Recent data suggests that golden eagle (Aquila chrysaetos) populations are declining in the Western United States with no known, definitive causes (Kochert and Steenhof 2002, Hoffman and Smith 2003, Good et al. 2007). In addition, predicted increases in future impacts from energy development (Hunt 2002, Smallwood and Thelan der 2007), climate change (McIntyre et al. 2006, Whitfield et al. 2007) and shifts in land use (Kochert and Steenhof 2002, Watson 2010) has prompted management agencies to focus attention on the regional golden eagle population. This increase in attention has exposed the fact there is little available information on population trends with adequate baseline data to make an informed assessment of the current population status.

Beginning in 1962, an effort began to monitor a breeding golden eagle population near Livingston, Montana. The focus of the original research was to determine the density of the population, productivity rates, prey selection and effects of pesticides on golden eagles. These projects resulted in some of the earliest published work on golden eagles in Montana (McGahan 1968) and established the foundation for what is now the longest-term dataset on breeding golden eagles in the Rocky Mountain West. We began monitoring the study site again in 2010 to determine the current status of the population using the baseline data collected in the 1960’s for comparison. Contrary to findings elsewhere, the breeding population in this area has expanded by 42%. In addition, the current population density is one of the highest recorded in the Rockies. These findings have prompted a full investigation into the causes for the increase in breeding density and more general questions related to breeding golden eagle ecology. The information below is a summary of the information collected during the 2012 breeding season and a summary of information collected to this point.

**Methods and Definitions**

In order to identify active golden eagle territories we first located all known, historically used nesting locations documented during the previous phases of the study (1963-68, 1993-94, 2010-11). In addition, we searched for new territories in areas where historic nests had not been documented and also found new territories opportunistically while traveling around the study site. We visited historic, known nest sites for two 2-hour periods early in the breeding season to document whether adult eagles were present in the territory. If no adult eagles were detected during those visits, we classified the territory as “unoccupied.” If we located at least one adult eagle during our initial survey periods of the territory, we continued to watch for signs of
breeding behavior. These behaviors include carrying nest material, nest building, escorting, territorial flights, copulation and/or incubation (Driscoll 2010). If any of these behaviors were observed, we classified the territory as “occupied” and continued monitoring to determine if pair initiated incubation. Since not all eagles in active territories initiate egg laying (Watson 2010), we defined a territory as an “active nest” only if we saw an adult in incubation posture. If we did not see an adult on eggs at any point during the breeding season but did see territorial birds, we defined this as an “occupied, non-nesting” pair.

In addition to monitoring occupancy and productivity rates, we continued the tracking component of the study and expanded from only adults to nestlings as well. To catch adult, breeding eagles, we placed road kill deer carcasses with net launchers (Trapping Innovations LLC, Kelly, WY) in known territories. Net launchers were fired by on-site biologists using remote controls. Birds were immediately removed from nets upon capture and were outfitted with 30-g solar Argos/GPS PTT transmitters (Microwave Telemetry, Columbia, MD) using a backpack style harness. These transmitters were capable of recording 15 locations per day, per bird. These transmitters were well under 3% of the body mass of each individual captured as recommended by Gustafson et al. (1997). Trapping occurred in February which is before incubation to minimize the potential for disturbance. Nestlings were captured by hand in the nest during week prior to fledging. Nestlings received 35-g PTT transmitters (Microwave Telemetry, Columbia, MD). These transmitters record one location every 3 days to maximize life of the transmitter. All trapping and handling was approved by the University of Montana Institutional Animal Care and Use Committee (IACUC), Animal Use Protocol #009-12EGDBS-020812.

Beginning in 2012, we began collecting prey remains at golden eagle eyeries for comparison with prey collected in the 1960’s. Prey remains were collected at failed nests by searching below the nest and by climbing into the nests. We also opportunistically collected prey remains from nests when we banded nestlings. Food items were also found by searching below the nest and collecting remains from the nest. Any prey item that still had food available for the nestlings was left in the nest.

Results

Occupancy and Productivity

McGahan (1968) and Reynolds (1969) documented 31 territories within the study area. Entering the 2012 nesting season, we had documented 43 known territories within the study area. We located one additional territory in 2012, bringing the total number of golden eagle territories to 44 or a 42% increase in the number of active territories since the 1960’s. This is one of the few, if not only, areas with a documented population increase of golden eagles in the Western United States in recent years.

Of the 43 territories located in 2010 and 2011, 41 (95.3%) were occupied in 2012. When calculating proportion of occupied territories, only historically located territories were used due
to our inability to locate new, unoccupied territories for any given year. Since productivity is a function of total young produced per occupied territory, nesting or not, we used all territories to estimate a productivity rate. From all 42 occupied territories in 2012, 27 (64.3%) initiated nests while 13 (31.0%) had occupied, non-nesting pairs. We could not determine incubation status of the remaining 2 territories but both were occupied. Of the 27 territories that initiated nesting, 16 (59.3%) were successful in fledging a total of 22 young resulting in a productivity rate of 0.52 young/active territory. Of the 27 active nests, 15 (55.6%) were located on cliffs and 12 (44.4%) were located in trees.

In the 1960’s, productivity rates were typically calculated as number of young fledged per active nest instead of the current definition which is number fledged per occupied territory. Considering only the active nests when estimating productivity produces an inflated estimate because production of non-nesting territorial pairs are not considered. That said, productivity rates in the 1960’s varied from 0.78-1.53 young/active nest but are estimated at 0.54-1.30 young/active territory (after taking active non-nesting territories into account) with an average of 0.83 young/active territory.

Table 1. Summary of all phases of Livingston study (± SD). Note all values for the 1960’s are an average of all years combined.

<table>
<thead>
<tr>
<th></th>
<th>1963-1967</th>
<th>2010-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. # Active Nests/yr*</td>
<td>17.0 ± 4.0</td>
<td>29.0 ± 2.0</td>
</tr>
<tr>
<td>Avg. Successful*</td>
<td>76.5% ± 14.8%</td>
<td>63.4% ± 8.4%</td>
</tr>
<tr>
<td>Avg. Total Fledged</td>
<td>18.8 ± 4.9</td>
<td>21.7 ± 0.6</td>
</tr>
<tr>
<td>Avg. Fledged/Nest*</td>
<td>1.11 ± 0.78</td>
<td>0.75 ± 0.67</td>
</tr>
<tr>
<td>Avg. # Tree Nests</td>
<td>30.6% ± 3.6%</td>
<td>42.5% ± 2.1%</td>
</tr>
<tr>
<td>Avg. # Cliff Nests</td>
<td>69.4% ± 3.6%</td>
<td>57.5% ± 2.1%</td>
</tr>
</tbody>
</table>

* p ≤ 0.05
Figure 1. Location of golden eagle nests found in the study area in the 1960’s and from 2010-2012.

Tracking

In 2012, we captured and outfitted 6 adult males and 4 adult females with GPS transmitters. In 2011, we were able to catch 3 adult males bringing our total for the 2 years to 8 adult males and 4 adult females. From the 10 adults captured this year, 9 remained in the study area while one migrated north to the Brooks Range of northern Alaska. The remaining birds included 2 pairs, 1 territorial fourth-year female and 1 territorial fourth-year male (golden eagles typically breed at age 5), and 2 adult males and 1 adult female. Both territories with the sub-adults were the result of turnover from 2011 (i.e. adult mortality or emigration). The 2 adult males and 1 adult female initiated nests; the female’s nest failed while both males fledged young. Neither captured pair nested nor did the sub-adults. It is well known golden eagles do not nest every year (Watson
2010) therefore the lack of nesting is not likely a result of capture. To date, we have collected over 34,000 locations from the 13 birds, including 27,500 locations from adults alone since February.

In addition to the 10 adults, we put 4 transmitters on nestlings at 3 different nests. One of the nestlings was the product of one of our successful males with a transmitter and the others were from nests with young in the proper age range. To date, we have collected over 260 locations from these 4 birds. As of the 23rd of September, none have left the study area or made movements far from the nest.

We collected prey remains from 7 nests in 2012. We treated this year as our pilot year to assess our ability to collect remains and also to analyze the bones, feathers and pellets we collected. We are currently processing the remains and have not cataloged what was collected at this point.

Figure 2. Adult breeding male golden eagle with a 30g solar GPS satellite transmitter. The transmitter is affixed using a backpack style harness with a break-away link and was 0.7% of the bird’s body mass.

Future Research Plans

We plan on continuing work in this area at a minimum through the 2013 breeding season but ideally through 2015 breeding season. We will continue monitoring all known territories to determine occupancy and productivity rates to get a firm understanding of current trends of this breeding population. Due to the annual fluctuation of breeding attempts of golden eagles, it is
important to monitor breeding populations for a number of years to accurately assess current status. We also will continue tracking adult breeding birds to gather the required amount of information to create the models of resource selection. Ross Crandall is analyzing these data as part of his Master’s thesis at the University of Montana. In addition we hope to continue gathering and analyzing the prey remains at golden eagle nest sites.

**Literature Cited**


Appendix A. Locations from breeding adult golden eagles in 2012. MCP=Minimum Convex Polygon which is total area used to date (March 25-September 25, 2012). KDE=Kernel Density Estimator which shows the areas of concentrated use, both at the 95% level and 50% level. The first map shows the entire area used and the second is a close up of high use areas for each bird.

Ferry Creek
Appendix B. Locations from pairs captured in 2012 that did not breed. Note the CMR Female was a fourth-year bird.

CMR Male
CMR Female

Clyde Park Female
Appendix C. Locations from non-breeding, fourth-year male.
Mission Creek
Appendix D. Locations of nestlings as of September 23, 2012.
Whitetail
Peterson

Ferry Creek

Clyde Park