A Summary and Evaluation of the Sightability Survey for Rocky Mountain Elk on the Arid Lands Ecology Reserve unit of the Hanford Reach National Monument
Prepared by H. Newsome, February 08, 2011, reviewed by M. Livingston, WDFW 03/04/11

Introduction:
The Rattlesnake Hills Elk herd (RHEH) is a sub-herd of the Yakima Herd. This group of elk resides east of the Yakima River and west of the Columbia River. Along with the Cascade Slope sub-herd, it forms the Yakima Herd (WDFW 2002). Since approximately 1975 (Rickard et al. 1977), the RHEH core range has been the Fitzner-Eberhardt Arid Lands Ecology Reserve (ALE) and private land to the south and west. Peripheral range has included the DOE’s Hanford Site, the Rattlesnake Hills west of state route 240, Yakima Training Center, and southern Grant and western Franklin counties.

Past research and aerial and ground counts since 2002, some of which were conducted in coordination with the WDFW, showed that these elk range widely across public and private lands and that numbers on the ALE fluctuate seasonally, from a range of 44 to 336 in spring and summer to a range of 264 to 767 in fall and winter. The increase in elk numbers on the ALE during the fall and winter can likely be attributed to elk moving away from hunting pressure on adjacent public and private lands as well as elk moving onto the ALE to make use of suitable winter habitat. Traditionally, the herd counts have taken place during the winter months, although it is recognized that this time period captures the maximum number of animals using ALE and does not represent the number of animals that reside on ALE year round.

Techniques to estimate the number of elk using the ALE during winter months have included intensive surveys of marked and unmarked animals to determine population size based on a mark:resight technique. Also, average maximum counts from multiple aerial surveys have also been used. Past techniques have not allowed for the variability of estimates to be determined or for a level of confidence in the estimate to be generated. In addition, both marking numerous animals with collars (or other visible markings) and doing multiple counts from aircraft are expensive and time consuming ways to generate values for herd size and composition.

During the winter of 2004/2005, a new method was implemented to determine the size and composition of the RHEH. A sightability survey was designed to be an efficient and cost effective way to determine herd size. A traditional aerial survey typically underestimates populations of ungulates because some animals are missed by observers. Sightability surveys are designed to account for animals that go unseen during survey events. In addition, the method allows for an estimate of variability to be generated and a confidence interval developed for the estimated parameters, including herd size and composition. The method is more efficient and economical because total population estimates can be achieved by surveying a sample of units rather that covering the entire area. The survey was designed to be used with the software program AERIAL SURVEY designed by professors at University of Idaho. The regression analysis and mathematical models developed within this computer-based software require the actual aerial survey to be conducted by helicopter.

The survey sampling units were designed based upon the history of the use of the ALE by elk during the winter. Survey strata were created based on elk use, and the number of animals thought to be present within different areas. Three strata were developed based on elk use; high, medium, and low. Physical
sampling units on the ground were developed based on the strata. The sampling units were designed to be completed in not more than one hour of helicopter flight time. The average time to complete the units has been about 30 minutes but ranges from 12 to 54 minutes. Additional information about the survey design parameters and technique for conducting the survey can be found in the handbook for using the program AERIAL SURVEY. (see Network Drive N:\Hanford\Biology\Fish & Wildlife\Elk\Aerial Survey 6\Aerial Survey\Beta6.1.3)

Initial Survey: winter 2004/2005

The initial sightability survey was conducted January 4 and 5, 2005. Survey units were developed that included six high, six medium and twenty-two low density units. Generally a minimum of 5 units within each strata must be surveyed for the computer based model to work properly. Because there was a relatively low number of high and moderate density units, all of those designated units were surveyed, and a random sample of the low density units were chosen. Therefore, all six of the high density units were sampled, all six of the medium density units were sampled and 9 of the 22 low use density were sampled. This required two days of helicopter use, the first day to cover all of the high and moderate density units and a few of the low use units, with the second day to sample the remainder of the selected low density units. The first season pilot was Jim Pope, of Valley Helicopter Service out of Lewiston, Idaho who has OAS qualifications for federal government use. The aircraft used was a Hiller Soloy. Observers were David N. Smith and Kevin Goldie of USFWS, Mike Livingston and Paul Wik of WDFW. (See Table 2)

The raw data count for this survey totaled 670 elk. The model generated an estimated total herd size of 674 (± 8) with a 90% confidence interval that the number is accurate based on the variability associated with the sightability of the elk during the survey. Total variance (SE²) equaled 22. The Herd composition was 62% cows, 24% bulls and 13% calves. Most elk observed were in two large groups in high density units, which explains the low variability. (See Table 1)


The second year of conducting the sightability survey took place on January 26 and 27, 2006. The pilot was Dave Vallenti of Inland Helicopters from Spokane, at this time Dave Vallenti was not OAS certified. WDFW has been using the same vendor and helicopter for other big game surveys in eastern Washington. The vendor used in 2005 was not available in winter 2006. Therefore, federal biologists could not accompany the survey. The aircraft used was a Robinson R-44 “Raven II” which is not exact to the specified aircraft in the Aerial Survey program (Hiller 12-E), however, the aircraft can fly at the low speeds designated by the survey protocol and had good visibility for the observers. The major difference between the two aircraft is that the secondary observer in the R-44 sits in the rear instead of the front. At this time, we are unsure of the bias this may contribute to our model estimates. Observers were Mike Livingston, Don Hand, Mike Keller and William Moore all of WDFW. (See Table 2) During this season’s survey, the units were the same as the previous season and all six of the high use units were sampled, all six of the medium use units were sampled and 9 of the 22 low use units were sampled.

Surveys began on 26 January at approximately 11:00. Sampling units were covered in the following order prior to the first fuel break: 5, 3, 4, 6, 1, and portions of 11 & 12. Observers had difficulty determining the boundary between units 11 and 12, and therefore, the units were lumped as one unit. A
A large group of elk was observed and a GPS location later verified that the group was in unit 12. This group took a long period of time to count and classify due to its large size and high winds. The pilot requested a break when the observers finished counting and classifying the group. As a result, units 11 and 12 were not completed until after the break. Following the break and fueling observers completed units 11 and 12. Observers located the large group previously counted in unit 12 prior to starting the survey. Winds progressively increased over the course of the day and precluded surveying the steeper units 2 and 7 (Snively Basin). This was unfortunate due to the possibility of animals moving into the area in between the first and second survey day. The following units were surveyed on the second flight of the first day: remainder of 11 & 12, 13, 34, 30, 29, 15, and 8.

A digital photo was taken by the pilot of the large elk group in unit 12 prior to observers breaking the group up for classification. A total count of elk in a group can be obtained from a digital photo. However, the photos are typically not close enough to distinguish between cows, calves and bulls. The difference between field-counts and counts from photo interpretations was assumed to have resulted from under estimation of cows during aerial field counts since closer observations are conducted to obtain calf and bull numbers. Generally, one observer counts bulls, the other counts all calves and the remainder of the total number counted are assumed to be cows. Cow elk are not directly counted. Therefore, the difference between field and photo counts was added into the cow portion of the total elk count.

On 27 January observers surveyed the remainder of the units in the following order: 2, 7, 21, 23, 19, 17, 16, and 9. Prior to starting the survey, the observers attempted to locate the two big groups counted the day before. They did quick searches in units 12, 11, 1, 6, 4 & 5. In unit 12, the biologists observed and photographed one group. Photo interpretation later yielded a count of 63 elk. The observers were unable to locate any other elk groups in the units that were surveyed the day before. The observers were confident that no other large group was present in units 11 and 12 because the topography is gently sloped and open. There is a possibility that observers overlooked a group(s) in units 5 or 6 since they are more topographically diverse and they were not covered entirely. However, observers did cover those areas where elk are typically observed. On the second survey day, biologists encountered one large elk group in unit 2 and another in unit 7. Digital photos were taken of each group.

A total 465 elk were aerial counted and 469 elk were photo counted from the first day. On the second day, a total of 418 were aerial counted and 530 were photo counted. Of the 530, a group of 63 were photographed in unit 12 prior to starting the survey (discussed above).

A decision was made on to proceed using the aerial/photo counts from the first day (i.e., 469) and then arbitrarily assigning the remaining 61 (i.e., 530 from day two minus 469) to units 2 and 7. Since the large elk groups present in units 2 and 7 on day two appeared to be influenced by the survey the day before. The 61 additional elk counted on day two were equally split, 30 and 31 and assigned to units 2 and 7 for analysis in Aerial Survey Program.

The raw data count for this survey totaled 533 elk. The model generated an estimated total herd size of 537 (± 7) with a 90% confidence interval that the number is accurate based on the variability associated with the sightability of the elk during the survey. Total variance (SE^2) equaled 18. The Herd composition was 53 % cows, 27% bulls and 19 % calves. (See Table 1)

The third year of conducting the sightability survey took place on January 24 and February 21, 2007. The intervening days had weather problems with low fog, clouds and other weather related issues that affected the survey. Obviously, having the two survey days so far apart in time introduced a variability factor that was not anticipated. A large assumption had to be made with this data, that the units of low density that were flown on the January 24 date also had no elk present on the February 21st date.

The pilot was again Dave Vallenti of Inland Helicopters from Spokane, at this time Dave Vallenti was (still) not OAS certified. Therefore, federal biologists could not accompany the survey. And again the aircraft was Robinson R-44 rather than a Hiller 12-E, however, we felt that having the same pilot and aircraft would reduce variability between years. Observers were Mike Livingston, Don Hand and Mike Keller of WDFW. (See Table 2)

Prior to this season’s survey, the sampling units were changed and lumped together to increase efficiency and better reflect elk movement patterns (see attached maps). Larger units that can still be covered in an hour of helicopter time, make the survey easier and more efficient to complete. The units were lumped based upon their category/strata identifier (high, medium, low) such that high density units 3, 4 & 5 were lumped into high density unit 2, high density units 1 & 11 were lumped into high density unit 1, and High and Medium density units were lumped into high density unit 3. That created a population of 3 high density units, that all must be surveyed due to the low sample size. Medium density units 19 and 21 were lumped into Medium density unit 5 and Medium density units 6, 7& 2 were lumped into Medium density unit 4. That created a population of 2 medium density units and all must be surveyed due to the low sample size. Several additional low density units to the west of the typically surveyed area were added, increasing the area surveyed on a mix of public and private lands west of ALE. The total number of low density units increased to 40, of which a minimum of five need to be surveyed, a sample of 16 of the low density units were flown.

Again this season digital photographs were taken of large groups observed during the survey and used to verify and modify field based counts. The photos are typically not close enough to distinguish between cows, calves and bulls. The difference between field-counts and counts from photo interpretations was assumed to have resulted from under estimation of cows during field counts since closer observations are conducted to obtain calf and bull numbers. Therefore, the difference between field and photo counts was added into the cow portion of the total elk count. Because it is often difficult to classify calves, the calf numbers are likely slightly under estimated, and likely some of the uncounted elk that later get lumped as cows could be calves.

Also due to the late date of this survey, some of the Bull elk may have already shed their antlers, and thus may also have been slightly under estimated.

The raw data count for this survey totaled 675 elk. The model generated an estimated total herd size of 681 (+ 11) with a 90 % confidence interval that the number is accurate based on the variability associated with the sightability of the elk during the survey. Total variance (SE^2) equaled 43. The Herd composition was 58% cows, 26% bulls, and 16 % calves.

The fourth season of conducting the sightability survey was conducted on Jan 15 & 16, 2008. Again Dave Vallenti was the pilot and the Robinson R-44 was the aircraft used.

Sampling units were slightly modified over the units that were used during the winter 06/07 survey (see attached maps). High density units were made to follow more defined boundaries on the ground, although their acreage did not change. There were still 3 high density units, and all were surveyed. The medium density units in Snively basin stayed the same and one unit north of Highway 24 was also identified as medium density (unit 13), and again all three were surveyed. The low density units were made much larger and the population of units to sample from decreased. The population of low density units was only 12 and seven of these units were flown. See maps for how these units were combined, the sampling of the units was done so that the number of acres surveyed matched the number of low density acres surveyed during the previous 06/07 survey. Lumping several low density units significantly reduced time spent searching for unit boundaries from the air, permitting observers to spend more time searching for elk. It also reduced the number of turns required by the helicopter, reducing overall flight time. From the experience of past years, these units have never taken a full hour to survey. This year, even with larger units, it only took 30 minutes on average to complete each unit with a range of 19 to 40 minutes. In past surveys, before units were grouped, some of the units could be surveyed in less than 10 minutes. Decreasing the number of units increased survey efficiency and safety, and reduced flight time due to fewer turns and ferrying between units.

Again large groups encountered were digitally photographed, and later interpreted in the office, and the number recorded in the field was adjusted by varying the number of cows in each large group. In most cases cows were added, but in one case the number of cows decreased based on photo interpretation of the data.

The raw data count for this survey totaled 510 elk. The model generated an estimated 639 elk (± 240) with 90% confidence that the number is accurate. The variability is much greater than in past survey years with the total variance (SE^2) equal to 21,345. This variance is attributed to the fact that the elk were widely scattered in unpredictable locations after large wildfires that scorched the ALE area. For instance, one group of 106 elk (20% of total) was observed in a low-density unit likely contributing substantially to this high variability. Because the model requires that the unit strata actually reflect the elk locations (high, medium and low areas), and because this was difficult to predict due to the dispersion of the elk into different use areas post fire, the estimate will contain this large variance for this season. The estimated Herd composition was 53% cows, 26% bulls, and 22% calves.


The fifth season of conducting the sightability survey was conducted on Jan 9 & 10, 2009. Again Dave Vallenti was the pilot and the Robinson R-44 was the aircraft used. Because Vallenti is not OAS certified, no U.S. Fish and Wildlife Service personnel participated in the survey itself. Washington Department of Fish and Wildlife employees completed the counts and provided data and copies of photos. U.S. Fish and Wildlife biologists then formatted the raw data and ran it through the AERIAL SURVEY program for analysis.
Sampling unit size was not modified over the units that were used during the winter 07/08 survey (see attached maps). There were still 3 high density units, and all were surveyed. The medium density units in Snively basin and north of Highway 24 stayed the same and two additional units were identified as medium density, for a total of 5, and all five were surveyed. The additional medium density units were unit 6 within Central Hanford, and unit 8 on the private lands immediately west and south of the ALE. The population of low density units was then reduced due to changing those units to medium density. Therefore, there were only 10 low density units, and four of them were surveyed. Next year effort should be made to sample at least 5 low density units as that is the minimum number for a sample recommended by the authors of the analysis software AERIAL SURVEY.

Again large groups encountered were digitally photographed, and later interpreted in the office, as in previous years (see above).

The raw data count for this survey totaled 630 elk. The model generated an estimated 639 elk (± 12) with 90% confidence that the number is accurate. The variability is reduced over last season with the total variance (SE²) equal to 53. The estimated Herd composition was 61% cows, 30% bulls, and 9% calves.

**Survey: winter 2009/2010**

The sixth season of conducting the sightability survey was conducted on Jan, 15, 16 and 21, 2010. Leading Edge Aviation of Lewiston ID/Clarkston WA was the contract vendor for the survey. Jason Dodds was the pilot and a Robinson R-44 helicopter was the aircraft used. Leading Edge is OAS certified and therefore USFWS biologists were able to participate in the survey. The initial day (01/15/10) the pilot was in transit from a project in Oregon and did not arrive until approximately 2 pm. There was only enough time to fly survey units in Central Hanford on day one (units 6 and 16). M. Livingston and D. Hand of WDFW flew this day. The following day (01/16/10), about 3.5 hours of flight time was spent, but the low clouds and fog never lifted. M. Livingston and H. Newsome were the observers this day. The only unit that was effectively surveyed on this date was unit 13 north of highway 24. No other data were used from this day because of the poor weather conditions for completing the survey, and the possibility of moving the animals in response to the aircraft. On Sunday, Jan.17 the pilot and crew returned to their base to await better weather conditions for the survey. On Thursday, Jan. 21 the clouds had lifted enough to complete all units remaining of the survey, including re-surveying some of the units flown on Jan. 16 (all but unit 13 north of highway 24). Washington Department of Fish and Wildlife employees compiled the raw data, and provided data to USFWS. U.S. Fish and Wildlife biologists then formatted the raw data and ran it through the AERIAL SURVEY program for analysis.

Sampling unit size was not modified over the units that were used during the winter 07/08 or 08/09 survey (see attached maps). There were still 3 high density units, and all were surveyed. The medium density units in Snively basin (units 4 & 5) and north of Highway 24 (unit 13) stayed the same and one additional unit was identified as medium density (unit 6), for a total of 4, and all four were surveyed. The additional medium density unit was unit 6 within Central Hanford. The population of low density units was then reduced due to changing those units to medium density. Therefore, there were 11 low density units, a sample of 6 of these low density units were randomly selected, and those six were surveyed. The total number of survey units was 18 and of those 13 were flown.
Because of a malfunction with the digital camera, no digital photos were taken of the large groups encountered during this survey.

The raw data for this survey totaled 671 elk. The model generated an estimated 677 elk (+11) with 90% confidence that the number is accurate. The variability is similar to last season with the total variance ($\text{SE}^2$) equal to 42. The estimated Herd composition was 59% cows, 30% bulls, and 11% calves. The variability was due to no elk being seen in unit 3 which was identified as a high density unit. Elk may have been pushed out of this unit by increased activity in and around old ALE Headquarters area, and increased traffic on the paved road up Rattlesnake Mountain. Department of Energy projects to consolidate towers on the top of the mountain and remove buildings both on the mountain and at the old ALE headquarters area have created much more human activity in this area. This activity likely pushed elk out of that area and unit 3 where they have been during past seasons.

Warmer winter temperatures during this January when compared to previous winters may have also contributed to the elk being distributed differently than in previous seasons. Average temperature for January 2010 was 38.0°F, whereas the average January temperature over the past decade (since 2000) was recorded as 32.6°F. In addition, average snowfall over the past 5 winters (since 04/05) was 13.74 inches, whereas this past winter snowfall through January had only reached 4.8 inches (data courtesy Hanford Meteorological Station (http://hms.pnl.gov/)). Therefore, elk may have had access to areas normally covered by snow in higher elevation areas, and may have moved from low lying areas (unit 3) to higher elevation sites.

Additional variance is likely due to the majority of the elk being recorded in units designated as medium density units. Therefore the model generates a prediction that there are animals missed in the other units. It is unlikely that any animals were missed due to good flight coverage (See Figure 4). However, because several days passed between the initial survey dates and the final survey dates, it may be possible that elk may have moved and/or been double counted between survey days.

Survey: winter 2010/2011

The seventh season of conducting the sightability survey was conducted on January 24 and 25, 2011. The pilot was Mark Hollis of Inland Helicopters from Spokane, at this time the aircraft from Inland Helicopters was not OAS certified. Therefore, federal biologists could not accompany the survey. The aircraft used was a Robinson R-44 “Raven II” which is not exact to the specified aircraft in the Aerial Survey program (Hiller 12-E), however, the aircraft can fly at the low speeds designated by the survey protocol and had good visibility for the observers. At this time, we are unsure of the bias this may contribute to our model estimates. Observers were Mike Livingston and Don Hand of WDFW. (See Table 2) Washington Department of Fish and Wildlife employees compiled the raw data, and provided data to USFWS. U.S. Fish and Wildlife biologists then formatted the raw data and ran it through the AERIAL SURVEY program for analysis.

Sampling unit size was not modified over the units that were used during the winter 09/10 survey (see attached maps). There were still 3 high density units, and all were surveyed. The medium density units stayed the same and all four were surveyed. There were 11 low density units, a sample of 5 of these low density units were randomly selected, and those five were surveyed. The total number of survey units was 18 and of those 12 were flown. (Map attached)
Digital photos were taken with digital camera of the large groups encountered during this survey. Counts were modified based on these photos after the survey was complete and photos could be printed and examined. The number recorded in the field was adjusted by varying the number of cows in each large group, where the total in the photo was different than field based counts.

The raw data for this survey totaled 767 elk. The model generated an estimated 772 elk (± 11) with 90% confidence that the number is accurate. The variability is similar to last season with the total variance (SE²) equal to 48. The estimated Herd composition was 63% cows, 23% bulls, and 14% calves.

Figure 1: Estimated Elk Herd Size for the Rattlesnake Hills Elk Herd using sightability model with program Aerial Survey, 2004/05 through 2009/10. Survey completed in January of the following year (2005-2010) and considered a post-harvest¹ population estimate. ¹ Most harvest occurs prior to January, but some years a small number of elk are harvested January through March. * Results from 2007/2008 have very wide confidence intervals due to elk being distributed within the strata differently than expected due to a large wildfire during the summer of 2007. Distribution changes due to the fire pushed a large group of elk into a low density unit and caused the model to extrapolate beyond what we believed the population size to be during that winter. Raw counts of elk during this winter may be closer to the actual herd size than estimated by the model. See Table 1 on page 12.
Figure 2: Estimated Elk Herd Size for the Rattlesnake Hills Elk Herd from historical information. From 1983 through 2003 the elk herd size information was compiled from direct counts, both aerial and ground based surveys, and was generally the maximum number of elk counted during any one winter season. From 2004/05 through 2010/11, new protocols have allowed for a confidence interval to be generated around the estimated herd size and will allow for statistical comparison between years.
Figure 3: Rattlesnake Hills Elk Herd Size data with data trendline showing moving average (2) of elk herd size over time. This season’s numbers indicate a trend of a slight increase over the past several years of data.

Figure 4: Flight following map produced by Hanford Dispatch for flight following on January 21, 2010.
Overall Evaluation: The implementation of the sightability survey for elk in the Rattlesnake Hills herd has several advantages to the past survey technique. These advantages include:

- The survey provides an estimate of actual population size and confidence intervals for those estimates.
- Changes in the population over time can be statistically tested to determine if significant differences or changes are occurring between years. Data collected over several years can be compared because the survey technique is the same and does not rely on a single observer, reducing observer based bias.
- The surveys are more economical (cost effective) because total herd size estimates can be determined by surveying a sample of units within the survey area rather than the entire area.
- The surveys are safer because flight time is reduced, reducing the chance for accidents to occur.
- Information about the distribution of the herd is refined annually based on locations of groups of animals in previous surveys.
- Variability in the data has been reduced by using the same number of observers, the same aircraft flying at the same speed, and using similar flight patterns each season.
- The survey has allowed varying agencies and interested parties to come to agreement on herd size. This agreement is based on agreement in the survey protocol and design each season prior to herd counts.

Some issues that have occurred during the survey to be aware of for future seasons are:

- Assigning the correct stratum to each unit on the ground is important for reducing variability in the data. Some preliminary ground surveys might help to determine how units should be assigned to strata prior to conducting the survey.
- When large groups are broken into smaller groups to classify animals, it is important to note that the data should be entered into the program as one large group only, not several smaller groups.
- It is important to try to sample all of the high and medium units in the first day of flight time because the disturbance from the aircraft conducting the survey has the potential to move animals among the various units. Conducting the survey across two days when animals may have moved due to the survey itself introduces large error into the sampling.
- The survey should be flown in two consecutive days, weather permitting. Large assumptions regarding animal distribution have to be made if a long time passes between survey days.
- Using digital photography can enhance the accuracy of field based elk group counts. Having a backup camera, or an extra camera would be a good idea.
- A minimum of 5 low density units surveyed is recommended.

Conclusion: Continuing with the sightability survey to determine annual post harvest herd size and composition of the Rattlesnake Hills elk herd is recommended for at least 3 more seasons, for a total of 10 years of data. We hope to further refine the data collection and be able to statistically test the data for trends and differences between years. After year 10, an evaluation could be made as to whether the survey could be conducted less than annually to gather the same type of information.
Table 1: Summary of Results for Sightability Survey for Rattlesnake Hills Elk Herd. * Results from 2007/2008 have very wide confidence intervals due to elk being distributed within the strata differently than expected due to a large wildfire during the summer of 2007. Distribution changes due to the fire pushed a large group of elk into a low density unit and caused the model to extrapolate beyond what we believed the population size to be during that winter. Raw counts of elk during this winter may be closer to the actual herd size than estimated by the model.

<table>
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<th>Winter</th>
<th>Raw Count</th>
<th>Herd Size Estimate (Model Generated)</th>
<th>90 % confidence interval (±)</th>
<th>Total Variance (SE^2)</th>
<th>Herd Composition</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>% Cows % Bulls % Calves</td>
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<tr>
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<td>8</td>
<td>22</td>
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<td>767</td>
<td>772</td>
<td>11</td>
<td>48</td>
<td>63 23 14</td>
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Table 2: Summary of Logistics for Sightability Survey for Rattlesnake Hills Elk Herd. (Attached Page)

*Note with regard to the 2010 survey. Due to poor weather conditions, additional charges for ferry time and per diem for Leading Edge Aviation put costs over what was expected for the survey. If the survey had been completed on one or one and a half survey days, as has been normal in the past the cost of the survey would be more comparable to previous years.
<table>
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<th>YEAR</th>
<th>DATE</th>
<th>PILOT</th>
<th>AIRCRAFT</th>
<th>OBSERVER 1</th>
<th>OBSERVER 2</th>
<th>Total Elk (estimate)</th>
<th>Variance (SE^2)</th>
<th>COST</th>
<th>Comments</th>
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<td>Hiller Soloy</td>
<td>D.N. Smith, USFWS</td>
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<td>Robinson R-44</td>
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<td>Weather created large time lag between survey dates. Other Observers: M. Kellar, WDFW</td>
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<td>Vallenti R-44</td>
<td>Robinson R-44</td>
<td>M. Livingston, WDFW</td>
<td>D. Hand, WDFW</td>
<td>639</td>
<td>21,345</td>
<td>$4,510</td>
<td>Other Observers: M. Kellar, WDFW Elk widely scattered due to large burned acreages on ALE area from fires in summer of 2007, increasing variability in estimate of herd size.</td>
</tr>
<tr>
<td>2009</td>
<td>Jan 9 &amp; 10</td>
<td>Vallenti R-44</td>
<td>Robinson R-44</td>
<td>M. Livingston, WDFW</td>
<td>M. Kellar, WDFW &amp; D. Hand, WDFW</td>
<td>639</td>
<td>53</td>
<td>$4,997</td>
<td>Elk were seen primarily in the usual locations, Variability in estimate was reduced from last season.</td>
</tr>
<tr>
<td>2010</td>
<td>Jan 15,16 &amp; 21</td>
<td>J. Dodds, Leading Edge Aviation</td>
<td>Robinson R-44</td>
<td>M. Livingston, WDFW</td>
<td>H. Newsome, USFWS</td>
<td>677</td>
<td>42</td>
<td>$4,122.05 &amp; $3,539.50 TOTAL = $7,661.55</td>
<td>Elk were not in Unit 3, usually a high density unit, and many more elk were counted in units designated as medium density, creating model variance. This is the first survey year where cows and calves were recorded in Central Hanford area unit 6. A group of elk (n=70-80) were reported on YTC the same day we surveyed YTC. The reported location was just west of our survey unit. Next year the area should be scouted from the ground prior to our survey; if the elk are documented we should consider adding the area as a medium density unit.</td>
</tr>
<tr>
<td>2011</td>
<td>Jan 24 &amp; 25</td>
<td>Mark Hollis</td>
<td>Robinson R-44</td>
<td>M. Livingston, WDFW</td>
<td>D. Hand, WDFW</td>
<td>772</td>
<td>48</td>
<td>$ 4,986</td>
<td>Elk were in expected areas, although more animals were encountered this season. Harvest numbers were only</td>
</tr>
</tbody>
</table>
around 50 animals with only half being antlerless for the past hunting season. Also, the timing of this survey hit the peak of elk being on ALE rather than surrounding areas.