase in fawn: doe ratios in the EMA was greatest during the first three years following implementing either-sex harvest, a period of relatively high fawn recruitment in both the EMA and control areas. It remains to be seen if increases in fawn: doe ratios will be realized over time.

During 2019–2020, the percentage of 38 checked doe mule deer harvested within the EMA and aged as ≥7 years old was 7.9, compared 24.8% (N=129, 95%CI=17.6–33.2) during 2016–2018. The percentage aged as 4–6 years was 52.6 in 2019–2020, compared to 31.0% (N=129, 95%CI=23.2–39.8) during 2016–2018. Although these data need to be interpreted with caution because of limited sample size, the noticeable shift to a younger age class during 2019–2020 may be the result of high mortality of old doe deer during the difficult winter conditions of late-February through April 2019. Additional years of age-structure monitoring will provide greater insight. If the proportion of old does in the population did decrease as our data suggests, we may observe a subsequent period of increased relative fawn recruitment.

*Hypothesis 4*—Annual harvest of antlerless mule deer would fluctuate with autumn snow accumulation. Field notes from the Alder Check-station indicate minimal autumn snow accumulation and ungulate migration to winter range during the 2016, 2017, 2018, 2019, and 2020 hunting seasons. Therefore, data to assess results relative to hypothesis 4 are not yet available.

*Hypothesis 5*—The either-sex regulation would increase mule deer harvest on private lands. After implementation of the either-sex regulation, the annual average percentage of mule deer checked at the Alder Check Station and harvested on private lands not enrolled in FWP's Block Management Program increased from 4.0 to 12.0%. However, the difference was not significant. Conclusive results will require additional data, but preliminary results suggest possible support for Hypothesis 5.

Preliminary results, following five years of implementation, suggest alignment with multiple management goals and support continuation of the either-sex regulation. Under either-sex management: opportunity for hunters to harvest doe mule deer has increased; there is evidence that buck: doe ratios have increased; and harvest on private land may also have increased. There is no evidence mule deer population growth has been impeded over the five years of either-sex management.

The either-sex regulation will remain in place through the 2021 hunting season. We intend to recommend to the Montana Fish and Wildlife Commission that the either-sex regulation be maintained across the EMA for the 2022 and 2023 hunting seasons. During that period, we would continue to collect data, evaluate relative to management goals and hypotheses, and draft progress reports.

# Habitat

We hypothesized that mule deer habitat across southwest Montana has been altered by conifer forest expansion (Figure 2) and approximately six decades of excessive browsing by mule deer, elk (*Cervus canadensis)*, pronghorn (*Antilocapra americana*), and moose *(Alces alces shirasi).* Conifer expansion, primarily by Douglass-Fir (*Pseudotsuga menziesii*) and Rocky Mountain Juniper (*Juniperus scopulorum)*, has replaced browse species such as curl-leaf mountain mahogany, big sagebrush (*Artemisia tridentate*), rubber rabbitbrush (*Ericameria nauseosa)*, green rabbitbrush (*Chrysothamnus viscidiflorus),* Rocky Mountain Maple *(Acer glabrum)*, quaking aspen (*Populus tremuloides*), chokecherry (*Prunus virginiana*), and dozens of species of deciduous shrubs, grasses, and forbs across hundreds of thousands of acres in southwest Montana. As browse reduction has occurred, ungulate management efforts, driven much by public desire for more deer, have attempted to grow mule deer populations back to peak levels observed during the 1950s and 1960s while simultaneously increasing elk, pronghorn, and white-tailed deer populations to peak levels observed during the last 20 years.

Beginning in the 1950s, populations of mountain goats (*Oreamnos americanus*) were established in the Tobacco Root and Snowcrest mountain ranges, while populations of bighorn sheep (*Ovis canadensis*) were established in the Greenhorn, Snowcrest, Tendoy, and East Pioneer mountain ranges. Survey data suggests elk populations have increased approximately six-fold since the 1970s and ten-fold since the 1950s (Figure 3) and pronghorn populations have increased approximately two-fold since the early 1970s (Figure 5). Harvest data suggests white-tailed deer populations have increased approximately six-fold since the 1960s (Figure 4). We hypothesized this combination of factors has intensified browse use and facilitated retrogression of browse availability, reducing carrying capacity for mule deer relative to ≥30 years ago. The long-term trend of fawn recruitment is a notable indicator. As the mule deer population has trended down, so has fawn recruitment. During 1970–1986, average annual recruitment across the EMA was 58.0 fawns: 100 adults (N=13, SD=7.3, 95% CI=53.7–60.3), compared to 39.9: 100 (N=14, SD=6.3, 95% CI=37.1–42.7) during 2006–2020—a 30.0% reduction (MFWP Unpublished Data). Survey data from the Gravelly and Greenhorn Mountains portion of the EMA during 1966–1970 show average annual recruitment of 68 fawns: 100 adults; suggesting that average recruitment had already declined by the time biologists expanded mule deer trend monitoring across the EMA. Reduced recruitment and populations may be indicating that mule deer habitat capacity has diminished through time.

Current debate exists among FWP wildlife biologists regarding the value of Rocky Mountain Juniper as a browse resource to mule deer, and the need to address expansion of the species and its replacement of other browse plants. This debate is driven by mule deer diet analysis that show Rocky Mountain Juniper as a measurable component. Kufeld et al. (1973) identified 28 published mule deer diet analyses that showed measurable use of Rocky Mountain Juniper. Research from the nearby Bridger Mountains in southwest Montana showed Rocky Mountain Juniper in 89% of 36 mule deer rumens during the winter and 81% of 73 rumens during the spring (FWP unpublished data). During that research, Rocky Mountain Juniper made up 27 and 20 percent of mule deer winter and spring diets by volume, respectively. High use of Rocky Mountain Juniper is often interpreted as an indicator of its value to mule deer. However, Rocky Mountain Juniper plants have grown through the browse zone and show minimal browsing in many sites where curl-leaf mountain mahogany, mountain maple, and chokecherry have been retrogressed to within the deer browse zone.

We recommend an evaluation of mule deer use versus availability of Rocky Mountain Juniper across southwest Montana to determine if mule deer are selecting it or merely utilizing it because it's the last remaining resource available to them. We also recommend evaluating fitness of individuals and populations of mule deer where Rocky Mountain Juniper is a dominate browse species. Although research has shown high use of Rocky Mountain Juniper by mule deer during winter and spring, research has also estimated that mule deer can tolerate Rocky Mountain Juniper only up to 20% of their diet, without incurring inhibition of rumen bacteria (Schwartz et al. 1979). Research has also shown mule deer preferred juniper species with the lowest volatile oil content and selected against Rocky Mountain Juniper relative to two other juniper species (Dietz and Nagy 1976). When feeding on Rocky Mountain Juniper, mule deer also showed preference for rations of Rocky Mountain Juniper with the lowest concentration of volatile oils. Anecdotally, we have observed a small proportion of Rocky Mountain Juniper trees within mule deer winter range across southwest Montana with architecture that indicated intense browsing by mule deer (Figure 16). We hypothesize volatile oil content varies between individual Rocky Mountain Juniper trees and a relatively high percentage of mule deer consumption comes from a relatively small proportion of plants.

In response to the desire of most hunters to preserve doe deer and allow populations to return to the peaks observed during the 1950s and 1960s, restrictive antlerless harvest regulations have been implemented across southwest Montana since the mid-1970s. Forty years of implementation has failed to produce an increase in mule deer populations. We hypothesized that past peak populations of mule deer cannot currently be sustained across southwest Montana given available browse, high inter-specific competition with other ungulates, and the general lack of habitat disturbance such as fire or tree cutting and that sustaining larger mule deer populations across southwest Montana will require measurable shifts in habitat management and land productivity.

In addition to harvest management, we are working with federal and state agencies, private landowners, and non-government organizations such as The Nature Conservancy, the Mule Deer Foundation, the Rocky Mountain Elk Foundation, and the Ruby Watershed Conservation District to enhance mule deer habitat across southwest Montana. The goal is to effect landscape-level successional disturbance, with a focus on enhancing and expanding deciduous-dominated forest, curl-leaf mountain mahogany, and shrub grassland. As of 2020, 1,685 acres of aspen, 14,573 acres of sagebrush grassland, 722 acres of deciduous-dominated riparian, and 612 acres of curl-leaf mountain mahogany enhancement have been completed across southwest Montana (Table 3).

Table 3. Completed habitat enhancement projects in Southwest Montana, 2016–2020.

| Habitat Type | Mountain Range | Watershed (Hunting District) | Prescription | Land Owner | Year | Acres | Contributors |
|---|---|---|---|---|---|---|---|
| Aspen Forest | West Pioneers | Christiansen Creek (332) | D | USFS | 2017 | 200 | USFS |
| Aspen Forest | Gravelly | W. FK. Madison (327) | A | USFS | 2019 | 285 | RMEF, MDF |
| Aspen Forest | Lima Peaks | Shineberger Creek (300) | B | USFS | 2019 | 200 | USFS |
| Aspen Forest | Snowcrest | Snowslide Creek (324) | B | DNRC | 2019 | 5 | DNRC, FWP, TNC, RMEF, NFWF, RWCD |
| Aspen Forest | East Pioneers | Lost Creek (331) | C | Private | 2019 | 90 | FWP, RMEF, Private |
| Aspen Forest | Lima Peaks | Deadwood Gulch (300) | B | USFS | 2019 | 185 | USFS, TNC |
| Aspen Forest | Tobacco Roots | Sand Coulee (320) | B | Private | 2019 | 20 | Private |
| Aspen Forest | Snowcrest | Clear Creek (324) | C | USFS, Private | 2020 | 700 | USFS, Private |
| **Aspen Forest Total** | | | | | | **1,685** | |
| Sagebrush Grassland | SweetwaterHills | Sweetwater Creek (326) | B | Private | 2016 | 250 | NRCS |
| Sagebrush Grassland | Ruby | Spring Canyon (322) | B | Private | 2016 | 60 | Private |
| Sagebrush Grassland | Greenhorn | Virginia City Pass (330) | B | Private | 2017 | 1,200 | NRCS |
| Sagebrush Grassland | Medicine Lodge | Medicine Lodge (328) | C | BLM, Private, DNRC | 2017 | 815 | BLM, DNRC, TNC, FWS, NRCS, Private |
| Sagebrush Grassland | Snowcrest | E. FK. Blacktail Deer Creek (324) | C | FWP | 2017 | 400 | FWP, MDF |
| Sagebrush Grassland | Tobacco Root | Sand Coulee (320) | B | Private | 2018 | 20 | Private |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sagebrush Grassland | Ruby | Spring Canyon (322) | B | Private | 2018 | 100 | Private |
| Sagebrush Grassland | East Pioneer | Badger Pass (331) | B | BLM, Private | 2018 | 800 | BLM, TNC, FWS |
| Sagebrush Grassland | Snowcrest | Ledford Creek (324) | B | FWP | 2018 | 85 | FWP, MDF |
| Sagebrush Grassland | Ruby | Dry Hollow (322) | C | Private | 2018 | 20 | FWP, MDF, Sportsmen, |
| Sagebrush Grassland | Greenhorn | Greenhorn Creek (330) | B | Private, DNRC | 2018 | 170 | Private |
| Sagebrush Grassland | Medicine Lodge | Medicine Lodge Creek (328) | C | BLM, Private, DNRC | 2018 | 2,400 | BLM, DNRC, TNC, FWS, NRCS, Hansen Ranch |
| Sagebrush Grassland | Greenhorn | Greenhorn Creek (330) | B | Private | 2019 | 170 | Private |
| Sagebrush Grassland | Snowcrest | Ledford Creek (324) | B | DNRC | 2019 | 750 | DNRC, FWP, TNC, RMEF, NFWF, RWCD |
| Sagebrush Grassland | Snowcrest | Ledford Creek (324) | C | FWP | 2019 | 770 | DNRC, FWP, TNC, RMEF, NFWF, RWCD |
| Sagebrush Grassland | East Pioneers | Lost Creek (331) | C | Private | 2019 | 180 | FWP, RMEF, Smith 6-S Ranch |
| Sagebrush Grassland | Snowcrest | Cream Creek (324) | B | Private | 2019 | 120 | Private |
| Sagebrush Grassland | Ruby | Dry Hollow (322) | C | Private | 2019 | 80 | FWP, MDF, Private |
| Sagebrush Grassland | Tendoy | Muddy Creek (302) | C | BLM | 2019 | 900 | BLM, TNC, BHWC |
| Sagebrush Grassland | Greenhorn | Ruby River Tributaries (330) | B | BLM | 2019 | 400 | BLM, TNC, RWCD |
| Sagebrush Grassland | Gravelly | Red Rock River (327) | B | FWS | 2019 | 720 | TNC, NFWF |
| Sagebrush Grassland | Tobacco Root | Sand Coulee (320) | B | Private | 2019 | 140 | Private |
| Sagebrush Grassland | Ruby | Spring Canyon (322) | B | Private | 2019 | 120 | Private |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sagebrush Grassland | Snowcrest | Ledford Creek (324) | C | FWP | 2020 | 120 | DNRC, FWP, TNC, RMEF, NFWF, RWCD |
| Sagebrush Grassland | Ruby | Spring Canyon (322) | B | Private | 2020 | 110 | Private |
| Sagebrush Grassland | Tobacco Roots | Sand Coulee (320) | B | Private | 2020 | 130 | Private |
| Sagebrush Grassland | Tobacco Roots | Granite Creek (320) | C | Private | 2020 | 644 | NRCS |
| Sagebrush Grassland | Tobacco Roots | Granite Creek (320) | C | Private | 2020 | 78 | NRCS |
| Sagebrush Grassland | Tobacco Roots | California Creek (320) | C | Private | 2020 | 549 | NRCS |
| Sagebrush Grassland | Tobacco Roots | Granite Creek (320) | C | BLM | 2020 | 640 | BLM |
| Sagebrush Grassland | Greenhorn | Alder Gulch (330) | C | Private | 2020 | 472 | NRCS |
| Sagebrush Grassland | Greenhorn | Ruby River Tributaries (330) | C | BLM, Private | 2020 | 1,550 | BLM, Private |
| Sagebrush Grassland | Sweetwater Hills | Red Canyon (326) | B | BLM, Private | 2020 | 250 | BLM, Private |
| **SBGL Total** | | | | | | **14,573** | |
| **Habitat Type** | **Mountain Range** | **Watershed (Hunting District)** | **Prescription** | **Landowner** | **Year** | **Acres** | **Contributors** |
| Deciduous Riparian | Tobacco Root | Sand Coulee (320) | B | Private | 2018 | 35 | Private |
| Deciduous Riparian | Gravelly | Ruby River (324) | A | USFS | 2018 | 20 | USFS, RMEF, MDF |
| Deciduous Riparian | Greenhorn | Ruby River Tributaries (330) | B | DNRC, Private | 2019 | 160 | TNC, DNRC, NFWF, Private |
| Deciduous Riparian | Gravelly | Ruby River (324) | A | USFS | 2019 | 50 | USFS, RMEF, NWTF |
| Deciduous Riparian | Greenhorn | Greenhorn Creek (330) | E | DNRC, Private | 2020 | 215 | Private |
| Deciduous Riparian | Greenhorn | West Greenhorns (330) | B | DNRC, Private | 2020 | 162 | TNC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Deciduous Riparian | Gravelly | Ruby River (324) | C | USFS | 2020 | 70 | USFS, RMEF |
| Deciduous Riparian | Tobacco Roots | Horse Creek (320) | B | Private | 2020 | 10 | Private |
| **DR Total** | | | | | | **722** | |
| Mahogany | East Pioneers | Lost Creek (331) | B | Private | 2019 | 20 | Private, FWP, RMEF |
| Mahogany | Lima Peaks | Big Sheep Creek (300) | B | DNRC | 2019 | 185 | FWP, TNC, DNRC |
| Mahogany | East Pioneer | Scudder Creek (331) | B | BLM | 2019 | 350 | BLM, FWP |
| Mahogany | East Pioneer | Dice Creek (331) | B | BLM | 2020 | 27 | BLM, MDF, FWP |
| Mahogany | East Pioneer | Scudder Creek (331) | B | BLM | 2020 | 30 | BLM |
| **Mahogany Total** | | | | | | **612** | |

A—Removal of conifer trees by cut, pile, and burn;

B—Removal of conifer trees by cut, lop, and scatter;

C—Removal of conifer trees by cut, lop, scatter and jackpot burn concentrated debris;

D—Prescribed fire;

E—Mastication;

RMEF—Rocky Mountain Elk Foundation;

MDF—Mule Deer Foundation;

NRCS—Natural Resource and Conservation Service;

FWP—Fish, Wildlife, & Parks;

BLM—Bureau of Land Management;

DNRC—Montana Department of Natural Resources and Conservation;

TNC—The Nature Conservancy;

NFWF—National Fish and Wildlife Foundation;

RWCD—Ruby Watershed Conservation District;

NWSF—National Wild Sheep Foundation;

BHWC—Beaverhead Watershed Committee;

FWS—U. S. Fish and Wildlife Service;

NWTF—National Wild Turkey Federation;

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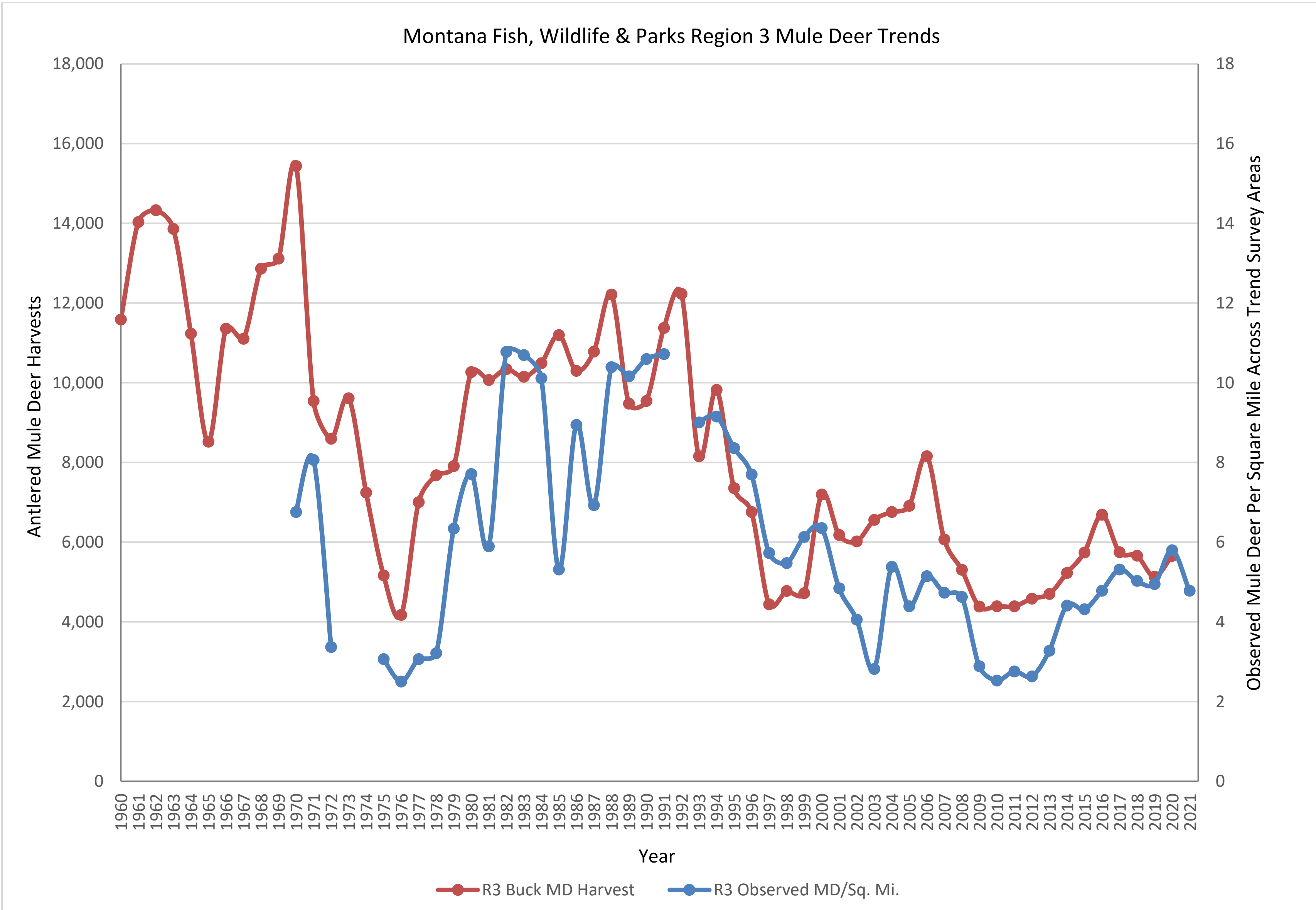


Figure 1. Montana Fish, Wildlife & Parks Region 3 antlered mule deer harvest and observed mule deer per square mile, 1960–2021.


Figure 2. Illustration of conifer forest expansion during 1921–2015, across the east slopes of the Snowcrest Mountains in southwest Montana.

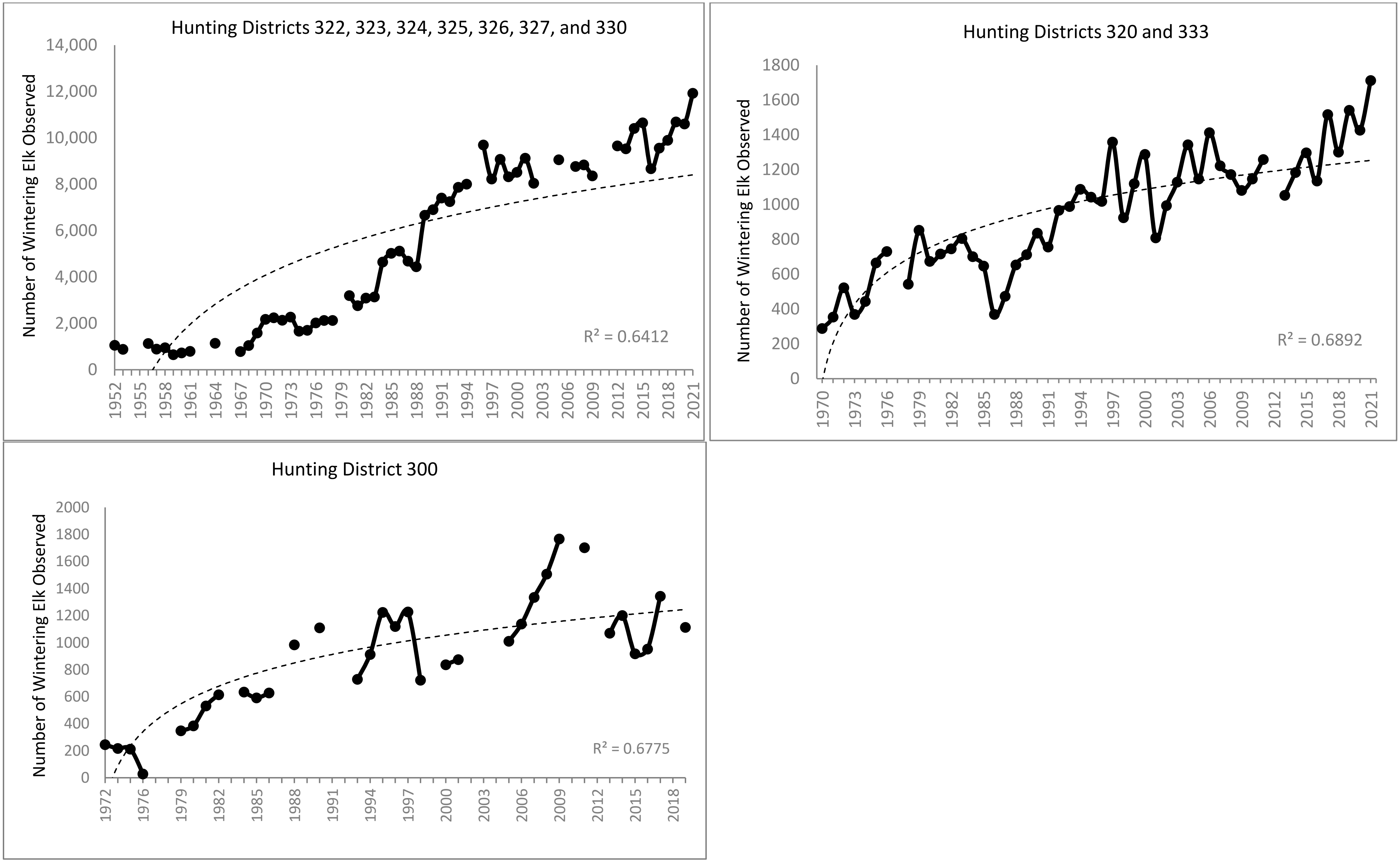


Figure 3. Population trends for three elk herds that overlap the Either-sex Management area. Dashed lines represent the log trends.

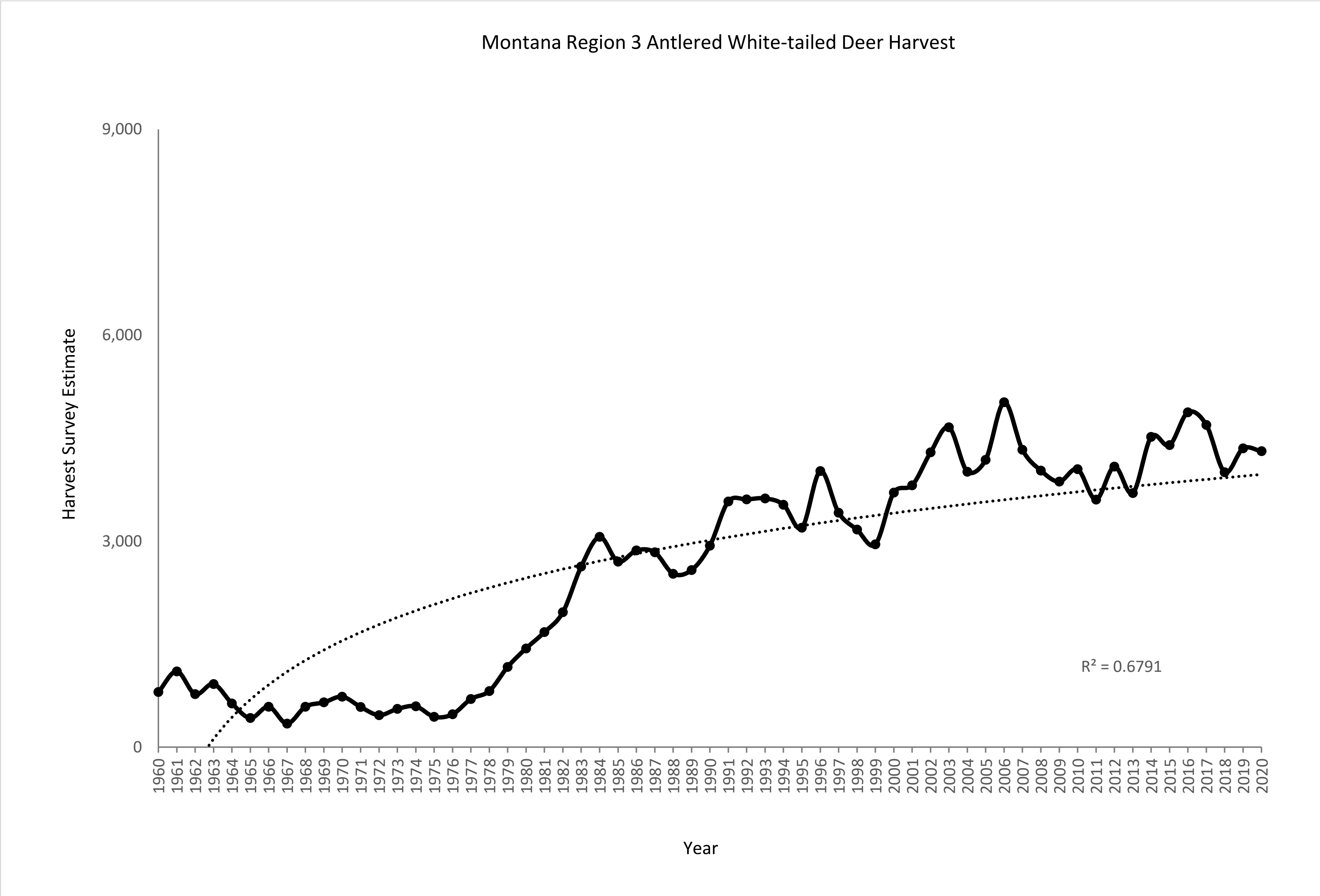


Figure 4. Unlimited one-per-hunter-license antlered white-tailed deer harvest for Montana Fish, Wildlife & Parks Region 3, 1960–2020. The dashed line represents the log trend.

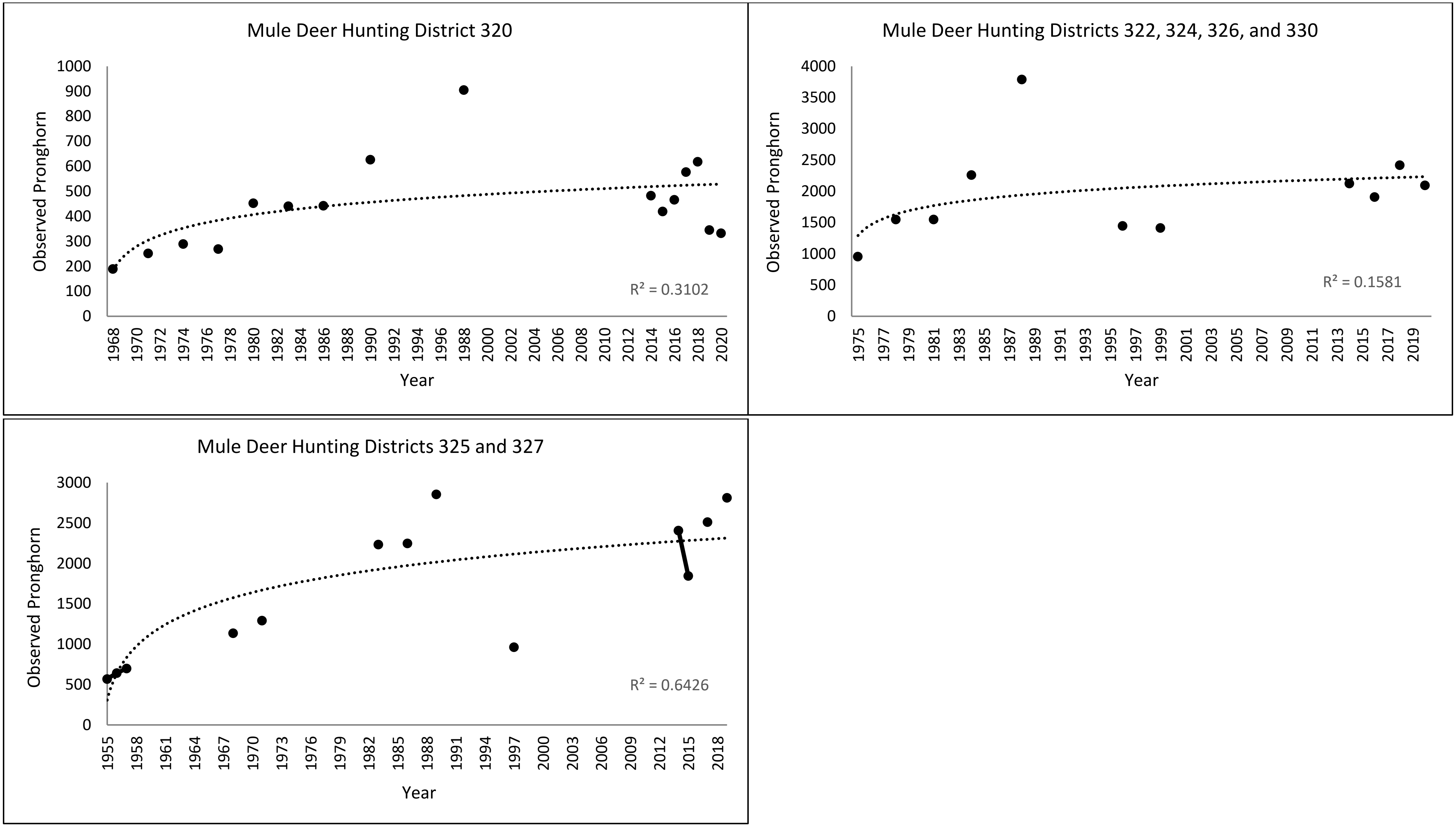


Figure 5. Population trends for three pronghorn herds that overlap the Either-sex Management area, 1955—2020. Dashed lines represent the log trends.

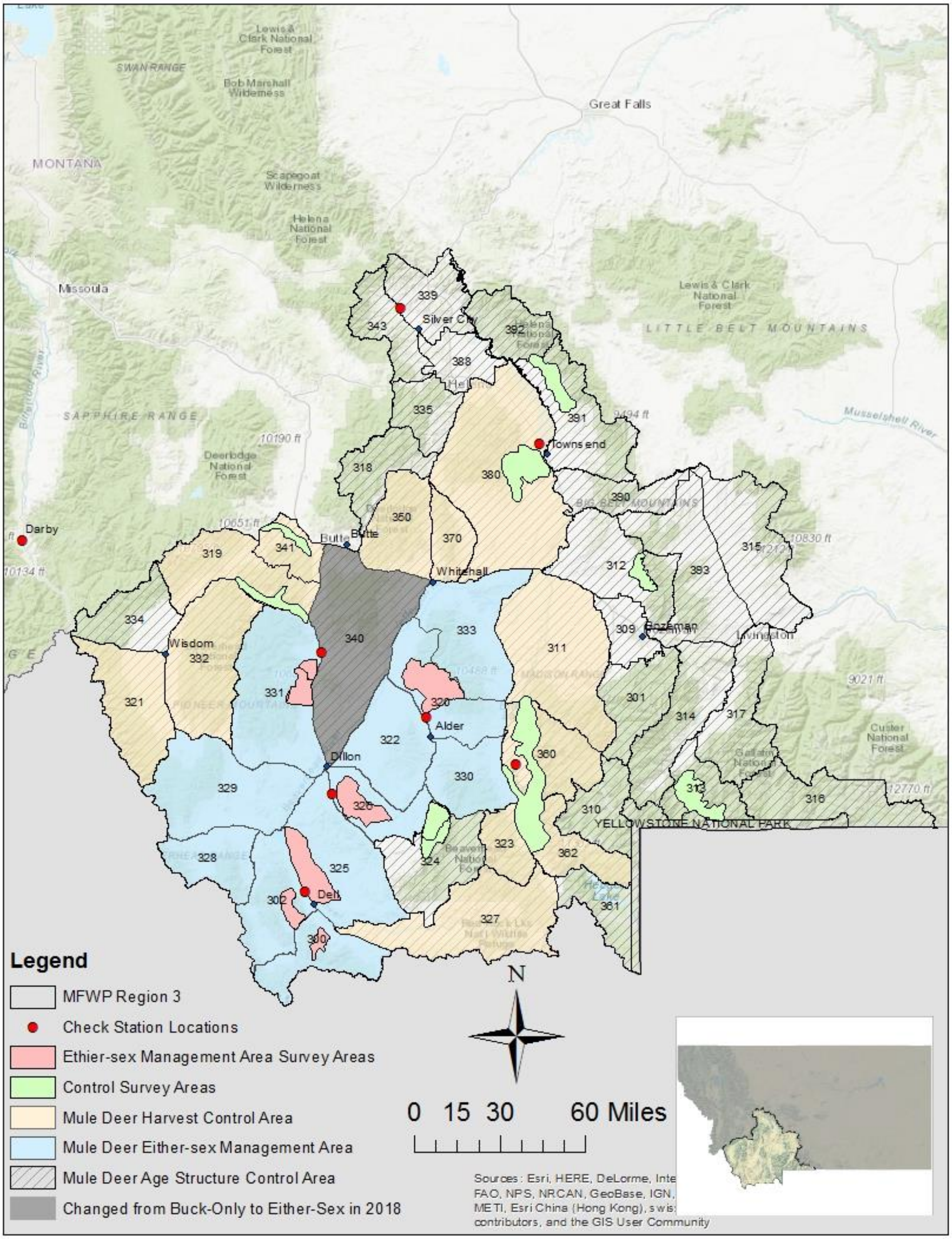


Figure 6. Study Area.

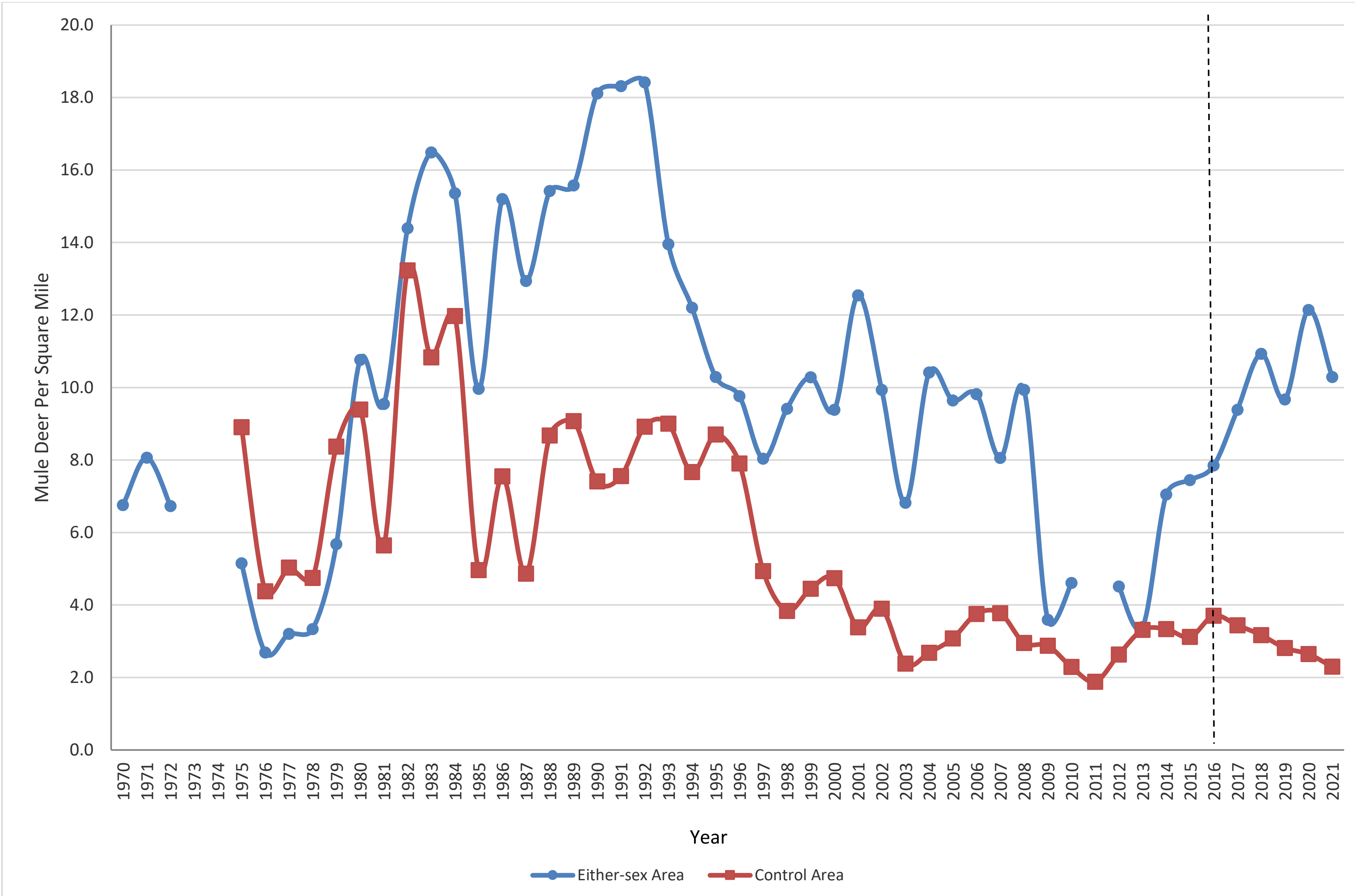


Figure 7. Mule deer population trend in the either-sex management and control areas, 1970–2021. The dashed vertical line represents the year either-sex harvest was implemented in the Either-sex Management Area.

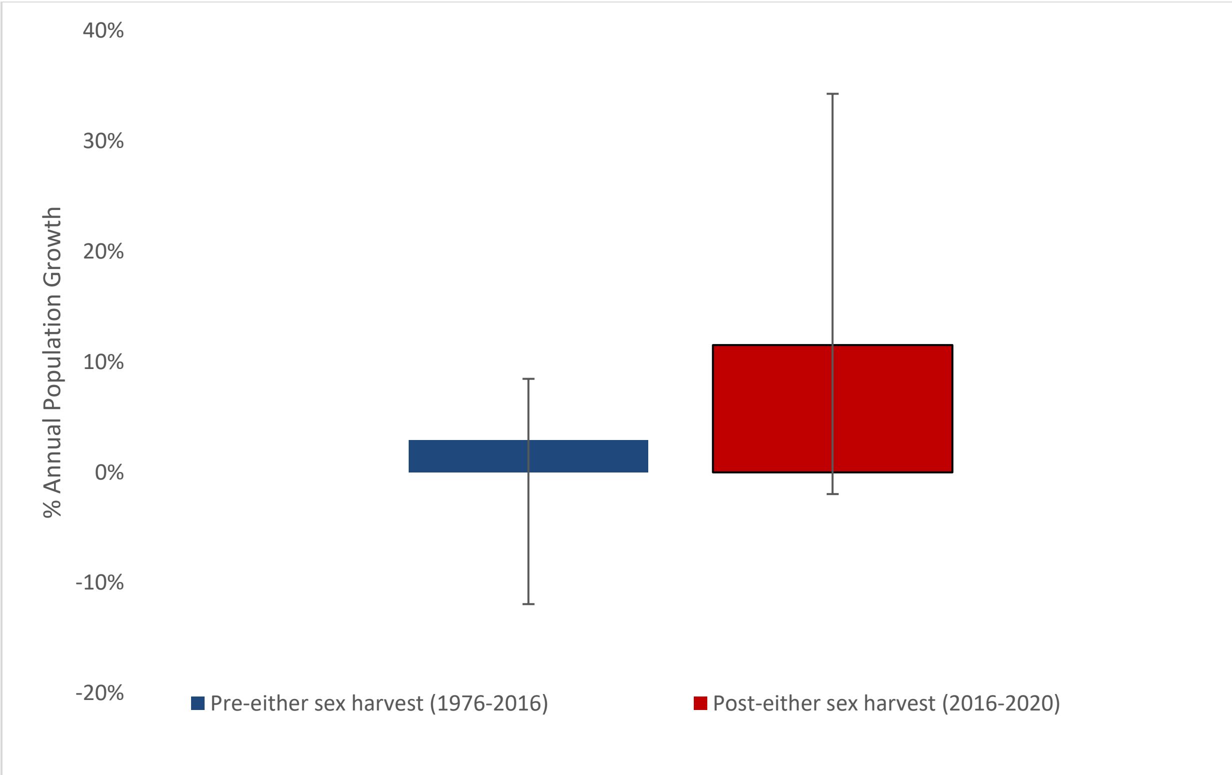


Figure 8. Estimated mean annual population growth of mule deer in Either-sex Management Area in the years since implementation of either-sex harvest (red) and the 40 years prior to either-sex harvest (blue). Population indexed by deer per square mile observed during spring green-up flights pooled across all EMA trend areas. Whiskers on graph represent 95% confidence intervals of geometric mean population growth.

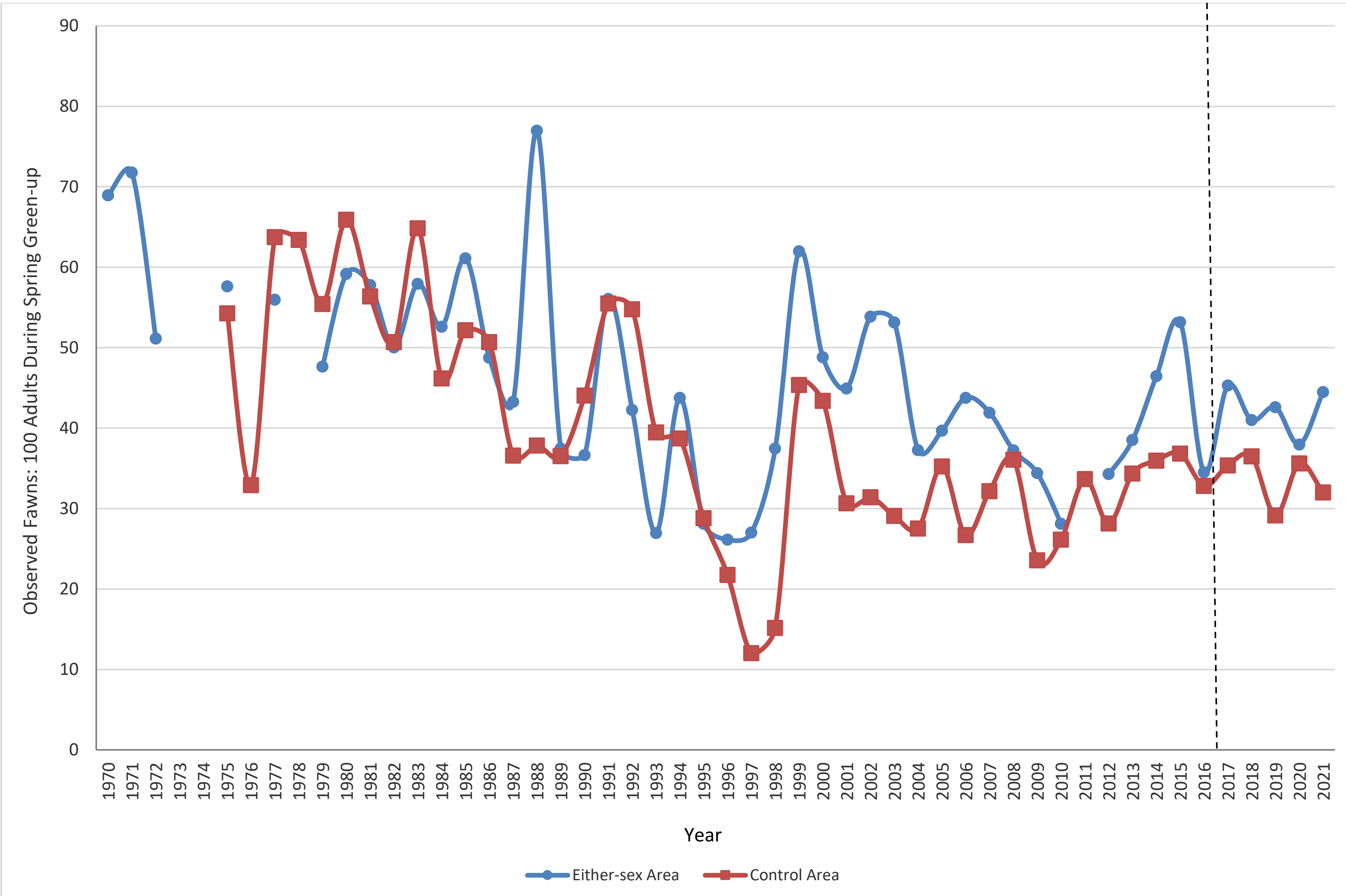


Figure 9. Mule deer recruitment trend in the either-sex management and control areas, 1970–2021. The dashed vertical line represents the year either-sex harvest was implemented in the Either-sex Management Area.

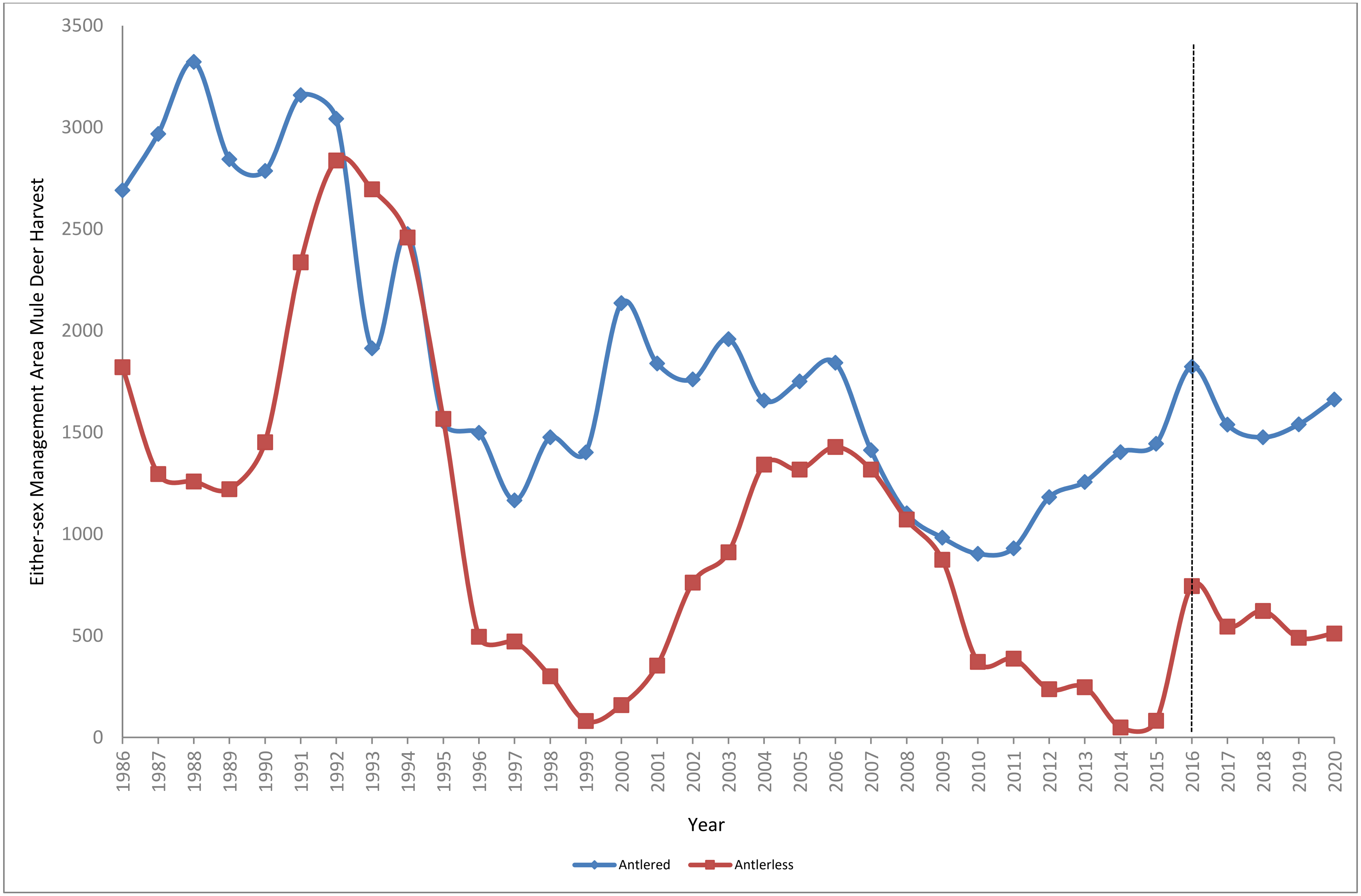


Figure 10. Mule deer harvest in the Either-sex Management Area, 1986–2020. The dashed vertical line represents the year either-sex harvest was implemented in the Either-sex Management Area.

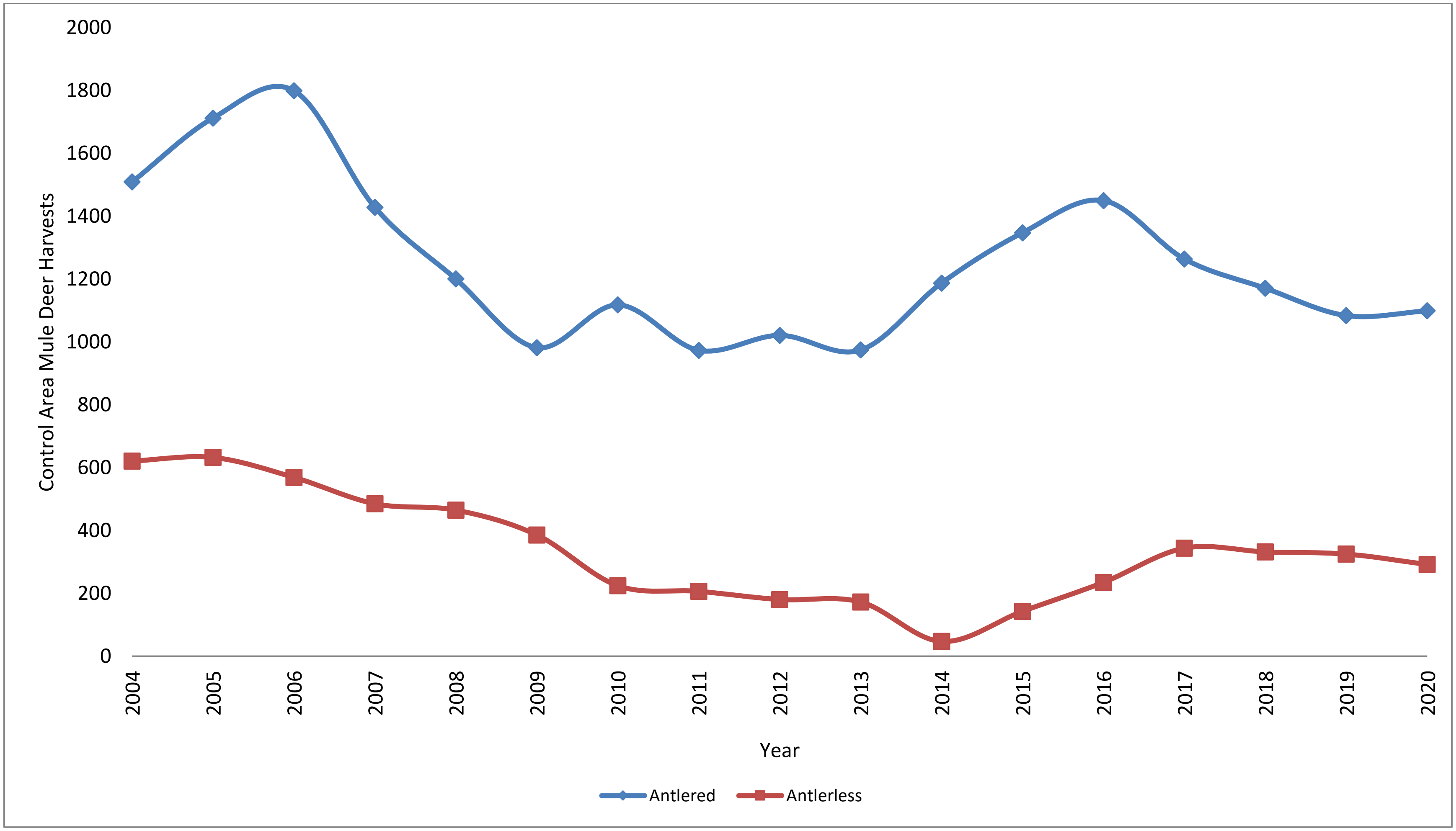

Figure 11. Mule deer harvest in the harvest control area, 2004–2020.

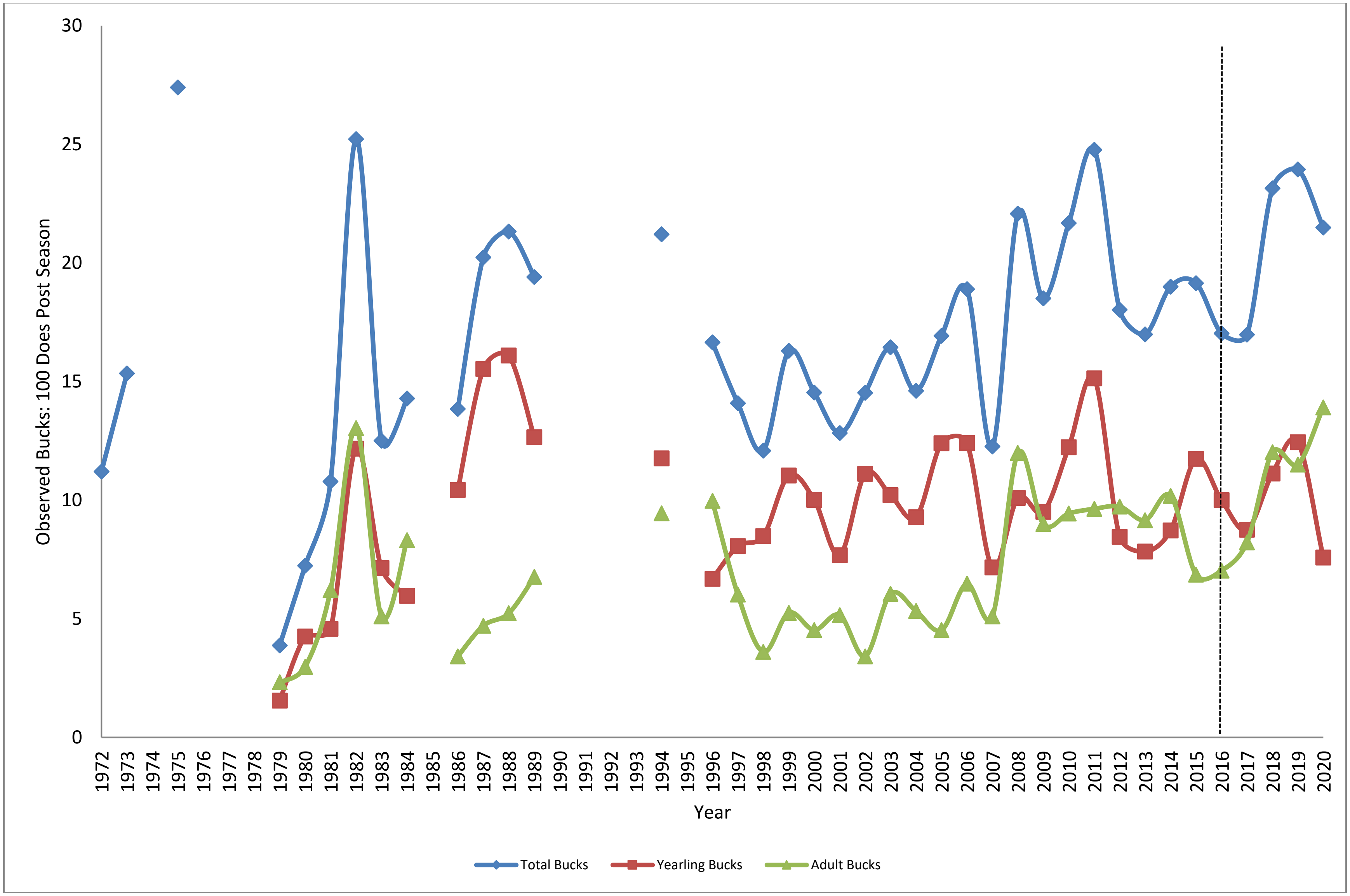


Figure 12. Mule deer post-season buck: doe ratios in the Either-sex Management Area, 1972–2020. Note: The dashed vertical line represents the year either-sex harvest was implemented in the Either-sex Management Area.

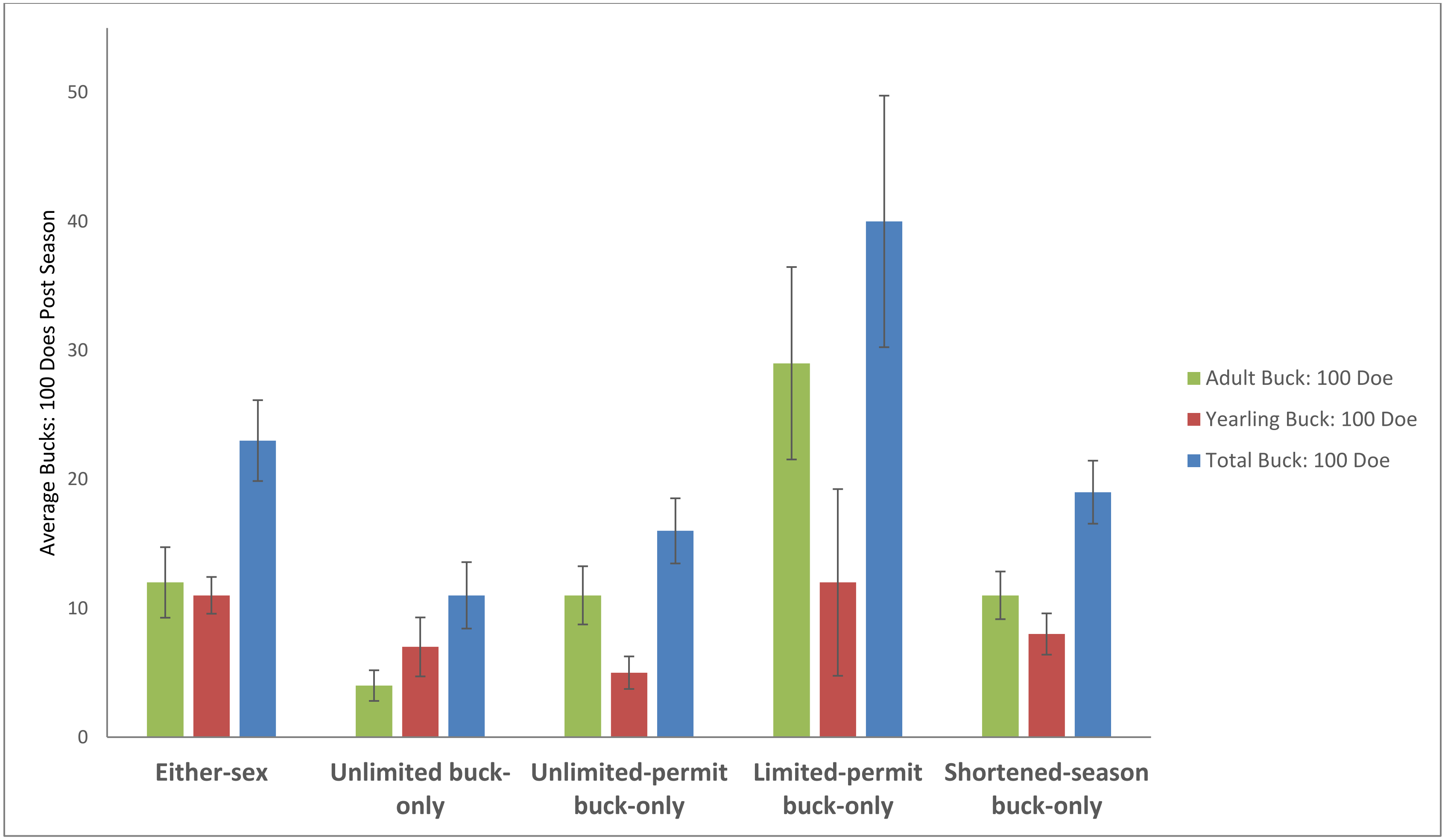


Figure 13. Average post hunting season buck: doe ratios observed under five harvest management regulations during 2016–2020 across southwest Montana. Under either-sex management hunters can harvest antlered or antlerless mule deer with a deer license during the 5-week general season. Unlimited buck-only hunters may harvest only bucks with their license and antlerless harvest is restricted. Unlimited-permit buck-only requires a permit to hunt buck mule deer, but there is no limit on number of permits issued. Limited-permit buck-only requires a permit to harvest mule deer bucks with a set number of permits available. Shortened season buck-only is similar to unlimited buck-only but restricted to a 3-week season.

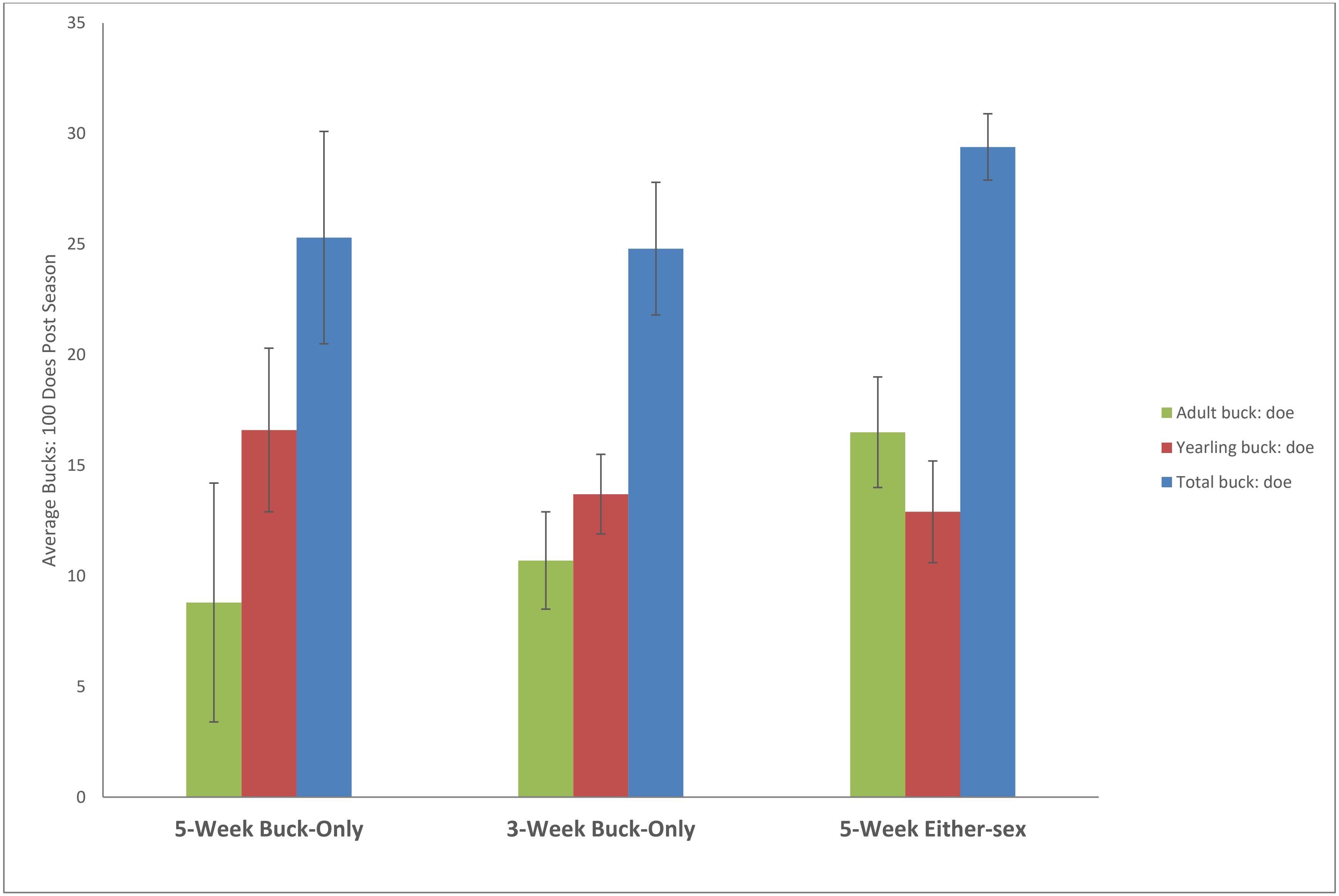


Figure 14. Average post hunting season buck: doe ratios observed in the Tobacco Root Mountains (Hunting District 320) survey area under three harvest management regulations during 1986–2020. Error bars represent 95% confidence intervals.

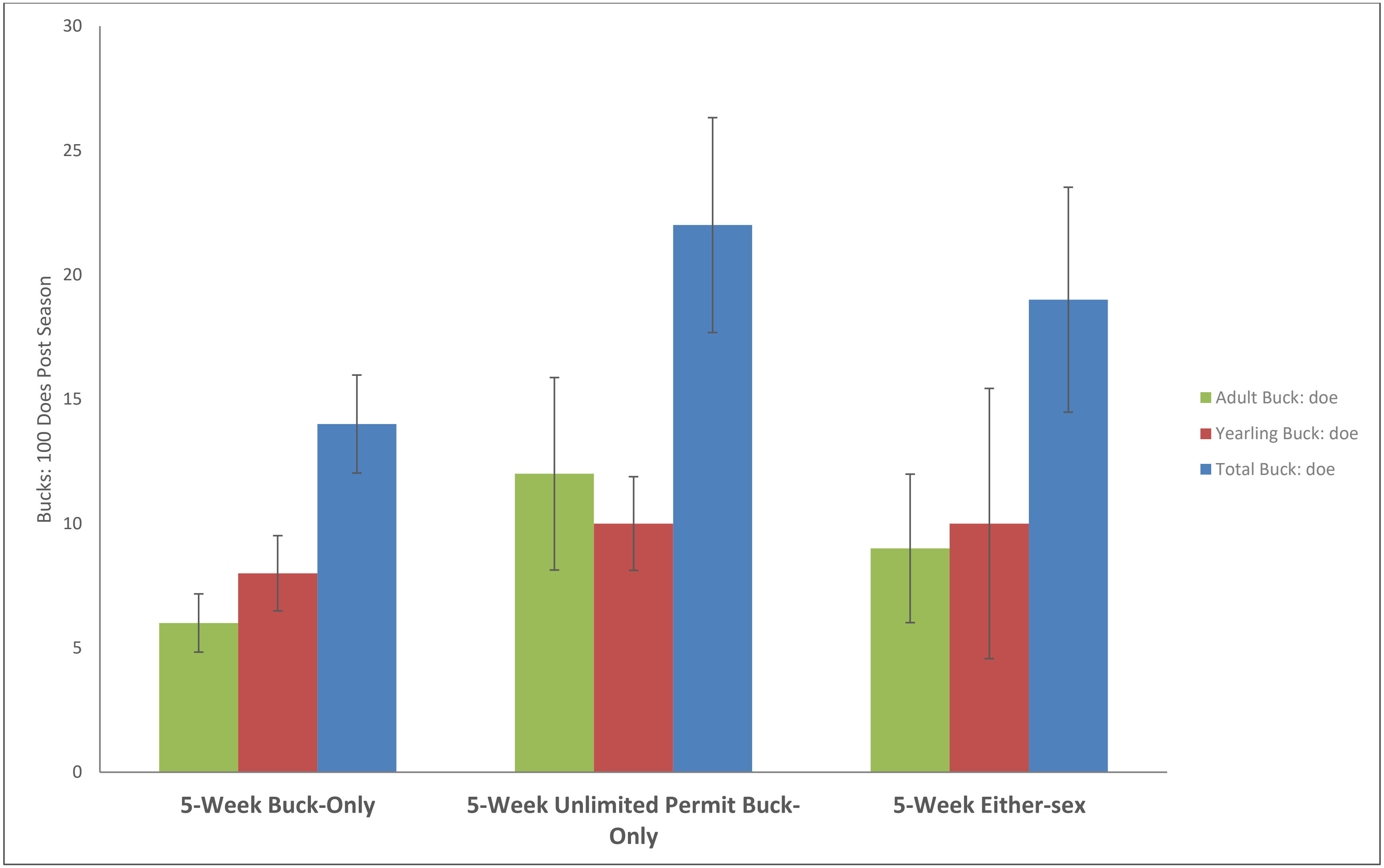


Figure 15. Average post hunting season buck: doe ratios observed in the Tendoy Mountains (Hunting District 302) survey area under three harvest management regulations. From 1980-2009 HD 302 was unlimited-one-per-hunter buck only licenses. From 2010-2015, regulations changed to unlimited buck-only permits. During 2016-2020, the hunting district was managed under an unlimited-one-per-hunter either-sex license.

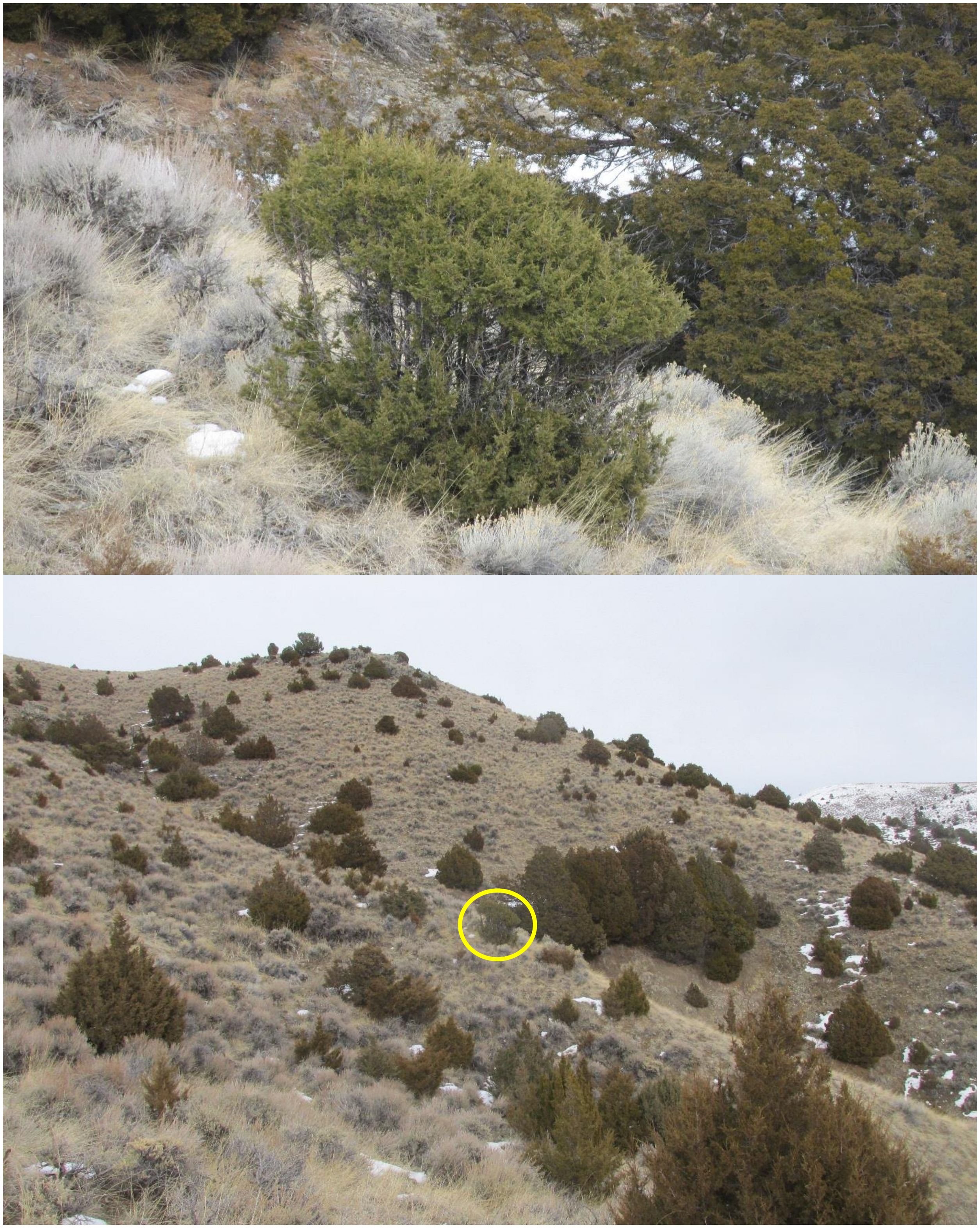

Figure 16. Illustration of a relatively low percentage of Rocky Mountain Juniper trees showing signs of intense browsing within mule deer winter range in southwest Montana.