East Kootenay Urban Deer Translocation Trial

Prepared For:

BC Ministry of Forests, Lands and Natural Resource Operations
Upper Kootenay Ecosystem Enhancement Program
(Fish & Wildlife Compensation Program, Columbia Basin, and Columbia Basin Trust)
BC Urban Deer Cost Share Program
District of Elkford
City of Kimberley
City of Cranbrook
District of Invermere
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"I'm going to the country,
Sunshine, smile on me…"

- Bruce Cockburn

L. Jalbert, photo

EXECUTIVE SUMMARY

The East Kootenay Urban Mule Deer Translocation Trial was a cooperative undertaking of BC Ministry of Forests, Lands & Natural Resource Operations (FLNRO), four municipalities in the East Kootenay region of southeast British Columbia: Elkford, Kimberley, Cranbrook and Invermere, and many volunteers. The trial was undertaken to test animal translocation as a non-lethal method of controlling overabundant mule deer populations within these municipalities.

The trial objectives were:

1. To determine the causes of and rate of mortality during each stage of the translocation process (capture, handling, transport and post-release).
2. To document movement and home range of radio-collared translocated urban mule deer.
3. To compare translocated urban deer survival and movements to non-urban populations.

In February and March 2016, 60 mule deer were translocated from these communities to four release sites on mule deer winter ranges in the East Kootenay. Twenty-nine of these 60 deer were fitted with GPS transmitter collars to track their movement and survival. In March 2017, an additional 25 deer were translocated, all to the “Gibraltar” area at km 28.5 on the Kootenay River Forest Service Road northeast of Canal Flats, BC. Eighteen of these deer were also fitted with GPS transmitter collars. Most deer were captured by free-range darting using BAM-II (a combination of butorphanol, azaperone and medetomidine) or, in 2016, MAA (medetomidine, alfaxalone and azaperone) to immobilize deer. They were carried by hand or vehicle to a stock trailer modified for deer transport, and translocated to the release site on the same day as capture. All releases were directly from the trailer or “hard releases”.

Forty-one of 47 GPS deployed collars (Vectronic Aerospace) were programmed to record and transmit the collar’s location every 13 hours. The other six collars (Lotek Wireless) were programmed to transmit location every 23 hours. Collars not moving for 8 hours transmitted a “mortality alert” by text message and email.

Movement of individual collared deer after release varied greatly among individuals. Movement generally increased in May, consistent with typical non-urban mule deer migration pattern in the East Kootenay region, then declined abruptly in mid-June when fawns were born. Movement increased again through late summer and autumn, without a clear, concentrated migration timing as was evident in the spring. Lowest movement rates occurred in winter.

Three main categories of migratory movement were recognized:

- **Migratory**: deer showed typical seasonal home ranges, moving between them in spring and fall; 13 deer were classified as migratory.
- **Non-migratory**: deer showed no difference in seasonal location, remaining (more or less) in the same area year-round; 15 deer were classified as non-migratory.
- **Wandering**: deer typically showed long distance, short-term movement that was usually one-way and continued until a community was “found” where the deer stayed; 12 deer were classified as wandering.

Wandering deer had the largest home ranges, while non-migratory deer had the smallest home ranges. On average, translocated deer had smaller home ranges than non-urban deer in the same migration category. Most non-urban deer were migratory (some were non-migratory) and no non-urban mule deer exhibited the “wandering” behaviour. Non-urban deer tended to migrate farther but maintained smaller discreet summer and winter home ranges.

Sixteen of 40 radio-collared deer surviving more than 60 days (>60) post-release moved to a town or community at some point. Twelve of these 16 remained in that town. Nine other deer moved to rural communities or properties with six of them permanently remaining in that area. In some cases deer moved away from these areas (two left towns; three left rural areas). Of deer moving to towns, seven generated complaints to the BC Provincial Report All Poachers and Polluters (RAPP) toll free line; while one deer at a rural property also generated complaints. The movement of habituated deer to human development is a major potential limiting factor to the implementation of translocation as an ongoing operational tool to manage urban deer populations in the East Kootenay. An *a priori* plan to deal with habituated deer possibly settling in other communities is necessary prior to any future urban deer translocations. Fifteen of the 40 radio-collared deer surviving >60 days were never recorded in a town or rural area and all these deer were either migratory (n = 8) or non-migratory (n = 7).

Annual Kaplan-Meier survivorship of translocated deer for the period May 1, 2016 through April 30, 2017 was 51.1% (95% C.I. range: 27.9 – 74.4%). This estimate was lower than non-urban mule deer which showed 78.9% (95% C.I. range: 69.4 – 99.0%) annual Kaplan-Meier survivorship over the same period.

The raw percentage of collared individuals surviving from translocation through late August in both years was similar: 71.4% in 2016 and 72.2% in 2017. Mortality rate by month was very similar between translocated and non-urban mule deer. Greatest levels of mortality occurred in April and May during spring migration for both translocated and non-urban mule deer.

Translocated deer (24.9%) had a slightly lower proportion of collared individuals killed by predation compared to non-urban deer (28.1%). This result suggests that urban deer are not predator-naïve but able to seek protection and avoid predation as well as non-urban deer. The overall higher mortality rate of translocated deer was attributable to a number of causes, primarily translocated deer being destroyed for aggressive behaviour or dying in an emaciated condition. Whether deer were weakened because they were not familiar with local food sources or were not in seasonally appropriate habitats or were simply in poor body condition (e.g. aged) is unknown.

The 50% first year annual survival rate was consistent with other recent urban mule deer translocation projects in New Mexico and Utah. However neither of these projects reported deer exhibiting the wandering behaviour and none had habituated deer become problem animals in other communities or private land.

Overall, the results of the translocation trial are mixed with highly individualized responses by the deer that were moved. Some individuals showed the preferred response of exhibiting typical migratory behaviour and never returned to any community. The propensity of some individuals to seek out a community in which to settle is problematic because regional wildlife managers do not want to distribute habituated mule deer to other communities. The translocated deer showed they are not predator-naïve and are capable of surviving outside largely predator-free urban environments.

Specific conclusions include:

1. Complications associated with capture and transport were minimal. The new BAM-II and MAA drug combinations delivered by free-range darting were efficient, effective and the experienced team members provided safe procedures for deer, handlers and public.
2. Clover trapping was used initially for capture but was not efficient. Capture rates were low and species, sex and age classes could not be targeted.
3. Transporting deer using modified livestock trailers worked well. Specific modifications included canvas curtains to block light and facilitate adding additional deer to the trailer, deep straw bedding, and padding to cover sharp protrusions. There were no significant injuries associated with transporting deer in the trailer.
4. Release sites must be as far from communities as possible. Given the distance moved by some individual deer post-release, distance may ultimately not matter. However, all actions to minimize the likelihood of wandering individuals finding a community should be undertaken.
5. No single factor can predict individual deer response to translocation. In the future, a multi-factorial analysis of various traits including: originating municipality, urban vs interface home range, age, and body condition score may help identify which individuals are most likely to succeed with translocation. This has not been done to date.
6. Release sites around Lake Koocanusa are not suitable for translocation. None of the deer released to the two sites near Koocanusa showed significant migratory behaviour. One deer showed a short north-south migration with no elevation change, which is not typical of mule deer migratory patterns in this area. She did not migrate at all in the fall of 2017. All but one deer (who died at the 60 day survival threshold for including deer in analyses) released to the two Koocanusa area release sites encountered either a community or rural property and only two moved on. Deer released to these sites also generated a disproportionate amount of complaints.
7. There is evidence that deer from different communities responded differently to translocation. None of the translocated Invermere deer generated complaints, and all exhibited migratory behaviour. Conversely, only one of 14 Kimberley deer showed migratory behaviour and five of 12 deer that wandered long distance in search of a community originated from Kimberley.
8. Translocated deer did not necessarily move farther than non-urban deer, but did move in different ways. No non-urban deer showed “wandering” behaviour and were much more likely to migrate than translocated deer.
9. Translocated deer incurred higher mortality than non-urban deer; primarily from deer killed for overly aggressive behaviour, or dying of emaciation for unknown reasons. Predation rates were similar between the two groups.
10. The major issue arising from this study is movement of habituated deer to other communities. Note that with the high twinning rate in urban deer, one translocated doe can become up to seven deer within just over 12 months of translocation.

Several recommendations and a detailed budget for future translocations are provided.

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East Kootenay Urban Deer Translocation Trial

1 BACKGROUND

Mule and white-tailed deer populations in many North American and British Columbian urban centres have dramatically increased in the past decade. Many communities in the East Kootenay region now face conflicts in terms of public safety, primarily from mule deer doe behaviour, collisions with vehicles and deer considered nuisance animals due to their behaviour or feeding patterns. Over the same time period, non-urban mule deer populations have declined throughout the East Kootenay region (Stent 2017; BC FLNRO 2014; Mowat and Kuzyk 2009) and across their western North America range (Forrester and Wittmer 2013). Factors driving this decline are unknown, but may involve forage quality and quantity limitations, changes to predator-prey dynamics and climatic variability (P. Stent pers. comm.). Over the past decade, several East Kootenay communities have addressed overabundance of mule deer within their boundaries by culling deer and distributing meat to local food banks. This resulted in substantial negative public reaction and socio-political pressure from numerous groups and individuals. One reason for the objection to killing urban mule deer was that non-urban mule deer populations in the area are low.

The management of hyper-abundant deer in North America has attracted much scientific and public interest (Urbanek et al. 2012; Rudolph et al. 2011; McShea et al. 1997) leading to the implementation of a number of mitigation measures including recent translocation trials (C. Howard pers. comm.; Ashling 2015; Ortega-Sanchez 2013; Beringer et al. 200; Galindo and Weber 1994). However, survivorship of translocated mule deer has been very low in past attempts due to complications associated with capture, handling, and transport techniques resulting in poor animal welfare and mortality. Deer are highly sensitive to the stresses associated with capture and handling and commonly suffer from a usually fatal muscle condition (capture myopathy) as well as high rates of physical injury. Appropriate standards of care with experienced personnel reduce complications but there was no way to remove this risk to their welfare. Capture related mortality rates in excess of 29% are commonly reported in the literature (Beringer et al. 2002, Haulton et al. 2001). Translocation risks also include the movement of disease and parasite pathogens to new areas (IUCN/SSC 2013). Translocated deer also are challenged by being moved to a new home range, with no knowledge of forage sources or predators (Owen-Smith 2003). This may be especially be true for habituated urban deer with unknown knowledge of non-urban environments.

This report discusses the trial translocation of urban mule deer from four communities in the East Kootenay region of British Columbia. Recent mule deer translocation trials in Utah (C. Howard pers. comm.) and New Mexico (Ashling 2015) demonstrated reduced mortality from capture associated myopathies and lower levels of post-release mortality with newly developed protocols. On the basis of results in these jurisdictions, the BC government permitted this translocation trial under research conditions, including the development of new capture and transport protocols and the evaluation of urban mule deer health with a comparison to free-ranging non-urban deer health for variety of health measures.

Supplementing free-ranging mule deer populations with urban deer from nearby communities may help support non-urban East Kootenay mule deer populations, but also presents risks to both the translocated animals (uncertain fate) as well as the recipient herds (potential health concerns). The goal of this project was to manage these risks and to test translocation as a cost effective management option for urban mule deer in the East Kootenay.

The objectives of the trial translocation study were to:

1. Determine the mortality rate and causes of mortality during each stage of the translocation process (capture, handling, transport and post-release).
2. Document movement of radio-collared translocated urban mule deer.
3. Compare translocated urban deer survival and movements to non-urban mule deer populations.

2 METHODS

2.1 2016 Captures

The trial targeted adult female does and their fawns (regardless of sex). Most does are pregnant in late winter; removing them from urban areas at this time should ensure their fawns are born outside of town. Adult males were not selected for safety reasons; bucks tend to be more active and could potentially injure does and fawns within the closed confines of a transport trailer.

Deer were captured by one of two methods: free-range darting with chemical immobilization, or Clover trap capture. Captures occurred in the four participating municipalities in the East Kootenay region of southeastern British Columbia: Cranbrook, Elkford, Invermere and Kimberley (Figure 1). Captures took place over three days in each municipality between February 16 and March 10, 2016. Darted deer were identified as a suitable translocation candidate (either an adult female or an adult female with its 2015-born fawn) in locations considered safe for both deer and general public where the project team had permission to dart (municipal land or private land with permission from landowner). Deer were darted by experienced wildlife professionals using either Pneu-Dart™ (Pneu-Dart Inc., Williamsport, PA) or Dan-Inject™ (DanWild LLC, Austin, TX) projectors and, generally 1 ml low impact darts.

One of two immobilization drug combinations were used (Table 1):

1) a premixed combination of butorphanol, azaperone and medetomidine (BAM-II™, Chiron Compounding Pharmacy, Guelph, ON) or
2) a premixed experimental combination of medetomidine, alfaxalone and azaperone (MAA, see Mathieu et al. 2017).

Darted deer were monitored until recumbent and safe to handle, then restrained with hobbles and blindfolded and transported immediately using a handling blanket (Animal Handling Systems, Lundbreck, Alberta) to a shuttle vehicle for transfer to a modified horse trailer for processing and translocation. Details are provided below.

Clover trapping occurred only in Kimberley and Cranbrook in Feb/March 2016. Trap sites were established on private land with landowner permission for up to one week prior to being set. Each trap was baited with apples and a grain mixture. Traps were set between 10:00 PM and midnight, then checked starting at 5:00 AM the next morning. Deer considered suitable for translocation (adult does) were restrained (trap collapsed with two workers restraining deer) and immediately administered immobilization drugs by hand injection. They were held until anesthetized, restrained with hobbles, blindfolded and removed from the trap with transport as above.

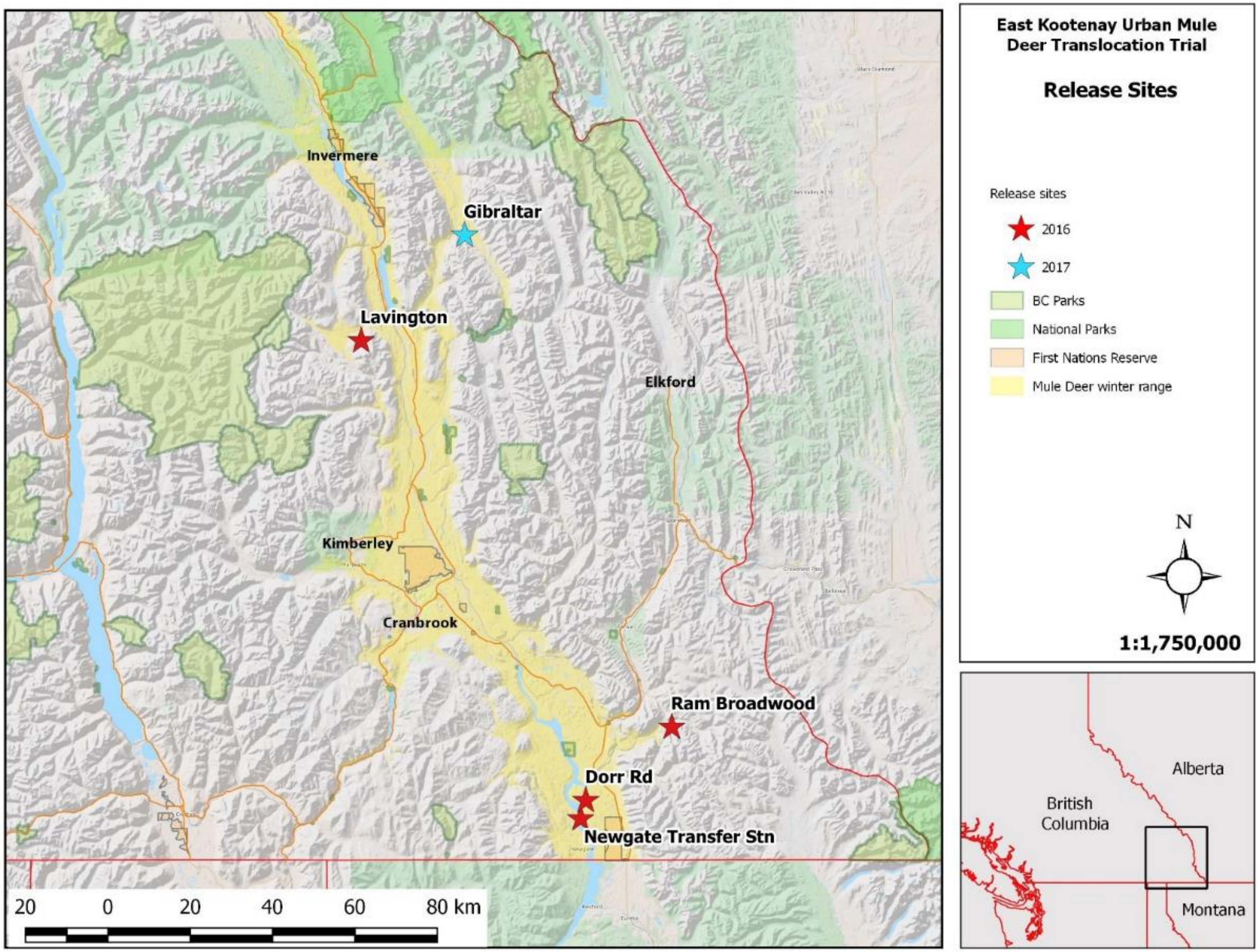

Figure 1: Mule deer winter range in East Kootenay (yellow) and release sites (stars) for translocated urban mule deer in the East Kootenay, 2016 and 2017.

Table 1: Drug combinations and manufacturer recommended standard dosages for mule deer.

Combination	Immobilization		Reversal	
	Drugs	Dosage[1]	Drugs	Dosage
BAM-II	Butorphanol tartrate (27.3 mg/mL)	Fawns: 0.5 cc Adults: 1.0 cc	Atipamezole (25 mg/mL)	Fawns: 1.0 cc Adults: 2.0 cc
	Azaperone tartrate (9.1 mg/mL)		Naltrexone [2] (50 mg/mL)	Fawns: 0.25 cc Adults: 0.5 cc
	Medetomidine hydrochloride (10.9 mg/mL)			
MAA	Medetomidine hydrochloride (10.9 mg/mL)	Fawns: 0.5 cc Adults: 1.0 cc	Atipamezole (25 mg/mL)	Fawns: 1.0 cc Adults: 2.0 cc
	Azaperone tartrate (9.1 mg/mL)		Naltrexone (50 mg/mL)	Fawns: 0.25 cc Adults: 0.5 cc
	Alfaxalone hydrochloride (10.9 mg/mL)			

[1] These standard dosages were altered according to size of the deer and individuals' response to drug following its delivery. Additional amounts of combined drug was delivered by dart or hand injection as required to achieve desired level of sedation.

[2] Naltrexone was rarely given to retain residual butorphanol effects and maintain calmer animals in the trailer.

2.2 2017 Captures

In 2017, captures were conducted between March 6 and 9, 2017 in Kimberley and Cranbrook. The objective was to redeploy collars retrieved from mortalities following 2016 translocations. All deer were immobilized by free-range darting, using the same procedures outlined above for 2016. There was no use of Clover traps in 2017. Only BAM-II was used to immobilize deer in 2017.

2.3 Field Crews

All sedated deer were physically examined, sampled and monitored by experienced biologists and supervised by a wildlife veterinarian. The project was authorized by BC Wildlife Permit # CB16-224332 in 2016 and Permit #CB17-260952 in 2017; the permits included Animal Care approval. Pictures illustrating capture, transport and release of deer are included in Figure 2.

Field crew varied with each municipality and included technicians, wildlife and other private veterinarians, volunteers, subcontractors, BC FLNRO staff and University of Calgary researchers. In 2016, crew size averaged eight to nine people. In 2017, the project operated with a crew of five:

- Crew lead biologist
- Wildlife veterinarian
- Experienced wildlife biologist
- Two handlers

This lower number was sufficient and streamlined the capture process. At least one crew member was trained and experienced in wildlife immobilization.

2.4 Deer Handling

Depending on where the deer was captured, biological samples were collected and the deer was ear-tagged and fitted with a radio-transmitter collar (if applicable) while recumbent if it was safe for the deer, crew and public. Alternatively, the deer was immediately moved to the transport trailer location for "processing". The latter (moving first, processing at a parked trailer) was the preferred method. Deer were moved to a shuttle vehicle with a carrying blanket and transported to the transport trailer while immobilized. Use of a shuttle vehicle eliminated the need to frequently move the transport trailer (significantly reducing disturbance to deer inside) during daily capture activity. Also, the shuttle vehicle was more maneuverable, which minimized the carrying distance for the immobilized deer and handlers.

All immobilized deer were assigned a BC Wildlife Health Identification number (WLH ID) and uniquely numbered ear tag. Biological samples and data were collected according to a standard sampling protocol. Sampling included a 6 mm ear biopsy, at least 30 hairs with roots, feces was collected directly from the animal when possible, and at least 25 ml of blood was collected from the jugular vein. Deer were subjectively scored for body condition (excellent, good, fair, poor, or emaciated) based on the amount of lumbar spine fat and muscle cover. The degree of tick infestation around the perianal region was estimated (heavy, moderate, few, none obvious) while collecting fecal samples. Deer were weighed in Invermere and Cranbrook for data for the MAA trial (see Mathieu et al. 2017); weights were not otherwise recorded.

2.5 Radio Collars

Adult and young adult females selected to be radio-collared were fitted with the collar while anesthetized. Collars were deployed on the first possible suitable individuals. In 2016, 28 GPS transmitter collars (GlobalStar Survey collars, Vectronic Aerospace Inc, Berlin, Germany) were deployed on 29 appropriate size/age females up to a maximum of seven collared deer per municipality[1]. In 2017, 12 of these collars were redeployed, plus an additional six GPS transmitter collars available from BC Ministry of Forests, Lands & Natural Resource Operations (FLNRO) Kootenay Region staff (Lotek Wireless, Newmarket, ON).

The Vectronic collars attempted to record and transmit the collar's location every 13 hours; the Lotek collars attempted to record every 23 hours. Both featured a mortality sensor that transmits an alert if the collar is motionless for eight hours. Once on "mortality mode", Vectronic collars transmit locations every 30 minutes for six hours, then reverts to a 13 hour programmed schedule, but stays on "mortality" mode unless it detects movement at least once in a four minute interval for 20 consecutive minutes (designed to avoid collar movement by scavengers re-setting the collar to "normal"). Vectronic collars also had a VHF signal programmed to transmit for eight hours each day.

[1] Eight deer were collared in Elkford as one collared deer from Kimberley was predated and the collar retrieved in time to redeploy the collar. Thus, in 2016, 29 deer were fitted with 28 available collars.

Approaching a deer for darting; Cranbrook.

Immobilized mule deer in shuttle vehicle; Invermere.

Darting deer; Kimberley (Marysville).

Deer in trailer at Ram/Broadwood release site.

Transporting deer from point of capture to shuttle; Elkford.

Deer release at Gibraltar.

Figure 2: Pictures of capture, transportation and release of translocation of urban mule deer in the East Kootenay in February/March 2016 and March 2017.

2.6 Trailer

Transport trailers were 2- or 3-horse livestock trailers modified for the project. All sharp edges were padded with water pipe insulation tubes held in place with duct tape and/or plastic cable ties. Trailers were darkened as much as possible using cardboard or plywood to cover vents and windows, but ensuring good ventilation, and lined with 20 to 25 cm of clean straw. A flap-covered hole was available for visual checks of deer inside the trailer. A canvas tarp curtain was installed near the back of the trailer with enough room between the curtain and the door to lay down immobilized deer prior to drug reversal. The curtain blocked the view of deer already in the trailer when adding additional deer. Immobilized deer were placed in this "porch", hobbles and blindfolds were removed, and reversal drug(s) were administered. The transport trailer was parked at a single location each day and not moved until departure for the release site.

Efforts to completely cover windows and vents and the hanging canvas curtain attachment to both sides and the roof were very important. Reducing external light sources within the trailer and keeping the broader environment around the trailer quiet were critical to reduce stimulus and stress to the deer.

2.7 Release Locations

Potential release sites were chosen based on the following criteria:

- Known mule deer winter range
- Accessible by truck with horse trailer in mid-February / March. i.e. low snow and/or well-plowed and not icy
- > 30 km from home community
- > 20 km from other communities
- > 10 km from primary highways

The distance from other communities criterion could not always be met. Particularly south of Highway 3 in the Lake Koocanusa area, most sites were within 20 km of other communities. Four release sites were chosen for initial translocation in 2016, one for each originating municipality (see Figure 1):

- Kimberley to Newgate Transfer Station
- Invermere to Lavington
- Cranbrook to Dorr Road
- Elkford to Ram/Broadwood

A fifth release site, Gibraltar, was identified in 2016 but not used until 2017 (see Figure 1). All deer from Kimberley and Cranbrook were translocated to Gibraltar in 2017.

2.8 Transportation and Release

Deer were transported to release sites daily as soon as possible after the trailer reached capacity. In most cases, no more than six deer were transported at once. The project team attempted to allow at least two hours of daylight following release. Release was a 'hard-release' where the trailer door was opened and the deer exited; no food or security were offered to the deer at the point of release.

No attempt was made to relocate deer released without radio collars. Post-release survival and movement data are only available for deer fitted with radio collars.

2.9 Post-Release Deer Movement

Movement was calculated as a summed distance between consecutive 13 hour GPS locations. GPS locations greater than 13 hours apart were excluded from analyses because they can greatly underestimate distance travelled during the time interval. Even 13 hours is not necessarily a close reflection of the distance moved by a deer within that time frame. However, it is the shortest interval available for the program assigned to the GPS collars and was consistent across all fix intervals analyzed.

Minimum distance between consecutive 13 hour fix intervals was calculated using a 3-dimensional Pythagorean formula: $(\text{distance})^2 = x^2+y^2+z^2$ where x = the difference between Universal Transverse Mercator (UTM) easting values, y = the difference between UTM northing values and z = the difference between elevation values, all data transmitted by the collars.

Home ranges were calculated for both 95% of activity and 100% of activity using Brownian Bridge movement models in R software (after Kranstauber et al. 2012; Horne et al. 2007). Brownian Bridge models are generally preferred for telemetry data because they take the animal's movement path into consideration rather than just individual points. All spatial data other than home ranges and maps were generated using QGIS software (version 2.18 "Las Palmas", Open Source Geospatial Foundation, www.qgis.com) in NAD 83 datum, UTM zone 11.

Deer were classified as to whether they moved to a town or rural area or stayed in natural habitats[2]. Rural areas include ranches, large acreages, campgrounds, lakes with primarily secondary homes (e.g. Rosen Lake near Jaffray, BC) and similar places. "Towns" include small, unincorporated communities such as Baynes Lake up to incorporated villages and cities (e.g. Canal Flats, BC and Libby, Montana).

2.10 Mortality Assessments

When a mortality alert was received, an attempt to retrieve the collar and assess cause of mortality was initiated as soon as possible. Crews combined the generalized GPS location with the VHF beacon to locate the collar (Figure 3). At the location of the mortality, the body condition of the animal was recorded along with signs of trauma, predator sign, and the location of the deer remains. Basic necropsies were performed to determine the cause and time of death. This involved skinning the deer carcass to look for puncture wounds or other signs of trauma, in addition to any obvious signs of injury. Samples of major organs (heart, lung, liver, kidney and spleen) were collected for future health testing. The lower jaw and a length of femur were also recovered for aging (tooth) and body fat (femur marrow) analysis. All samples were frozen as soon as possible and cross-referenced with the animal's WLH ID.

2.11 Concurrent Non-Urban Mule Deer Project

The Ministry of Forests, Lands and Natural Resource Operations (FLNRO) is conducting a 5-year study to monitor survival, cause of mortality and recruitment in four populations of non-urban mule deer. Preliminary survival, mortality and movement data from deer collared during the translocation period were provided by FLNRO for comparison with translocated urban deer. The non-urban mule deer project was initiated in late 2014 (Stent 2015; 2017). Mule deer were captured either by net gunning from helicopter or darting with the BAM-II drug combination. Deer were fitted with GPS collars that attempted to capture and transmit the deer's location 1 to 2 times per day.

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[2] These assessments were made by examining location data with satellite imagery (Google Earth™) and are therefore subject to the limitations of GPS telemetry data. Any of these deer may have encountered a property or community or stayed for a longer period of time between recorded data points.

Mule deer were captured during winter months in three main study areas for the non-urban project:

- **Koocanusa East**, primarily in the Galton Mountain Range east of Lake Koocanusa.
- **Koocanusa West**, primarily south of the Kikomun / Tepee Forest Service Road.
- **Columbia West**, BC Wildlife Management Unit 4-26 from Findlay Creek north to Invermere area.

Figure 3: Mule deer 20667-17 as found following predation by a cougar. Fresh snow fell between time of death and our arrival (<24 hours after kill). Note deer is partially buried with dirt and sticks.

These study areas correspond well to 2016 release sites for the translocation trial; there is no corresponding non-urban mule deer study area to the Gibraltar release site in 2017 (Table 2). For purposes of this report, only basic comparisons were made. A more rigorous analysis of these two deer populations will occur following completion of data collection in the spring of 2018.

Movement of non-urban mule deer is limited to home range size (same 95% and 100% Brownian Bridge home range polygons as completed for translocated deer). Mortality was calculated using both percentage of collared deer surviving, and Kaplan-Meier annual survival rate for the biological year of May 1, 2016 to April 30, 2017.

The biological samples collected while handling deer for translocation and/or collaring were used to compare disease and infection rates between the two populations. Testing of samples is ongoing as part of graduate research by Dr. Amélie Mathieu (Ohio State University, College of Veterinary Medicine); preliminary results only are presented here.

Table 2: Generalized corresponding study areas for translocated and non-urban mule deer.

Non-Urban Mule Deer Study Area	Translocation Trial Release Site
• Koocanusa East	• Ram / Mt. Broadwood • Dorr Road
• Koocanusa West	• Newgate Transfer Station
• Columbia West	• Lavington
• n.a.	• Gibraltar

3 RESULTS & DISCUSSION

Eighty-eight deer were captured over the two years of the translocation project (Table 3). Eight-five of these deer were translocated. In 2016, 63 deer were captured, of which 60 were transported and released. One deer died from acute aspiration while being carried from the capture site to the transport trailer; two others escaped the trailer while additional deer were being loaded. Most deer (n = 82, 93.2%) were captured by free-range darting. Clover trapping (six captures) was time consuming and less efficient for this project so was discontinued. In 2017, 25 deer were captured in Kimberley and Cranbrook, all by free-range darting.

The majority of deer captured were adults or young adults (n = 32 and 31, respectively; Table 4). Five deer considered aged were captured and translocated as well as 20 fawns. Three young adult bucks were translocated, all in 2016; two from Kimberley in 2016 (one darted, one captured in a Clover trap) and one from Elkford. An adult buck was also mistakenly darted in Elkford when shed antlers made distinguishing sexes more difficult. He was not translocated, but reversed on site after sampling. All other males translocated were fawns, captured with their mother.

Table 3: Summary of daily capture and translocation of urban mule deer from four municipalities in 2016.

	Cranbrook		Elkford	Invermere	Kimberley		
	Dart Gun	Clover			Dart Gun	Clover	Notes
2016							
16-Feb 2016					4	1	1 mortality
17-Feb 2016					7	1	
18-Feb 2016					6	2	
22-Feb 2016				5			
23-Feb 2016				6			
24-Feb 2016				3			1 escape
29-Feb 2016	4	2					
1-Mar 2016	2	0					1 escape
2-Mar 2016	5	-					Traps not set
8-Mar 2016			4				
9-Mar 2016			6				
10-Mar 2016			5				
Total 2016	**10**	**2**	**15**	**13**	**16**	**4**	60 translocated
2017							
6-Mar 2017					7		
7-Mar 2017	5						
8-Mar 2017	7						
9-Mar 2017					6		
Total 2017	**12**				**13**		25 translocated

* Clover trapping was only conducted in 2016 in Kimberley and Cranbrook.

Table 4: Summary of sex and age class of mule deer captured in 2016 and 2017 for translocation trial.

	Kimberley		Invermere		Cranbrook		Elkford		
Age Class	F	M	F	M	F	M	F	M	Total
2016									
Aged	1		1						2
Adult	7		6		6		8		27
Young adult	4*	2	7**		4**		3	1	21
Fawn	4	3			2	1	1	2	13
2016 total	*16*	*5*	*14*	*0*	*12*	*1*	*12*	*3*	*63*
2017									
Aged	2				1				3
Adult	4				1				5
Young adult	4				6				10
Fawn	2	1				4			7
2017 total	*12*	*1*			*8*	*4*			*25*
Total Captured	**28**	**6**	**14**	**0**	**20**	**5**	**12**	**3**	**88**
Total Translocated	**27**	**6**	**13**	**0**	**19**	**5**	**12**	**3**	**85**

* 1 individual died during handling.

** 1 individual escaped trailer prior to translocation

3.1 Capture

Deer were targeted opportunistically for free-range darting. Deer were only darted if they were on municipal land (including sidewalks and streets) or on private land where the landowner granted permission. Other factors taken into account prior to darting included: public safety (proximity of the public, especially children walking to school); proximity of major streets where darted deer might be at risk of injury during the induction period between darting and recumbency. Within municipalities, the preference was to target deer in high density housing areas as opposed to interface areas (more woodland, semi-rural areas on the periphery of communities). It was hypothesized that core area deer may be more habituated and less likely to migrate in summer away from the communities. This target was not always achieved. Given time and crew availability constraints, deer were targeted in peripheral interface areas when necessary.

The ability to dart deer was also constrained by landowner permission. Frequently deer were located on front lawns of private residences. Permission was always sought from the homeowner and was usually, but not always, granted. Most often, no one was home and the crew were unable to dart the deer. Acquiring permission was frequently moot because, while darters attempted to access the house for permission, the deer would be disturbed and move to an adjacent property before it could be darted. If translocation occurs again in the future, a process where landowners can "pre-approve" darting deer on their property would be very helpful. An arrangement that could work well is for municipalities to give landowners the option to grant permission via a checkbox (or similar) on annual property tax forms. A map could then be generated, giving field crews clear indication of which properties have approved darting, which have said "No thank you", and which properties have not answered.

Maps showing where deer were either darted or trapped in each municipality are provided (Appendix A: Capture Sites). Multiple individuals were captured at some locations, so the number of "dots" on maps does not necessarily correspond to Table 3.

In both years, most deer were assessed to be in "fair" body condition based on a subjective assessment of overall appearance and lumbar spine fat and muscle cover. Deer were generally in better condition in 2016 than 2017 (Table 5). This likely reflects the much more severe winter conditions of 2016/17 than 2015/16.

3.2 Release

Over two years, 85 deer were translocated, 47 with GPS radio collars (60 in 2016, 29 with GPS radio collars; 25 in 2017, 18 with GPS radio collars). Details of location and originating municipalities are provided in Table 6.

No injuries were observed when translocated deer were released. Deer appeared generally calm at release. Frequently, they were bedded down in the straw when the trailer door was opened, occasionally individuals had to be encouraged to leave the trailer. In most instances, they slowly walked away from the trailer, pausing to browse. Only once (February 23, 2016, deer from Invermere) did the released mule deer stot[3] away from the trailer and in this instance they only moved 10 to 20 m off the road before stopping. Most animals did not have the butorphanol (one of constituent BAM-II drugs) reversed with naltrexone to allow some degree of sedation to reduce stress during transport.

Table 5: Summary of body condition score by age class for all deer translocated in 2016 and 2017. Total number of deer handled in each age class is provided.

	Excellent	Good	Fair	Poor	Emaciated	# deer
2016						
Aged		1.7%			1.7%	2
Adult	3.3%	13.3%	25.0%	1.7%		26
Young adult	5.0%	11.7%	15.0%			19
Fawn		5.0%	13.3%	3.3%		13
Total	**8.3%**	**31.7%**	**53.3%**	**5.0%**	**1.7%**	**60**
2017						
Aged			8.0%	4.0%		3
Adult		4.0%	4.0%	12.0%		5
Young adult			28.0%	12.0%		10
Fawn			20.0%	8.0%		7
Total		**4.0%**	**60.0%**	**36.0%**		**25**

[3] Four-legged bounding exhibited by mule deer

Table 6: Number of mule deer from each participating municipality translocated to five different release sites in 2016 and 2017.

Originating Municipality	Release Site	Distance[1]	Nearest Community[2]	Dates	Total Deer	# Collars
Kimberley	Newgate T.S.	78 km	Baynes Lake: 15 km[3] Eureka, MT: 17 km[3]	Feb 16-18, 2016	20	7
	Gibraltar	77 km	Canal Flats: 23 km	Mar 6, 9, 2017	13	10
Elkford	Ram/Mt. Broadwood	82 km	Elko: 11.5 km	Mar 8-9, 2016	10	6
	Newgate T.S.	103 km	Baynes Lake: 15 km[3] Eureka, MT: 17 km[3]	Mar 10, 2016	5	2
Invermere	Lavington Flats	41 km	Canal Flats: 12 km	February 22-24, 2016	13	7
Cranbrook	Dorr Road	57 km	Baynes Lake: 11 km	Feb 29 - Mar 2, 2016	12	7
	Gibraltar	92 km	Canal Flats: 23 km	Mar 7, 8, 2017	12	8
Total					**85**	**47**

[1] Shortest straight-line distance between point of capture and release.
[2] Straight-line distance to nearest community.
[3] Across Lake Koocanusa.

3.3 GPS Collar Performance

The Vectronic Aerospace Inc. Vertex collars performed well. For deer surviving long enough to provide >100 locations, the Vectronic collars transmitted, on average, 89.1% of scheduled location fixes (SD = 8.0, range = 58.9% to 96.6%, n = 36 individuals). There were occasional instances of “false mortality alerts” where an alert was received, but a position was never transmitted and the collar reverted to transmitting “normal” locations at regularly scheduled 13 hour intervals. These individuals were assumed to be alive.

Conversely, the Lotek collars performed poorly, albeit with much smaller sample size; only six individuals were fitted with these collars. The Lotek collars successfully transmitted their location, on average, only 24.4% of the time (SD = 13.5, range = 4.2% to 39.0%). More data are available if the collar is recovered (deer dies or is recaptured), but these data are unavailable until then. Because of this poor performance, as well as the different location schedule (13 hour interval for Vectronic vs 23 hour interval for Lotek), only Vectronic collar data were used for most analyses. Lotek collars did provide some additional survival data for deer translocated in 2017, but even these were compromised by at least two collars that did not successfully transmit a mortality alert.

A total of 16,992 data locations were used for home range analyses for the 41 individual mule deer released with Vectronic GPS collars. These data ranged from first translocations on February 16, 2016 through June 30, 2017 when data collection was cut off for this report. Six deer fitted with Lotek collars released on March 8 and 9, 2017 provided 173 data points.

3.4 Movement

Movement of individual collared deer was highly variable (Figure 4). Movement generally increased in May, the typical mule deer migration period in the East Kootenay. Movement declined abruptly in mid-June when fawns were born. Movement increased again through late summer and autumn, without a clear, concentrated migration timing as was evident in the spring. Lowest movement rates occurred in winter. Using distance between consecutive 13 hour location intervals averaged over previous seven locations, spring migration movement of 2016-translocated deer dropped considerably between 2016 and 2017.

Individual variation is also shown in mean[4] monthly distance moved per day for each collared deer (Appendix B: Monthly Movement). These values ranged from 5.6 km/day to a low of 0.1 km/day over a one month period. The mean distance moved per month (31.8 km ± 12.8 SD) varied widely across individuals ranging from as low of 15.2 km per month (deer 20836) to a maximum of 78.0 km per month (deer 20834). The distance moved between consecutive 13 hour fixes summed across an entire month has limited biological value because it is only marginally indicative of total distance moved. However, it is a good relative indicator of the range of variation in movement shown by translocated deer. Some moved a lot, others very little.

Migration

Translocated deer showed a range of migratory behaviour. Three main categories of movement were defined:

- **Migratory**: deer showed typical seasonal home ranges, moving between them in spring and fall.
- **Non-migratory**: deer showed no difference in seasonal location, remaining (more or less) in the same area year-round.
- **Wandering**: deer typically showed one, often large, movement that was usually one-way and continued, sometimes with pauses for up to a few days, until a community was "found" where the deer stayed.

Three deer exhibited partial migratory behaviour. These individuals used different areas during different seasons, but did not show discreet use of seasonal ranges. They frequently moved between these areas, particularly during summer months. These deer were classified as either migratory (n=1) or non-migratory (n=2) depending on the degree to which they demonstrated a migratory pattern. This behaviour is not exhibited by non-urban deer. Non-urban mule deer either showed clear migration and discreet seasonal range use or did not migrate at all and maintained a single home range year-round.

There were clear differences in movement patterns across the four originating municipalities (Table 7). All seven GPS-collared deer from Invermere exhibited typical migratory behaviour. All deer from Invermere migrated to lower elevations in fall 2016 and all that survived to spring 2017 again migrated to summer range.

[4] "mean" is largely synonymous with "average"

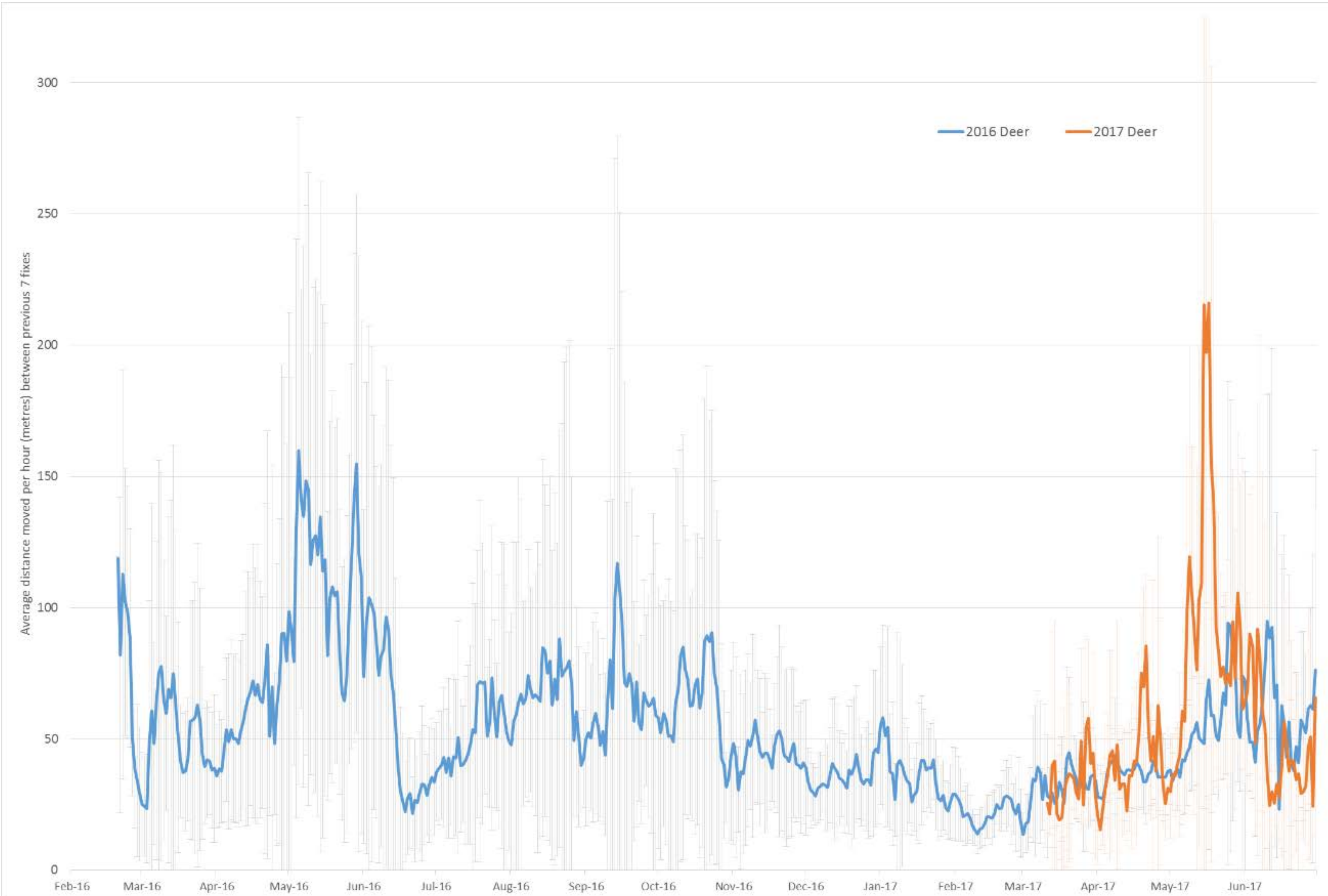


Figure 4: Moving 7-location average (±SD) of hourly distance (metres) between consecutive 13 hour GPS collar locations of mule deer translocated in 2016 (blue) and 2017 (orange). Number of deer contributing to each mean value changes daily based on number of deer alive and number of collars transmitting data.

Table 7: Number of GPS-collared mule deer surviving >60 days showing different migratory pattern.

Municipality Release site	Migratory	Non-Migratory	Wandering *	Total
Cranbrook				
Dorr Road	1	2	2	5
Gibraltar	1	3	3	7
Elkford				
Newgate T.S.		2		2
Ram / Broadwood	3		2	5
Invermere				
Lavington	7			7
Kimberley				
Gibraltar	1ɫ	4	4	9
Newgate Transfer Stn.		4	1	5
Total	**13**	**15**	**12**	**40**

ɫ Collar rarely transmits data. This deer appears to have migrated to higher elevations nearby but full extent of its movements is unknown.

* Deer had a significant (>50 km) one-way movement within 3 months of translocation then settled in a community, usually not its originating municipality.

Conversely, none of the deer translocated from Kimberley showed true migratory behaviour. Only one deer from Kimberley (deer 20666-17) translocated to the Gibraltar release point in 2017 showed partial migratory behaviour. This deer spent the majority of summer 2017 (through August) at higher elevations. However, she had repeated forays to the lower elevations near the release point during this time period. In 2016, five of the six deer from Kimberley surviving >60 days showed no movement from areas around Lake Koocanusa. The sixth was a “wandering” deer that moved to Libby, MT. All large movements shown by Kimberley deer were long distance wanderings that stopped as soon as the individuals discovered a new town (to Libby, Montana in 2016 and to Cranbrook or Kimberley in 2017).

Almost all wandering deer, once they reached a town, stopped their long distance movements. For example, deer 20664 who moved south to Libby, Montana, showed typical movement pattern of long distance wandering (Figure 5). Her core home range in Libby was barely one km^2 (164 of 174 location points; minimum convex polygon) from mid-July, 2016, through her death in late October, 2016. This pattern was consistently observed with other wandering deer that eventually settled in Yaak, Cranbrook (n = 3), Baynes Lake (n = 4)[5], Kimberley, Canal Flats, Fairmont Hot Springs and Wasa.

[5] One deer (20839) settled briefly in Baynes Lake, eventually moving on after three weeks. Another deer (20665) was re-captured and released west of Lake Koocanusa; she continued to wander, eventually settling in Yaak, MT. Two other deer moved to Baynes Lake in early October, 2016. One of these (20655) was injured and euthanized in November, 2016, the other (20654) was still in Baynes Lake as of August 31, 2017.

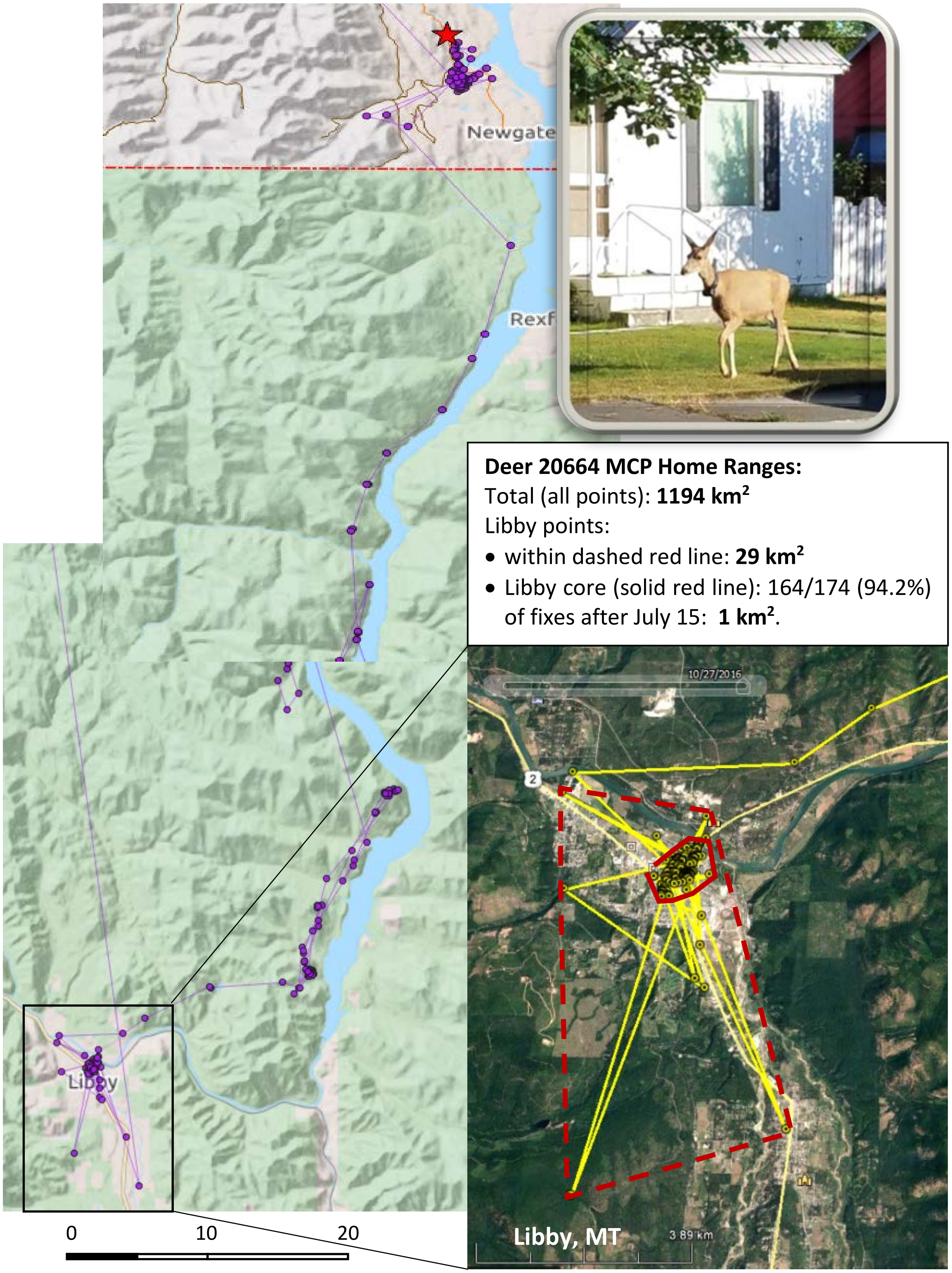


Figure 5: Location data for translocated deer 20664 (top right in Libby) from February 17 to October 27, 2016. Inset shows her locations in Libby, MT, from July 15 until her death (road mortality) October 27, 2016. Red star is Newgate Transfer Station release point. Anonymous photo provided by T. Chilton-Radandt, MT Fish & Wildlife.

Time spent wandering by deer exhibiting this behaviour was relatively short (Table 8). They tended to move relatively quickly from the general release site area until they found a community in which to stay. Mean number of days spent wandering was 13.8 (SD=9.1, range: 3 – 35 days, median = 10 days). In many of the longer wandering intervals, the individual spent several days in one location before moving on again. Only one individual (20839) was predated while wandering.

Table 8: Calendar date and number of days post-release that "wandering" deer initiated wandering movement away from generalized release area.

Collar	Year	Origin	Release Site / Settled	Period of wandering	Period of wandering days post-release (# of days wandering)
20834_17	2017	Cranbrook	Gibraltar to Canal Flats Canal Flats to Fairmont	May 4 – 25, 2017 Aug 2 – Aug 14, 2017	58 – 79 (21d) 148 – 160 (12d)
20658_17	2017	Cranbrook	Gibraltar to Wasa	April 23 – May 2, 2017 May 15 – 25 Aug 10 – 17	46 – 54 (8d) 68 – 78 (10d) 155 – 162 (7d)
20834	2016	Cranbrook	moved around Koocanusa area; predated near Dorr Rd[1]	March 11 - 14, 2016 May 1 to Oct 20, 2016	8 - 11 (3d) 59 – 232 (off and on)
20664	2016	Kimberley	Newgate Transfer Station to Libby, MT[2]	May 5 – May 18, 2016 July 11 – July 15, 2016	78 – 90 (12d) 145 – 149 (4d)
20660_17	2017	Kimberley	Gibraltar to Cranbrook	May 5 - 15, 2017	60 – 70 (10d)
20670	2016	Cranbrook	Dorr Road to Rexford, MT	March 2 - 15, 2016 May 7 – 26, 2016[3] Sep 9 – 19, 2016[3] July 6 – July 12, 2017[3] + several shorter forays	1 - 14 (14d) 67 – 86 (19d) 192 – 202 (10d) 492 – 498 (6d)
20663_17	2017	Kimberley	Gibraltar to Cranbrook	May 5 - 15, 2017	60 – 70 (10d)
20664_17	2017	Kimberley	Gibraltar to Cranbrook	May 5 - 15, 2017	60 – 70 (10d)
20665	2016	Elkford	Ram/Mt. Broadwood to Yaak, MT	March 20 – 29, 2016 Re-translocated April 26; April 27 – June 1, 2016	12 – 20 (8d) 49 – 84 (35d)
20661_17	2017	Kimberley	Gibraltar to Kimberley	March 29 – April 9, 2017 May 14 – June 7, 2017	23 – 34 (11d) 69 – 93 (24d)
36096_17	2017	Cranbrook	Gibraltar to Ft. Steele	April 17 – May 10, 2017	39 – 62 (23d)
20839	2016	Elkford	Ram/Mt. Broadwood – (predated near Canuck Ck)	March 20 – 29, 2016 April 20 – May 22, 2016	12 – 20 (8d) 43 – 75 (32d)

1 crossed (swam) Lake Koocanusa at least 15 times, "visited" Eureka, MT, three times, never stayed >3 days. Never settled in a town.

2 spent May 18 to July 11 on west side of Koocanusa northeast of Libby, MT. She may have given birth to a fawn which subsequently died. She never reported with a fawn in Libby.

3 travelled three times from Rexford Bridge area in Montana to Dorr Road release site, crossed Lake Koocanusa and travelled up Gold Creek to about the same place, then returned to Rexford, MT, area, re-crossing Koocanusa to the Dorr Road release site.

Post-release movement of both Elkford and Cranbrook deer showed a range of response to translocation. The only Cranbrook deer translocated in 2016 that showed migratory behaviour (20652) did not migrate to higher elevation. She remained near the Dorr Road release site through summer of 2016, then moved south to the Canada / USA border where she spent the winter in lower Phillips Creek near Roosville, BC. In spring 2017, she moved the short distance back north to the Elk River bridge along Highway 93, where she had spent the summer of 2016. She did not migrate back to Roosville/Phillips Creek in fall 2017. This movement is in contrast to non-urban mule deer in this area, all of which migrate eastward well into the Rocky Mountains, some as far as southwestern Alberta (see Section 3.6.1). Elkford deer showed the widest variation in movement. Some Elkford deer showed the greatest movements away from their release site, while others remained very close.

In all, 13 of 40 (32.5%) GPS-collared translocated deer exhibited migratory behaviour. The rest either did not migrate (17 of 40, 42.5%) or exhibited wandering behaviour where they kept moving until they found another community or died (10 of 40, 25.0%) (see Table 7).

Deer not moving significantly from their release site is not necessarily a negative outcome for translocation. Release sites were selected, in part, based on distance from potential conflicts with other communities and rural properties. However, many of the deer classed as "non-migratory" also found their way to nearby communities or rural properties.

Deer classified as Wandering were mostly captured in "urban" areas of originating municipalities as opposed to "interface" areas on the periphery of towns. Of the 12 deer classified as Wandering, ten were captured in urban areas (Table 9). This suggests that deer captured within a more urbanized setting may be more comfortable in these developed areas and more likely to move long distances in an attempt to find it again after translocation. Conversely, deer captured from interface areas are much closer to natural habitats on the edge of towns and more comfortable in wildlands following translocation. However, results do not suggest that deer captured in urban areas are more likely to wander in search of a town. The ten wandering deer originating from urban areas represent less than half of the total number (24) of collared deer captured in these more developed and higher housing density areas (Table 9). Thus any future translocation attempts should not seek to avoid capturing deer in urban areas. These areas are where deer – human conflicts are most common and where urban deer populations are in greatest need of reduction.

Many deer moved south into Montana. There were 22 GPS-collared deer released to sites south of Highway 3: Newgate Transfer Station, Dorr Road, and Ram-Mt. Broadwood. Of the 19 deer surviving >60 days, nine (47.4%) were in Montana at least once. Five of these nine deer established permanent home ranges in Montana. Two had to be destroyed by Montana Fish & Wildlife staff for aggressive behaviour and two more died in emaciated conditions (one was probably hit by a car). The fifth was killed in a vehicle collision on a bridge over Kootenai River in Libby, MT. Two deer remained alive in Montana as of August 31, 2017.

Table 9: Post-translocation migratory behaviour of mule deer captured in urban and interface settings for GPS-collared deer surviving >60 days.

Capture location	Migratory	Non-Migratory	Wandering	Total
Interface	6	8	2	16
Urban	7	7	10	24
Total	**13**	**17**	**10**	**40**

Capture location is not necessarily an accurate location of where that individual spends most of its time. For example, deer 20659, captured at Mt. Nelson Skate Park in Invermere, was classified as "urban" in origin. However, when she returned to Invermere in October, 2016, her subsequent locations throughout the winter were peripheral to this location and frequently west of Invermere in surrounding interface areas (Figure 6). Assuming her locations in winter 2016/17 are consistent with her range pre-translocation, this deer is clearly interface in origin. In Invermere, attempts to capture and translocate deer from core areas of town were unsuccessful due to difficulties in finding female mule deer in locations that were suitable for darting, or where permission had been granted.

The differences in migratory behaviour are also indicated by the range of elevation. Deer released to areas around Lake Koocanusa (Dorr Road and Newgate Transfer Station from Cranbrook and Kimberley, respectively (see Figure 1)) had lower ranges of elevations than elsewhere (Table 10; Appendix C: Migration & Range in Elevation). There were significant differences among ranges of elevation for deer released to different release sites in 2016 (1-way ANOVA: $F = 29.67$, $p < 0.001$). The only deer released to Dorr Road or Newgate Transfer Station that migrated was deer 20652 from Cranbrook; her migration was a short north-south movement at the same elevation.

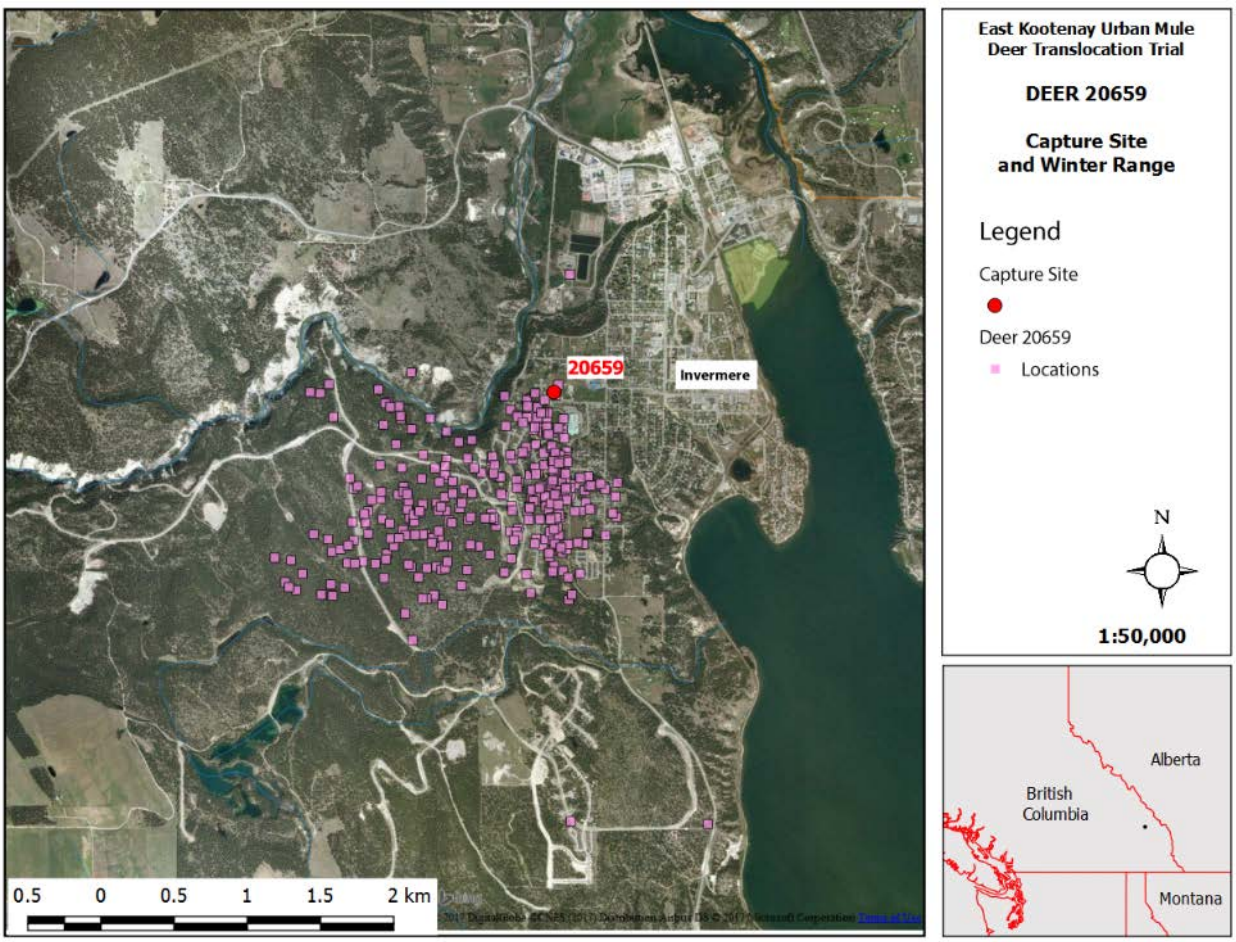


Figure 6: Capture location (Feb 23, 2016) and GPS collar locations from Oct 5, 2016 through May 19, 2017 for mule deer 20659 translocated from Invermere.

Table 10: Mean elevation range in metres (maximum elev. – minimum elev.) for mule deer translocated from municipality to release site. Standard deviation and number of individuals in parentheses.

Release site:	Cranbrook	Elkford	Invermere	Kimberley	Total
Dorr Road	627 (± 263.1; n=5)				627 (± 263.1; n=5)
Ram/Mt. Broadwood		1163 (± 136.5; n=6)			1163 (± 136.5; n=6
Lavington			1540 (± 212.4; n=7)		1540 (± 212.4; n=7)
Newgate Tfr. Stn.		286 (± 106.7; n=2)		530 (± 324.2; n=5)	460 (± 293.5; n=7)
Gibraltar	907.9 (± 208.7; n=5)			794 (± 119.4; n=6)	846 (± 167.6; n=11)
Total	767 (± 268.6; 10)	943 (± 424.0; 8)	1540 (± 212.4; n=7)	674 (± 261.1; n=11)	

The additional translocations to Gibraltar tested whether the differences in elevation range observed with 2016 translocations were a result of where the deer were released, or were indicative of possible behavioural differences among deer from the four originating municipalities. Results from 2017 translocation from Cranbrook and Kimberley to Gibraltar suggested there may be such differences, though not definitively. Elevation ranges among deer released to Gibraltar, Lavington and Ram/Mt. Broadwood also differed significantly (1-way ANOVA: $F = 31.74$, $p < 0.001$).

Settlement and Conflicts

Of the 40 deer surviving at least 60 days, 16 deer (40%) occurred in a town, nine deer (22.5%) occurred in rural areas and 15 deer (37.5%) remained in natural habitat (Table 11). Once translocated deer moved to a town or rural area, they usually stayed there. Only two of the 16 deer moving to a town did not stay, while three of the nine deer occupying rural areas moved on. The two deer that returned to Invermere (via very different routes and timeframes) were unique cases in that both subsequently demonstrated natural migratory behaviour, leaving town in spring 2017 for high elevation summer range. More than any of the four communities, the District of Invermere is situated directly on prime mule deer winter range, so movement of mule deer to this town in the fall is to be expected.

Table 11: Summary of translocated mule deer numbers that moved to communities, rural areas or neither and the number of public complaints received. Number of deer generating complaints in parentheses.

	Cranbrook		Elkford		Invermere	Kimberley		
Location Stayed on not	Dorr Road	Gibraltar	Ram/B'wood	Newgate T.S.	Lavington	Newgate T.S.	Gibraltar	Total
in town	**2 (1)**	**2 (1)**	**3 (2)**	**1 (1)**	**2**	**2 (1)**	**5 (1)**	**16 (7)**
Eventually moved on			1 (1)					1 (1)
moved on	1							1
Stayed	1 (1)	2 (1)	1 (1)	1* (1)		2 (1)	5 (1)	12 (6)
winter only					2			2
rural	**2**	**1**	**2**	**1**		**3**		**9 (1)**
Eventually moved on			1					1
moved on	1		1					2
stayed	1	1		1		3 (1)		6 (1)
Never in town/rural	**1ǂ**	**4**	**1**	**0**	**5**	**0**	**5**	**15**
Complaint received	**1**	**1**	**2**	**1**	**0**	**2**	**1**	**8**
Total	**12**		**7**		**7**	**14**		**40**

* one deer (20840) was destroyed by Montana wardens for aggressive behaviour toward humans within 36 hours of arriving in Eureka, MT.
ǂ this deer (20661) died barely over the 60 day survival minimum for data inclusion.

Several other deer passed through rural areas and town without staying. Four deer moved to a rural areas or town, but moved on within three days while another two deer stayed longer, but did eventually move on. Only seven of 24 deer translocated in 2016 that survived >60 days were not known to relocate or pass through a community or rural property. Four of these six originated from Invermere, and one each from Cranbrook and Elkford. Ten moved to towns or rural areas and stayed, another two overwintered in Invermere. Of the 16 GPS-collared deer translocated in 2017 surviving >60 days; eight (50%) moved to towns or rural areas and all of them stayed.

The difference in time-since-translocation affected this summary. Deer translocated in 2016 have had an additional year to move and find communities. Many of the 2016 deer were not located in a town or rural area until the fall of 2016 or later. One deer, 20670, repeatedly passed through communities and rural areas in BC and Montana for over one year. Only since mid-June, 2017 (more than 15 months after translocation), was she primarily in Rexford, MT, a community she passed through several times before settling there.

Kimberley deer in particular seemed to be drawn to communities. Of the 14 collared deer from Kimberley that survived over 60 days, seven (50%) moved to a town and all stayed. Another three remained in rural areas. The four Kimberley deer that never moved to a town or rural area were all 2017 translocations to Gibraltar in 2017, three of which were alive as of August 31, 2017.

Conversely, Invermere deer almost all stayed away from towns and rural properties. As discussed, two of seven found their way back to Invermere for winter range, but the other five were never located in towns. One was briefly near a rural property, but soon moved on.

Cranbrook and Elkford deer were more varied, with deer showing a wide range of response. However, both communities only had one deer in 2016 that was never located in either a town or rural area. The one deer from Cranbrook was predated right at the 60 day threshold so she never had a full opportunity to move to a community or rural property. This was the only deer released in the Koocanusa area (Newgate Transfer Station and Dorr Road) that was not recorded in either a community or rural property.

Formal complaints were received on eight translocated deer (Table 12). Five of the complaints were regarding deer classified as “non-migratory”, the other three were on “wandering” deer. No complaints were received regarding deer translocated without a collar. Collars are obvious on deer and make them clearly stand out from other individuals. All translocated deer were ear-tagged, but tags were not always highly visible. The extent to which people may be more likely to complain about a collared deer because it was immediately recognized as “different” and assumed to be a habituated translocated urban deer is unknown, but potentially significant.

Table 12: Summary of complaints received on translocated urban mule deer according to which release site they were translocated. Percentage of deer released to each site generating a complaint in parentheses.

	Complaint received?	
Release site	No	Yes
Dorr Road	4	1 (20%)
Newgate Transfer Station	4	3 (42.9%)
Ram / Mt. Broadwood	3	2 (40%)
Lavington	7	0
Gibraltar	14	2 (12.5%)

Detailed information on each collared deer, including whether they have encountered a town or rural area, the general area in which they have occurred, and their fate as of August 31, 2017 is included in Appendix D: Settlement and Complaints.

Translocated deer avoiding conflict was a key criterion for success of the translocation trial. Although zero encounters and complaints cannot be expected, the Newgate Transfer Station and Dorr Road release sites south of Highway 3 (and, to a lesser extent, Ram/Mt. Broadwood) appear to have been too close to attractants for translocated deer that are even partially habituated to human presence. The significant movements by several deer from the Gibraltar release point in 2017 suggest that no possible release point is far enough away from communities to eliminate the potential of translocated deer wandering in search of developed areas. Thus, any future translocation of urban deer in the East Kootenay must include some plan to address habituated deer moving to other communities.

Home Range

The Brownian Bridge 95% kernel home ranges reported here include GPS collar data from all Vectronic collars from translocated deer surviving >60 days. Data are for the time period from the individual's translocation up to June 30, 2017 (Table 13). Home range area reported here include combined 95% home range polygons for individuals that had multiple home ranges indicated at the 95% kernel level (see individual maps available online via link in Appendix E: Home Range Maps).

Mean home range area did not differ statistically among originating municipalities for 2016-translocated deer (F= 0.79, p = 0.513) (Figure 7). The large standard deviations (error bars) relative to mean values indicate the wide variation in home range size among individuals.

Deer released to Newgate Transfer Station and, to a lesser extent, Dorr Road tended to have smaller home ranges than those released elsewhere. However, mean home range size did not differ statistically depending on where deer were released (F= 1.93, p = 0.130) (Figure 8).

There were significant differences in home range area depending on post-release behaviour of the deer, with "wandering" deer having much larger home ranges, at least while they were wandering (F= 25.99, p < 0.001) (Figure 9). However, home range size of wandering deer should be considered temporary and an artefact of their search for a community in which to settle. Once in a community, they maintained very small home ranges (see Figure 5).

Table 13: Brownian Bridge 95% home range area (km^2) for translocated mule deer surviving >60 days from release through June 30, 2017. Days surviving and fate as of June 30, 2017 also given. Rows sorted by home range area.

Collar	Year	Origin	Release site	Movement pattern	Area (km^2)	Days alive to 2017-06-30	Fate at 2017-06-30
20658	2016	Kimberley	Newgate T.S.	Non-Migratory	30.5	255	dead
20655_17	2017	Kimberley	Gibraltar	Non-Migratory	32.7	116	alive
20838	2016	Elkford	Newgate T.S.	Non-Migratory	35.1	477	alive
20666_17	2017	Kimberley	Gibraltar	Non-Migratory*	45.3	116	alive
20835_17	2017	Cranbrook	Gibraltar	Non-Migratory	45.6	115	alive
20840	2016	Elkford	Newgate T.S.	Non-Migratory	47.0	81	dead
20836	2016	Elkford	Ram/Mt. Broadwood	Migratory	64.5	372	dead
20657	2016	Kimberley	Newgate T.S.	Non-Migratory	70.2	498	alive
20662	2016	Kimberley	Newgate T.S.	Non-Migratory	71.3	554	dead
20667	2016	Invermere	Lavington	Migratory	72.1	276	dead
20661	2016	Cranbrook	Dorr Road	Non-Migratory	84.1	59	dead
20652	2016	Cranbrook	Dorr Road	Migratory	84.3	485	alive
20654	2016	Cranbrook	Dorr Road	Non-Migratory	86.7	487	alive
20655	2016	Kimberley	Newgate T.S.	Non-Migratory	91.7	278	dead
20659	2016	Invermere	Lavington	Migratory	102.4	493	alive
20840_17	2017	Cranbrook	Gibraltar	Migratory	105.4	115	alive
20656	2016	Invermere	Lavington	Migratory	105.5	474	dead
20834_17	2017	Cranbrook	Gibraltar	Wandering	114.6	115	alive
20839_17	2017	Cranbrook	Gibraltar	Migratory*	116.5	115	alive
20841	2016	Elkford	Ram/Mt. Broadwood	Migratory	126.4	478	alive
20835	2016	Elkford	Ram/Mt. Broadwood	Migratory*	130.8	303	dead
20653	2016	Invermere	Lavington	Migratory	142.9	451	dead
20658_17	2017	Cranbrook	Gibraltar	Wandering	144.3	114	alive
20834	2016	Cranbrook	Dorr Road	Wandering	144.9	350	dead
20664	2016	Kimberley	Newgate T.S.	Wandering	144.9	253	dead
20660_17	2017	Kimberley	Gibraltar	Wandering	153.5	116	alive
20669	2016	Invermere	Lavington	Migratory	169.2	494	alive
20668	2016	Invermere	Lavington	Migratory	173.8	494	alive
20671	2016	Invermere	Lavington	Migratory	174.6	108	dead
20670	2016	Cranbrook	Dorr Road	Wandering	180.8	486	alive
20663_17	2017	Kimberley	Gibraltar	Wandering	188.3	116	alive
20664_17	2017	Kimberley	Gibraltar	Wandering	192.2	116	alive
20665	2016	Elkford	Ram/Mt. Broadwood	Wandering	236.2	331	dead
20661_17	2017	Kimberley	Gibraltar	Wandering	298.5	116	alive
36096_17	2017	Cranbrook	Gibraltar	Wandering	300.2	136	dead
20839	2016	Elkford	Ram/Mt. Broadwood	Wandering	315.3	74	dead

* Partially migratory

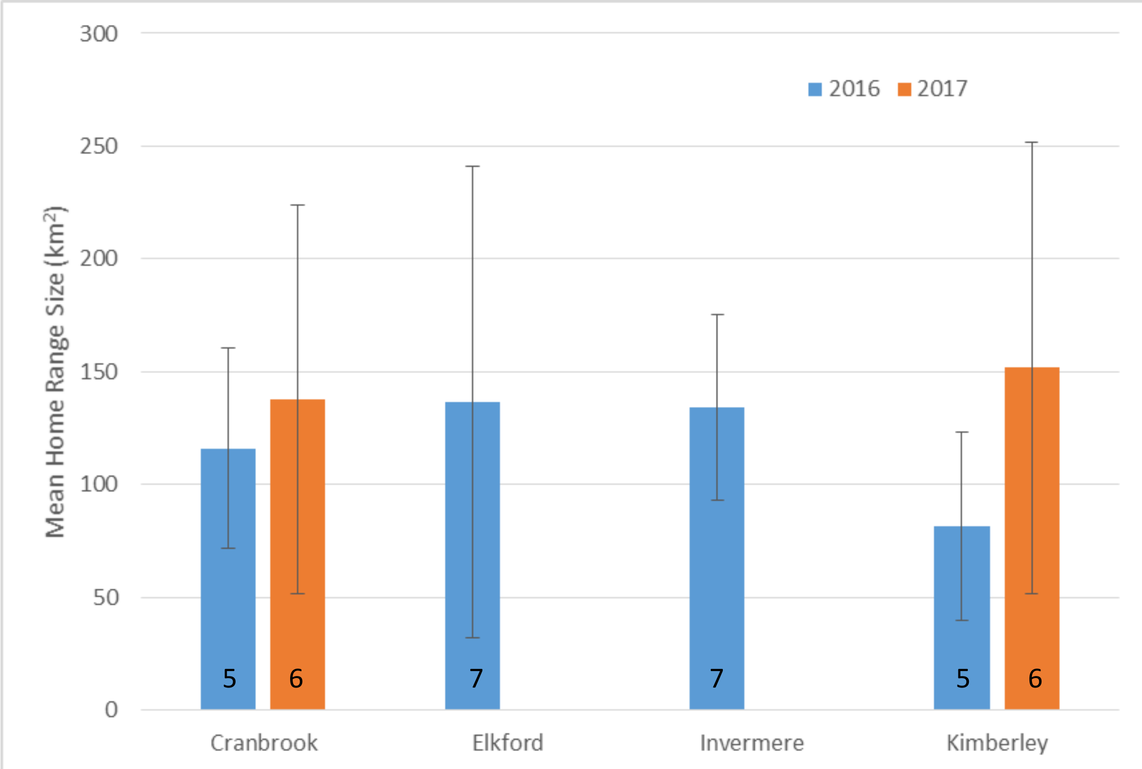


Figure 7: Mean home range size (± SD) for GPS-collared mule deer translocated from four different municipalities in 2016 (blue) and 2017 (orange). Sample size for each mean (number of collared individuals surviving > 60 days) are shown. There is no significant difference among the 2016 mean values.

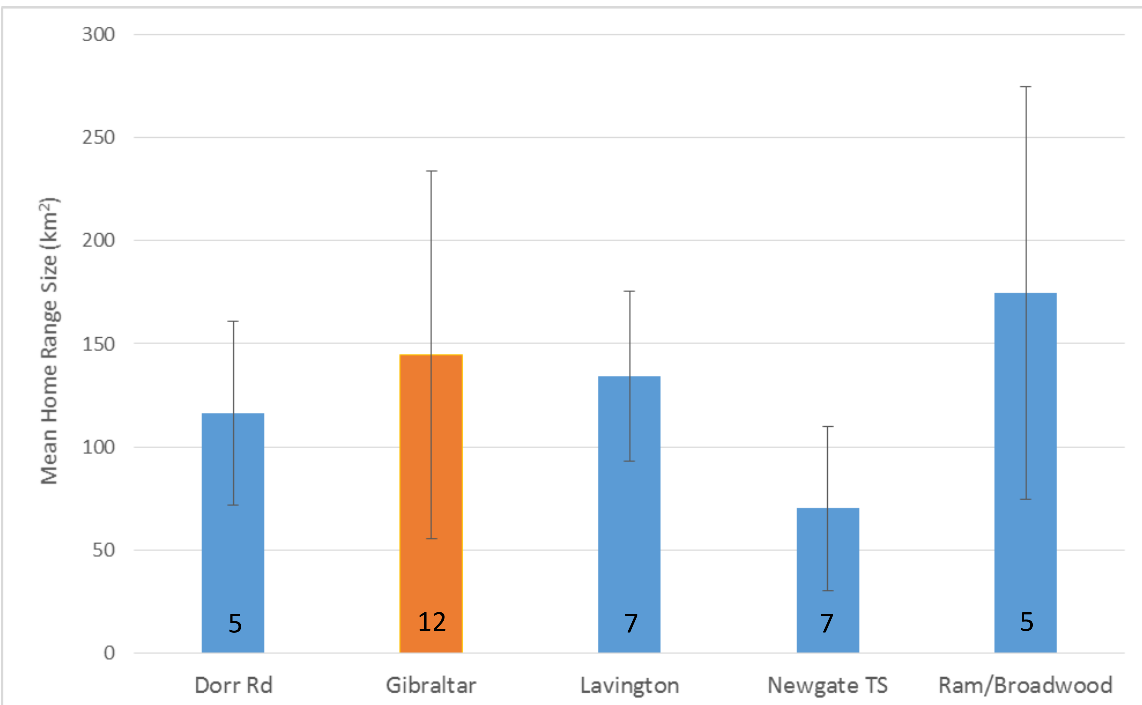


Figure 8: Mean home range size (± SD) for GPS-collared mule deer translocated to five different release sites in in 2016 (blue) and 2017 (orange). Sample size for each mean (number of collared individuals surviving > 60 days) are shown. There is no significant difference among these means.

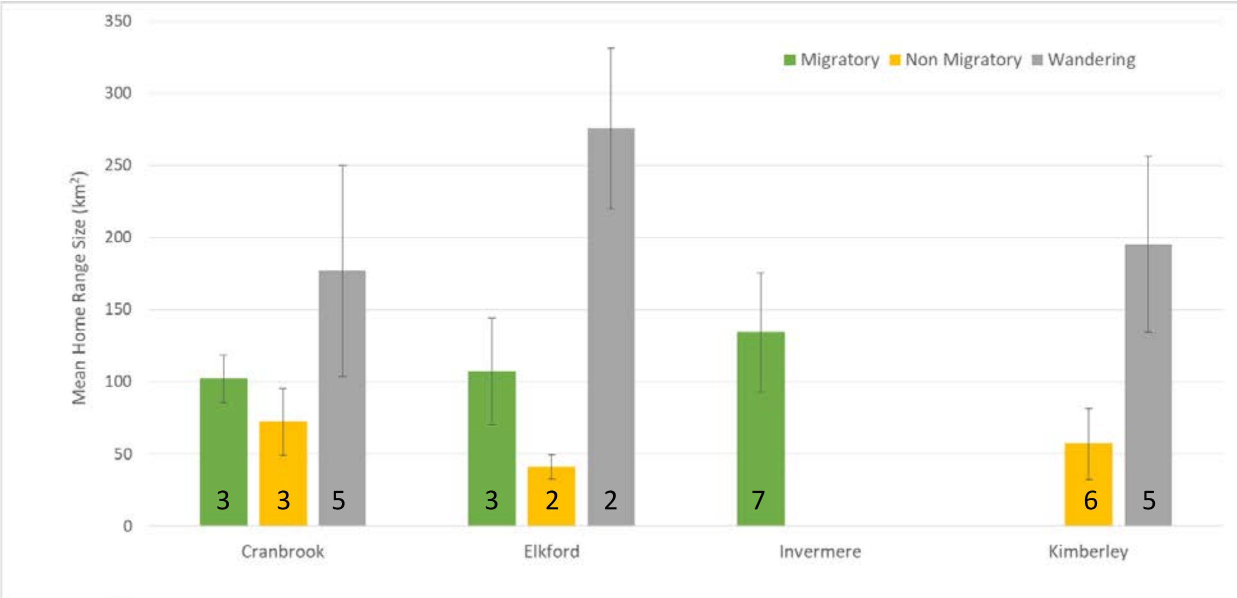


Figure 9: Mean home range size (± SD) categorized by migratory status for GPS-collared mule deer translocated from four different municipalities pooled across 2016 and 2017. Sample size for each mean (number of collared individuals surviving > 60 days) are shown. Means differed significantly among migratory status pooled across originating municipality.

3.5 Mortality

Kaplan-Meier annual survival rate for radio-collared deer translocated in 2016 and 2017 combined was 51.1% (95% C.I. range: 27.9 – 74.4%) for the biological year May 1, 2016 through April 30, 2017. A biological year is commonly used to report survival to facilitate comparisons with other mule deer populations and maintain consistency across studies. Kaplan-Meier analyses permits open populations with regular addition of new study individuals. Thus the influx of several newly translocated deer in March, 2017 does not affect this survival estimate.

A comparison of raw percent survival of collared deer through August 31 of their respective years, showed 2016 and 2017 were virtually identical: 71.4% surviving (20 of 28 collared deer with a known fate) through August 31, 2016 and 72.2% surviving (13 of 18 collared deer with a known fate) through August 31, 2017. This suggests survivorship in the initial six months (approximately) post-release is fairly consistent. Full details of individual deer fates, including number of days surviving post-release are provided in Appendix F: Mortality and Individual Fates through August 31, 2017.

The fate of most deer translocated without a collar (n = 38 over two years) is unknown. Notice of three deaths was received through August 31, 2017: two bucks legally hunted in Montana in fall of 2016 and one buck found dead in Fernie in February, 2017 (Table 14).

Table 14: Details of known mortalities, translocated mule deer including non-collared deer, through August, 2017.

Collar	Date	Cause	Certainty	Notes
20665	22-Feb-16	cougar	confirmed	Partially buried by cougar.
20660	15-Mar-16	cougar	probable	Difficult to recover, sign and location suggestive of cougar.
20663	1-Apr-16	cougar	probable	Dragged into culvert under road.
20666	7-Apr-16	cougar	confirmed	Cougar sign in area.
20661	28-Apr-16	cougar	confirmed	Very recent, partially buried.
20839	21-May-16	bear	very probable	Abundant bear sign in area, very little of deer consumed.
20840	30-May-16	destroyed	confirmed	Shot by Montana wardens following complaints of aggressive behaviour.
20671	10-Jun-16	wolf	probable	In Purcell Conservancy, located after 1 week, little left of carcass, collar damaged.
20664	27-Oct-16	roadkill	confirmed	Hit on bridge over Kootenai River in Libby, MT.
20658	28-Oct-16	emaciated	possible	Emaciated, very old, tip of tongue mostly severed.
2015-born buck (no collar)	10-Nov-16	hunting	confirmed	Hunter report using phone number on ear tag after legal hunt kill in Montana.
20655	21-Nov-16	euthanized	confirmed	Euthanized by Conservation Officer in Baynes Lake. Could not get up from unknown injury.
2015-born buck (no collar)	Late Nov-16	hunting	confirmed	Hunter report using phone number on ear tag after legal hunt kill in Montana.
20667	24-Nov-16	emaciated	possible	Older deer, very thin, rumen full of needles.
20835	5-Jan-17	emaciated	possible	Moved little in final 4 days, fawn seen nearby in good condition.
20665	3-Feb-17	euthanized	confirmed	Highly habituated deer in Yaak, MT. Hand-injected with BAM, then euthanized.
20834	15-Feb-17	cougar	probable	Predated in deep snow near Koocanusa.
Young adult buck (no collar)	21-Feb-17	road kill	probable	Found dead in Fernie by Conservation Officer.
20836	15-Mar-17	unknown	unknown	Deer spent winter on Mt. Broadwood outside typical winter range. Found highly scavenged.
20667_17	8-Apr-17	cougar	very probable	Sign of chase down creek gully; carcass buried with snow and dirt.
36093-17	21-Apr-17	cougar	very probable	Delayed recovery of collar. Scavenged, but signs of initial cougar kill.
20653	18-May-17	wolf	probable	Scattered remains, collar intact but head not found. Killed while migrating to summer range.
35831_17	1-Jun-17 *	predation	possible	No mortality notification, body largely decomposed and/or scavenged.
36092_17	8-Jun-17 *	predation	possible	No mortality notification, body largely decomposed and/or scavenged.
20656	10-Jun-17	drowning	very probable	Collar stopped transmitting June 10, transmitted mortality signal mid-August, found decomposed in log jam alongside Findlay Ck.
36096_17	22-Jul-17	train kill	confirmed	Reported injured beside tracks near Fort Steele, euthanized by Conservation Officer.
20662	23-Aug-17	road kill	probable	Found in ditch beside rural road in Montana. Emaciated.

* Mortality date approximate, no alert received.

Table 15: Number of deaths attributed to each mortality class (predation, human-caused or other) and specific cause attributed to each death of GPS-collared translocated mule deer.

Mortality Class Cause	Number of deaths
Predation	**11**
bear	1
cougar	8
wolf	2
Human	**6**
roadkill	2
injured	1
problem	2
railway	1
Other	**7**
unknown	3
drowned	1
emaciated	3
Total	**24**

Mortality causes were attributed to one of three classes: predation (n= 11), human-caused (n=6) or unknown (n=7) (Table 15). Within each class, specific cause of death was identified wherever possible. Probability of the assigned cause of death is provided in detailed summary of mortalities (see Table 14).

Predation was the most prevalent cause of death, with cougars being responsible for eight of 11 confirmed predations. There were also two predations by wolf and one by a bear (probably black bear). An additional two predations are suspected to have occurred in 2017, but cause of death could not be identified because of mortality notification failure on Lotek collars.

Two deer were killed by vehicles. One road mortality (deer 20664) occurred on the bridge over Kootenai River in Libby, Montana, the other (deer 20662) was probably hit by a vehicle in the West Kootenai[6] region of Montana, immediately south of Newgate, BC on the western side of Lake Koocanusa. This deer was also deemed to be emaciated and in very poor condition, which may have contributed to her death. Three other deer were considered emaciated based on their lack of fat reserves upon necropsy and visual assessment of femur bone marrow (clear, liquid).

Two deer were destroyed in Montana by State Fish & Wildlife officials. One of these (deer 20840) had moved to Eureka, MT, in late May, 2016 and was aggressively chasing people. The other deer (deer 20665) wandered until settling in Yaak, MT, where she became highly habituated and occasionally aggressive. She was hand-injected with a dose of BAM-II and then euthanized.

The three unknown mortalities were not recovered before decomposition and/or scavenging eliminated sign necessary to assess cause of death. One death occurred in late winter in a location that was not safe to access; the other two were a result of faulty mortality notification on collars. The collar signal for the

[6] The West Kootenai area of Montana is not the same at all as the West Kootenay region of British Columbia.

deer assumed to have drowned (deer 20656) disappeared June 10, 2017. A mortality alert was received in mid-August, 2017 and the decomposed remains of the deer, her ear tag and collar were found in and around a log jam on Findlay Creek several kilometres downstream from her locations prior to the loss of the collar's signal.

There was no evidence that the severe winter of 2016-17, particularly the deep snow levels in February / March 2017, negatively impacted the translocated deer. One deer (deer 20834) was killed by a cougar in deep snow on the east side of Lake Koocanusa and another deer (deer 20836) died in mid-March. This latter deer spent the entire winter on the north face of Mt. Broadwood, which is not considered mule deer winter range. Her death was likely due, at least in part, to her inability to locate appropriate winter range. Most other deer translocated in 2016 that were outside communities moved to mule winter range, characterized by steep, south-facing slopes with good browse and forage opportunities.

Survival of deer was not affected by body condition score (BCS) at point of capture (Chi-square = 3.146, p = 0.370); note that "Emaciated" was omitted from the Chi-square test due to the zero numerator and minimal sample size. Neither was there any relationship between mortality and whether the animal was classified as an "adult" or "young adult" (Chi-square = 2.788, p = 0.248). However, there was a trend toward deer in poor and fair condition dying sooner than deer in better condition. Also, deer classified as "aged" died sooner than younger age classes of deer (Table 16).

Table 16: Fate (to August 31, 2017) of translocated mule deer corresponding to body condition score (BCS) at time of capture, migration status, release site and age class.

Factor	Alive	Dead	Total	Mean Days survived by deer that died (± SD)
Body condition				
Emaciated	0	1	1	6
Poor	6	2	8	75 (± 22.6)
Fair	11	13	24	158 (± 133.2)
Good	3	6	9	325 (± 211.4)
Excellent	2	2	4	265 (± 16.3)
Age class				
Young adult	11	9	20	261 (± 196.4)
Adult	11	11	22	196 (± 136.4)
Aged	0	4	4	43 (± 35.7)
Release site				
Dorr Rd	3	4	7	112 (± 160.1)
Lavington	3	4	7	327 (± 170.8)
Newgate T.S.	2	7	9	211 (± 187.4)
Ram	1	4	5	270 (± 133.7)
Gibraltar ǂ	13	5	18	74 (± 41.8) ǂ
Migration*				
Migratory	7	6	13	330 (± 134.2)
Non-migratory	9	8	17	217 (± 176.5)
Wandering	6	4	10	198.5 (± 115.4)

* Only for deer surviving > 60 days.
ǂ Deer translocated in 2017 have one full year less of post-release time

Release site also did not significantly affect deer survival (Chi-square = 0.137, p = 0.934), though deer released to Dorr Road and Newgate Transfer Station tended to die sooner than deer released to Ram/Broadwood and Lavington. Note the large standard deviations around these means (Table 16) indicating wide individual variation in the length of time.

Migration pattern following release also did not significantly affect mortality (Chi-square = 8.348, p = 0.080). Overall survival was roughly the same across the three migratory patterns (Migratory, Non-migratory and Wandering). However, deer that wandered until they either found another community or died, and non-migratory deer, tended to die sooner than migratory deer. This finding is noteworthy because most non-urban mule deer mortalities occur during spring migration (P. Stent unpubl. data).

In summation, there was no clear single-cause predictor of what might place translocated deer at higher risk of mortality following translocation. Given the wide range of causes of death, this lack of determinant risk factor is logical. There may be a more detailed interaction among these parameters that could predict which deer are at greatest risk of mortality, however more detailed analyses have not be completed.

Deer dying by predation tended to be killed sooner than other causes. On average, deer dying from predation did so within three months of release (Table 17). Eight of the 11 predation deaths occurred in the first 75 days after translocation. There was significant difference among mean number of days surviving for deer among mortality class (F = 4.28, p = 0.030). This analysis excluded two collared deer translocated in 2017 (deer 35831-17 and deer 36092-17) whose death was estimated at 68 and 91 days, respectively, but whose collars did not transmit a mortality alert, resulting in an undetermined cause and date of death.

Both deaths were likely due to predation given the season and their location, but cause could not be assigned with any probability. This result suggests that translocated urban deer may be at slightly increased risk of predation during their initial post-translocation period.

The time of year that translocations occurred likely also contributed to deer dying by predation sooner. Most predation of non-urban mule deer occurs during April and May during spring migration (see Section 0 Mortality below). Because translocation occurs in late winter, this puts deer at an immediate risk of increased predation when they start moving either as a natural migration movement or a post-release exploration.

Table 17: Mean number of days survived by GPS-collared deer whose death was attributed to predation, human-caused or other. Deer with unknown cause of death (Table 15) not included.

Mortality Class	Mean Days surviving (± SD, number of deer)
Predation	110 (± 148.2 n = 11)
Human	272 (± 166.4 n = 6)
Other	327 (± 99.9 n = 4)

3.6 Comparison with Non-urban Mule Deer

Between December 2014 and early April 2017, 95 non-urban mule deer (Koocanusa East: 36; Koocanusa West: 31; Columbia West: 28) were fitted with GPS radio collars and monitored by FLNRO. The number of deer used in analyses below varies as not all deer recorded sufficient data to calculate reliable home range polygons or survival analyses. As of mid-February 2016, when the translocation trail began, there were 64 mule deer fitted with GPS collars transmitting data. Over the course of the translocation trial, through August 31 2017, an additional 22 deer were captured and fitted with GPS collars.

Movement

There were clear differences in movement patterns between translocated and non-urban mule deer. Non-urban mule deer were much more likely to migrate (84.7% of 76 deer used for analyses were migratory) and never showed the wandering pattern observed in some translocated deer (Figure 10).

Migration

Non-urban deer migrated in a predominantly east-west direction from winter range in or near the Rocky Mountain Trench to higher elevation summer range in the Rocky Mountains (Koocanusa East), McGillivary Mountains (Koocanusa West) or Purcell Mountains (Columbia West) (Figure 11). Mule deer translocated from Invermere to Lavington largely followed this same pattern (Figure 11A), while mule deer translocated to sites east of Lake Koocanusa were more random in their migration pattern (Figure 11B) and mule deer translocated to Newgate Transfer Station west of Lake Koocanusa did not migrate at all (Figure 11C).

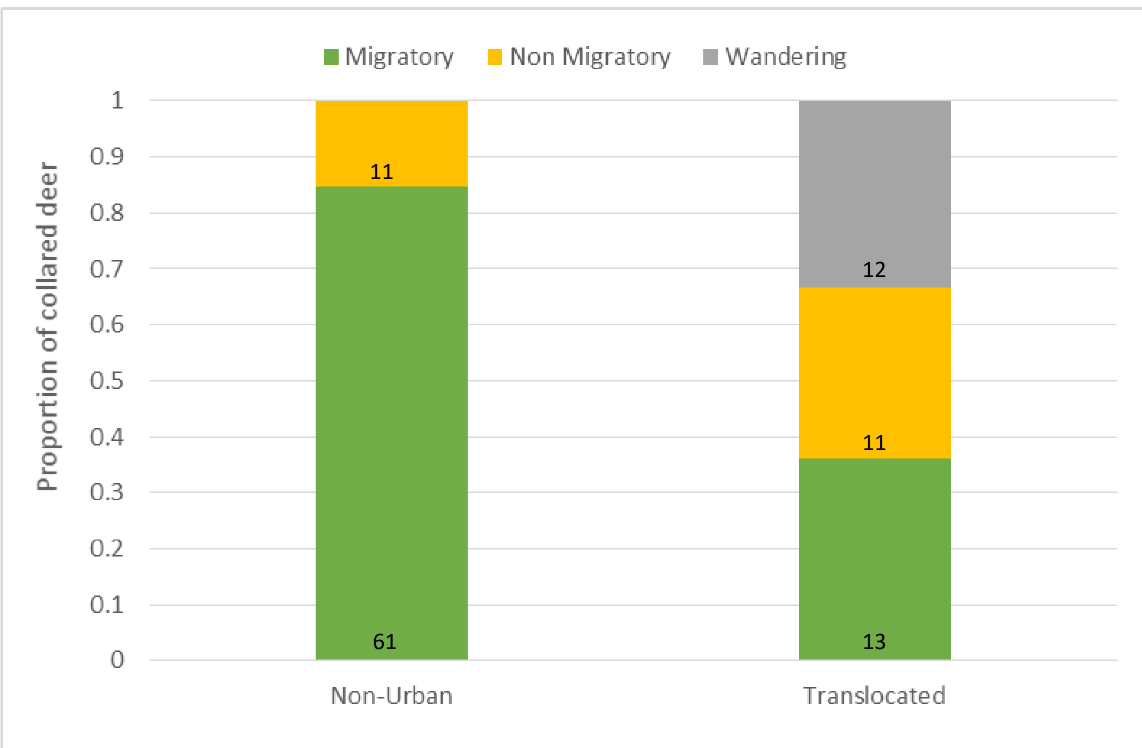
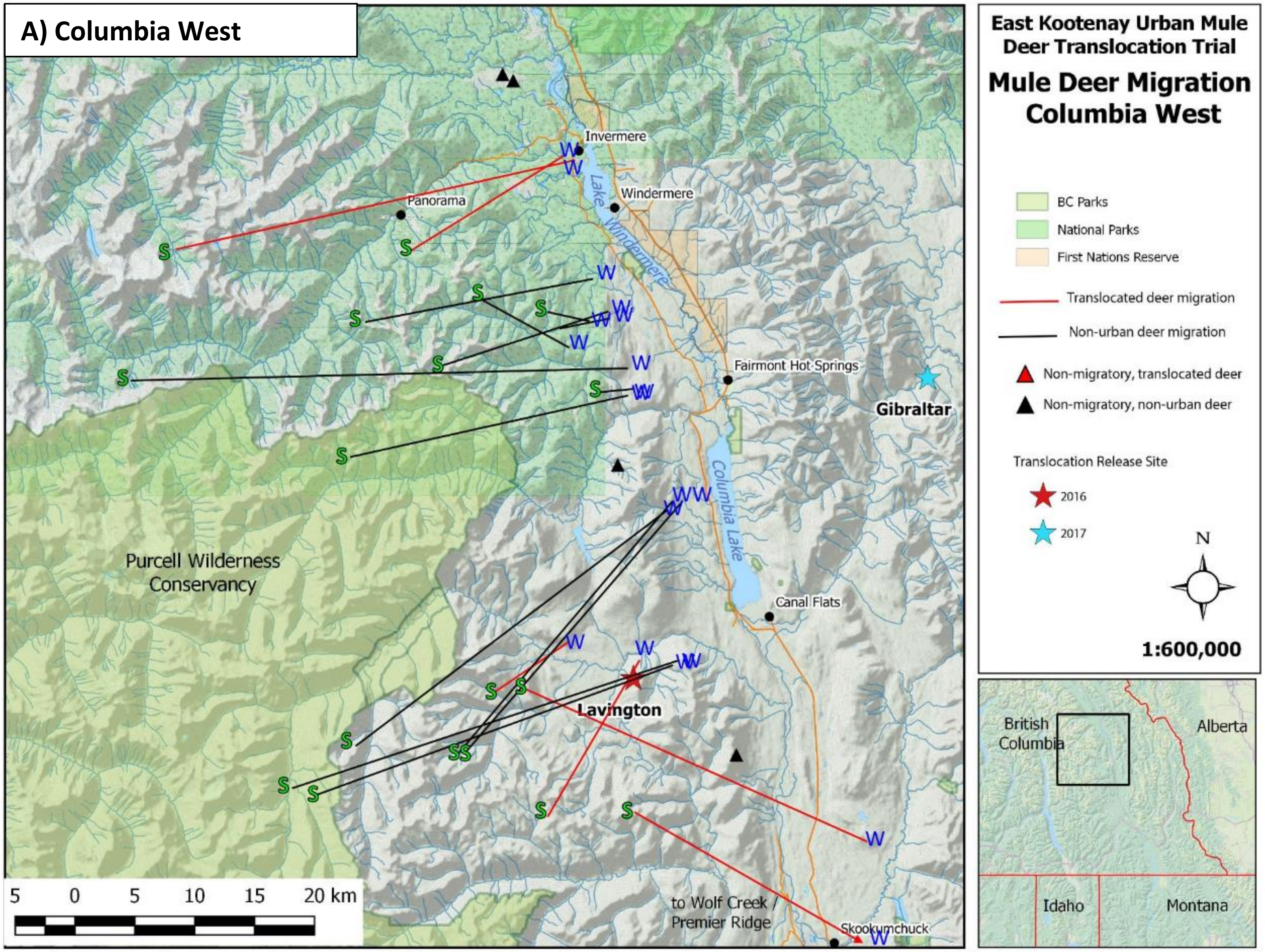


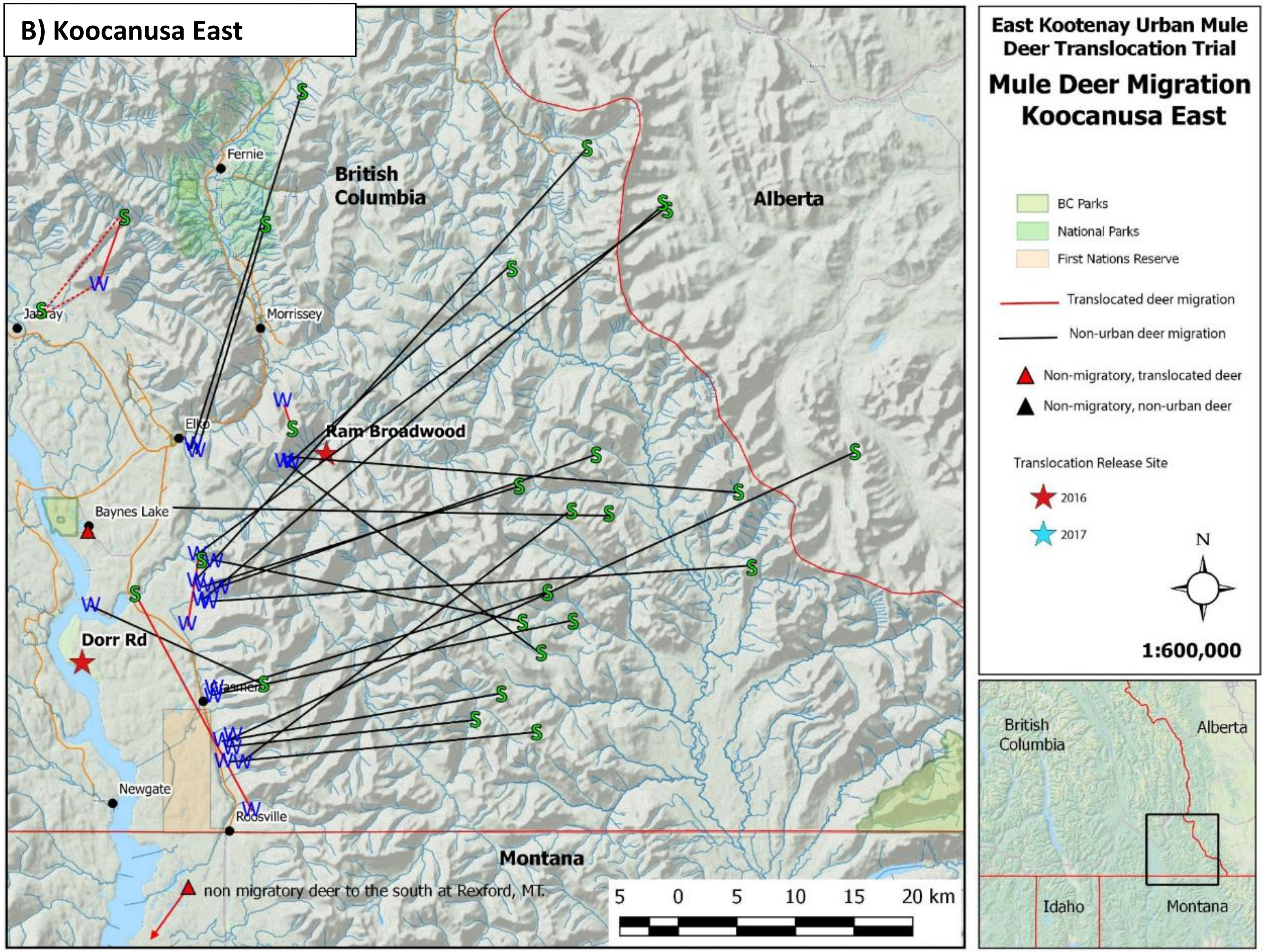
Figure 10: Proportion of collared mule deer classified as migratory, non-migratory or wandering in two concurrent projects in the East Kootenay region. Total number of deer indicated for each group.

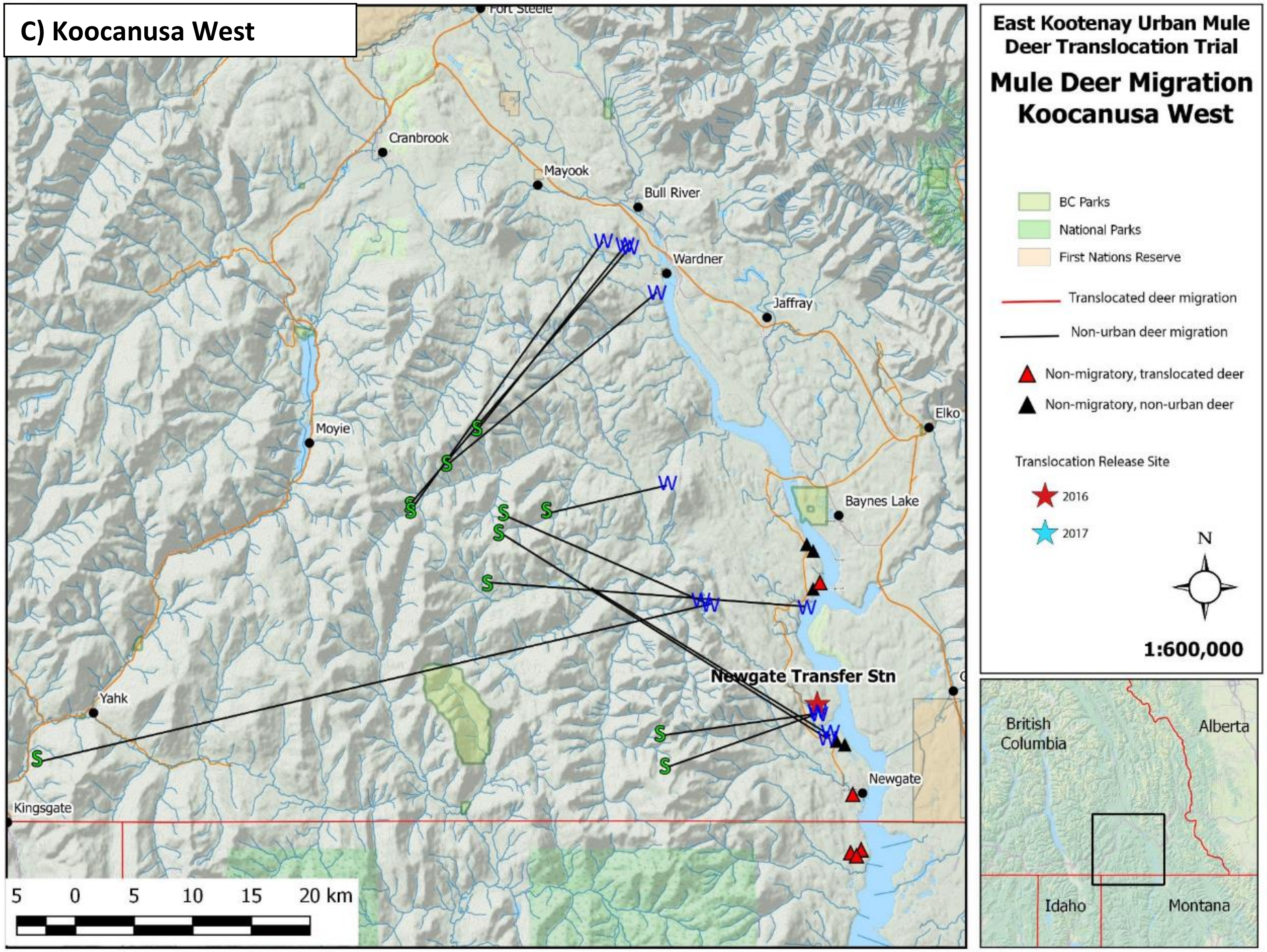
Overall differences between translocated and non-urban mule deer were most pronounced for deer east of Lake Koocanusa. All non-urban deer in this group migrated in an eastwardly direction. Some moved significant distance from their winter range in the Galton Range[7] as far east as Alberta across the Continental Divide. One deer west of Koocanusa was also a long distance migrant, moving from winter range near Koocanusa west to summer range near Yahk, BC (Figure 9C).

Figure 11 (next three pages): Schematic representation of migration distance and direction. Lines run from averaged location during winter months (W; Dec-Mar) to averaged location during summer months (S; Jun-Sep) for translocated urban mule deer (red) and non-urban mule deer (black). Lines do *not* represent migratory corridors. Triangles represent non-migratory mule deer both translocated (red triangle) and non-urban (black triangle). Wandering translocated deer are not shown.

[7] Mountain range between Lake Koocanusa (rising east of Highway 93) and Wigwam River valley.


A) Columbia West
East Kootenay Urban Mule Deer Translocation Trial
Mule Deer Migration Columbia West
BC Parks
National Parks
First Nations Reserve
Translocated deer migration
Non-urban deer migration
Non-migratory, translocated deer
Non-migratory, non-urban deer
Translocation Release Site
2016
2017
N
1:600,000
Invermere
Windermere
Panorama
Lake Windermere
Fairmont Hot Springs
Gibraltar
Columbia Lake
Canal Flats
Purcell Wilderness Conservancy
Lavington
to Wolf Creek / Premier Ridge
Skookumchuck
5 0 5 10 15 20 km
British Columbia
Alberta
Idaho
Montana


B) Koocanusa East
Fernie
British Columbia
Alberta
Morrissey
Elko
Ram Broadwood
Baynes Lake
Dorr Rd
Newgate
Roosville
Montana
non migratory deer to the south at Rexford, MT.
5 0 5 10 15 20 km
East Kootenay Urban Mule Deer Translocation Trial
Mule Deer Migration Koocanusa East
BC Parks
National Parks
First Nations Reserve
Translocated deer migration
Non-urban deer migration
Non-migratory, translocated deer
Non-migratory, non-urban deer
Translocation Release Site
2016
2017
N
1:600,000
British Columbia
Alberta
Idaho
Montana


C) Koocanusa West
Fort Steele
Cranbrook
Mayook
Bull River
Wardner
Jaffray
Moyie
Elko
Baynes Lake
Newgate Transfer Stn
Yahk
Kingsgate
Newgate
5 0 5 10 15 20 km
East Kootenay Urban Mule Deer Translocation Trial
Mule Deer Migration Koocanusa West
BC Parks
National Parks
First Nations Reserve
Translocated deer migration
Non-urban deer migration
Non-migratory, translocated deer
Non-migratory, non-urban deer
Translocation Release Site
2016
2017
N
1:600,000
British Columbia
Alberta
Idaho
Montana

There were also differences in how far deer moved within seasons, particularly summer months. Non-urban mule deer generally had small, discreet winter and summer home ranges. They moved relatively rapidly between these ranges during spring and fall. Conversely, many translocated deer continued to move around during the summer season. Many translocated deer showed substantial elevation ranges during the summer months, with some individuals repeatedly moving up and down. This is very likely a symptom of a deer not being familiar with its surroundings.

Overall mean elevation range (difference between maximum and minimum recorded elevation) did not differ between non-urban and translocated mule deer (1-tailed t-test: $t = 1.666$, $p = 0.197$) (Table 18). However, when overlapping study areas within each project were compared individually, there were significant differences between all three study areas. Non-urban mule deer in Koocanusa East had a significantly higher elevation range than deer released to the same area at Dorr Road and Ram/Mt. Broadwood (1-tailed t-test: $t = 1.753$, $p = 0.022$). Koocanusa West non-urban mule deer had a significantly higher elevation range than translocated deer released to Newgate Transfer Station (1-tailed t-test: $t = 1.753$, $p = 0.036$). Conversely, mule deer translocated to Lavington had a significantly higher elevation range than non-urban mule deer in the Columbia West study area (1-tailed t-test: $t = 1.708$, $p = 0.001$).

Difference between maximum and minimum elevation is a coarse surrogate for migration and translocated mule deer are shown elsewhere in this study to be less likely to adopt migratory behaviour (see Figure 10). Therefore translocated mule deer elevation range would be predicted to be narrower than non-urban conspecifics. That mule deer translocated from Invermere to Lavington showed a significantly wider elevation range than non-urban mule deer in the same area is particularly noteworthy. This difference likely results from all collared deer translocated to Lavington were migratory while several non-urban mule deer in the Columbia West study area were non-migratory.

Table 18: Mean elevation ranges[1] (± standard deviation) and number of collared deer for non-urban and translocated mule deer in sympatric study areas (by row).

Non-Urban Study Area	Mean Elevation range (± SD)	Translocated Study Area	Mean Elevation range (± SD)
Columbia West	1098 m (± 508.8) n = 22	Lavington	1540 m (± 212.5) n = 7
Koocanusa East	1169 m (± 279.7) n = 32	Dorr Rd Ram / Mt. Broadwood	627 m (± 486.4) n = 5 1163 m (± 136.5) n = 6
Koocanusa West	740 m (± 486.4) n = 28	Newgate Transfer Station	460 m (± 293.5) n = 7
n.a.		Gibraltar	846 m (± 167.6) n = 11
Total	**1003 m (± 461.8) n = 82**		**928 m (± 429.4) n = 36**

[1] elevation range = maximum elevation recorded – minimum elevation recorded.

Home Range

Non-urban mule deer had larger 95% Brownian Bridge home ranges than translocated deer (1-tailed *t*-test: $t = 2.742$, $p = 0.003$). Non-urban mule deer 95% home ranges averaged 254km^2 compared to 128.4 km^2 for translocated mule deer (Table 19).

Home range size for non-urban mule deer varied significantly depending on study area (1-way ANOVA $F = 7.025$, $p = 0.002$) and migratory status (1-tailed *t*-test: $t = 4.992$, $p < 0.001$). Compared to translocated deer, non-urban mule deer had significantly larger 95% home ranges in both Koocanusa East (1-tailed *t*-test: $t = 3.968$, $p < 0.001$) and Koocanusa West (1-tailed *t*-test: $t = 1.949$, $p = 0.033$) study areas. In the Columbia West study area, translocated mule deer had significantly larger home ranges, on average, than non-urban mule deer (1-tailed *t*-test: $t = 1.981$, $p = 0.034$).

Home range of migratory non-urban deer was similar to that of translocated deer that wandered until finding another community (Figure 12). The difference between these groups is that migratory non-urban mule deer return to winter range each fall whereas the wandering translocated deer had a one-way movement.

Table 19: Mean area in km^2 (± SD) of 95% isopleth Brownian Bridge home ranges for non-urban and translocated mule deer. Deer are divided by study area and migratory status.

Study Area Migration status	Non-Urban	Translocated
Columbia West	**94.7 (± 56.4) n = 20**	**134.4 (± 41.2) n = 7**
Migratory	110.5 (± 56.1) n = 15	134.4 (± 41.2) n = 7
Non-Migratory	47.2 (± 19.1) n = 5	
Koocanusa East	**364.1 (± 278.2) n = 29**	**135.3 (± 76.8) n = 9**
Migratory	364.1 (± 278.2) n = 29	101.5 (± 32.4) n = 4
Non-Migratory		85.4 (± 1.9) n = 2
Wandering		213.6 (± 89.8) n = 3
Koocanusa West	**255.3 (± 323.0) n = 16**	**90.9 (± 69.2) n = 8**
Migratory	272.7 (± 343.0) n = 14	
Non-Migratory	134.0 (± 42.2) n = 2	57.6 (± 23.9) n = 6
Wandering		190.6 (± 64.6) n = 2
Gibraltar		**144.7 (± 89.2) n = 12**
Migratory		111.0 (± 7.9) n = 2
Non-Migratory		41.2 (± 7.4) n = 3
Wandering		198.8 (± 73.6) n = 7
Total	254.4 (± 269.6) n = 65	128.4 (± 74.4) n = 36

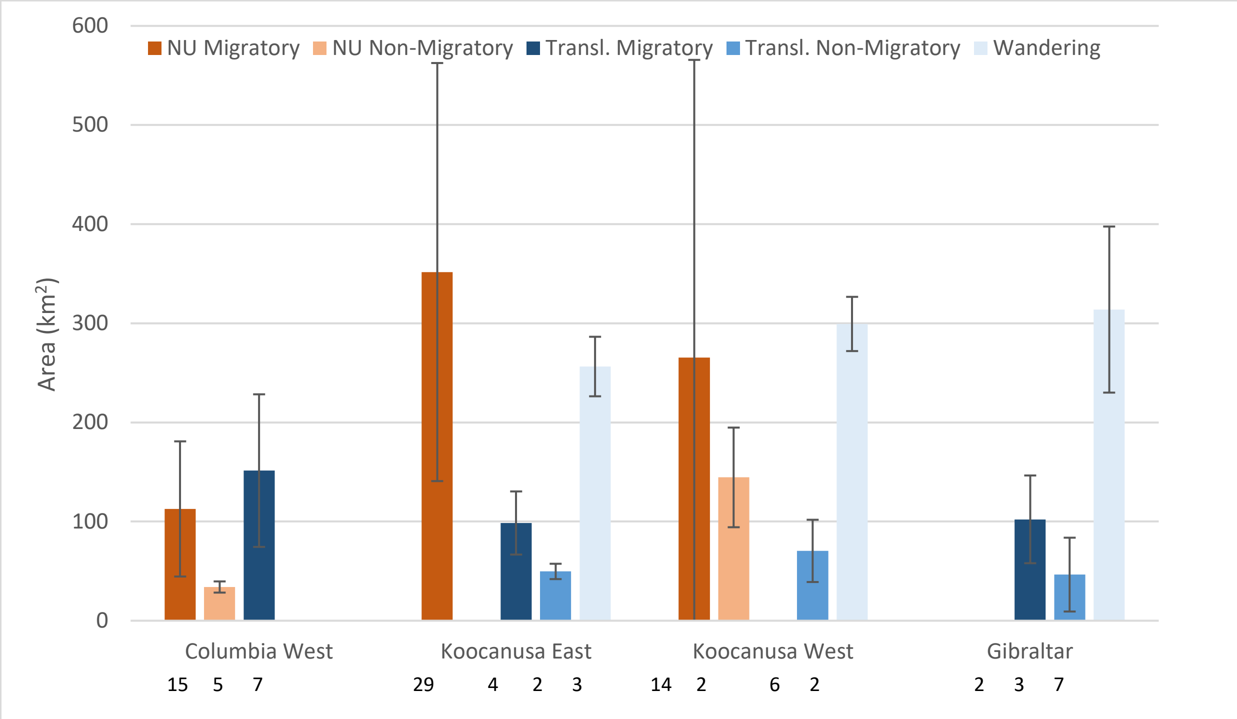


Figure 12: Difference in area (km^2) between mean 95% and 100% home range isopleths (± SD) for translocated (Transl.; blues) and non-urban (NU; oranges) mule deer classified as one of: migratory, non-migratory or wandering (translocated only) at four different study areas. Number of collared deer indicated below each histogram.

That all mule deer translocated from Invermere migrated and exhibited similar to larger home ranges than sympatric non-urban mule deer is evidence that many (though not all) mule deer wintering within the District of Invermere town limits are naturally migratory and leave town during the summer months. The mean home range size for the Columbia West translocated deer (all originating from Invermere and migratory) were at least partially inflated by the large movements of two deer during May/June, 2016. Both deer 20659 and deer 20668 made large *initial* movements that were more consistent with translocated deer classified as Wandering, but both settled into discreet high elevation, backcountry summer range, then demonstrated typical fall migration to Invermere for the winter before returning to summer range in spring 2017. When deer 20659 and deer 20668 are excluded from the analysis, there is no significant difference between migratory translocated and migratory non-urban mule deer in the Columbia West study area (1-tailed t-test: $t = 1.833$, $p = 0.190$). Their 2017 migration pattern and distance were consistent with migratory non-urban mule deer in the Columbia West study area.

Mortality

Over the biological year from May 1, 2016 through April 30, 2017, non-urban deer survival was 78.9% (95% C.I. range: 69.4 – 99.0%) while translocated deer survival (2016 and 2017 translocated deer combined) was 51.2% (95% C.I. range: 27.9 – 74.4%; Figure 13). This survival rate for non-urban mule deer is similar to that reported for mule deer in the South Selkirk Mountains, BC, area (Robinson et al. 2002) as well as other studies in similar habitat types (Forrester and Wittmer 2013). When comparing collar days per mortality, translocated deer had a significantly higher mortality rate than non-urban mule deer (Chi-square = 14.4036, $p = 0.0001$) (Table 20).

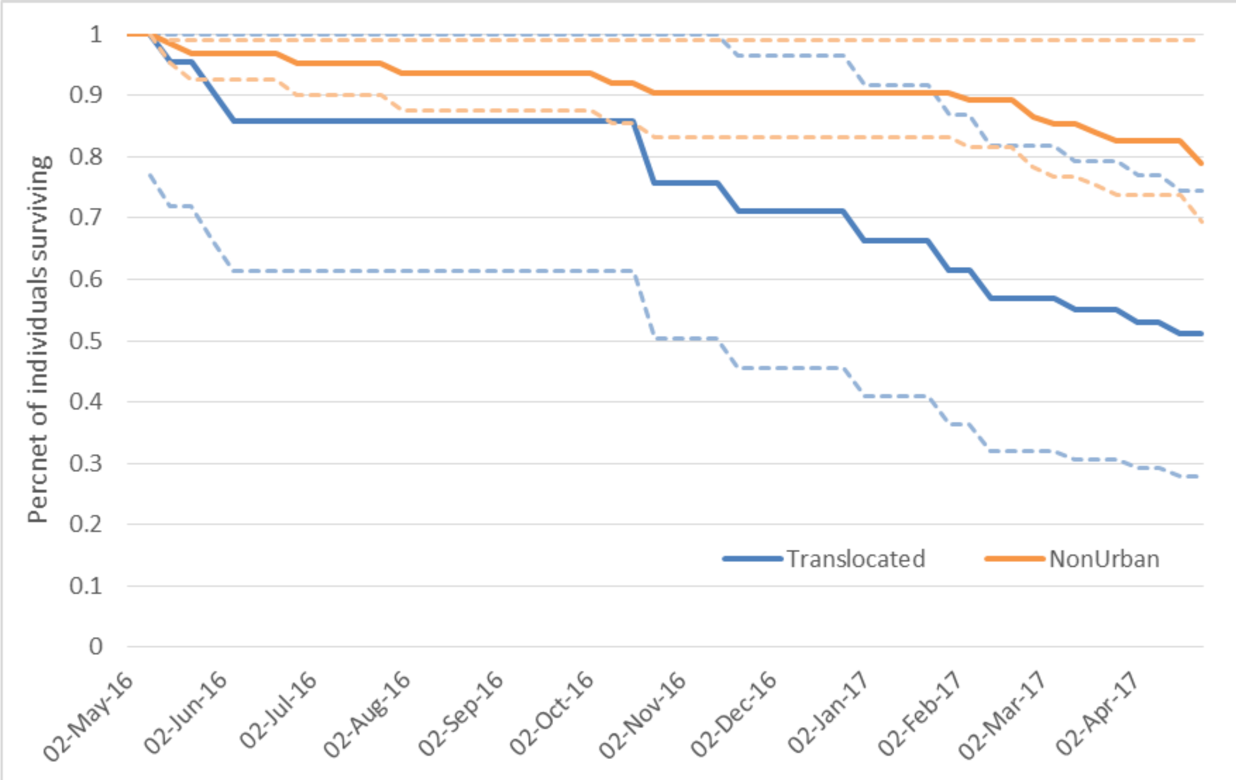


Figure 13: Kaplan-Meier annual survival curves (with 95% confidence intervals: dashed lines) for translocated (blue) and non-urban (orange) mule deer for the period May 1, 2016 through April 30, 2017.

Cause of predation differed slightly between non-urban and translocated mule deer. Predation was the leading cause of death for both groups, but comprised a slightly greater proportion of non-urban mule deer mortality (Table 21). When expressed as a percent of total collars deployed for each project (which accounts for sample size differences), predation rates are very similar: 25% of collars predated for translocated deer vs 28% of collars predated for non-urban deer (Table 22). The overall higher mortality rate for translocated deer results from higher levels of human-caused mortality and other sources. Causes of mortality for translocated deer that did not occur in non-urban deer during this period include: problem, injured and emaciated animals.

Interestingly, more non-urban deer died from road mortality than translocated deer. The conclusion that urban deer are more “street smart” and avoid road mortality is not supported by the high number of vehicle-deer collisions in municipalities. Given the large movements of some individual translocated deer, the lack of vehicle-deer collisions was surprising.

Timing of mortality was very similar between translocated and non-urban mule deer. Most mule deer died in late winter / spring (April and May) regardless of origin (Figure 14). Most of the spring mortality was predation; mule deer are clearly most susceptible to predation during spring migration. The slightly lower overall mortality rate due to predation on translocated deer is in some ways surprising. Many people predicted that urban deer would be highly susceptible to predation because they are perceived to have become either predator-naïve or lost fear of predators given their frequent aggressive response to dogs in towns. Results from this trial are not consistent with this. Translocated deer were no more susceptible to predation than non-urban deer.

Table 20: Mortality rates based on number of collar days for length of translocation trial project (February 16, 2016 through August 31, 2017).

Project	# Deer collared	Mortalities	% Mortality	Collar Days	Collar Days per mortality
Translocated	46	24	52.2 %	10,843	451.8
Non-Urban	86	28	32.6 %	34,832	1,244.0

Table 21: Comparison of overall mortality numbers and their cause for non-urban and translocated mule deer through August 31, 2017.

Mortality Class Cause	Non-Urban[1] (96 collared)	Translocated (46 collared)
Predation	**27**	**11**
bear		1
cougar	16	8
wolf	7	2
coyote	1	
unknown	3	
Human	**5**	**6**
roadkill	4	2
railway		1
injured		1
problem		2
poached	1	
Other	**8**	**7**
unknown	6	3
drowned		1
avalanche	1	
emaciated		3
health-related	1	
Total Mortalities	**40**	**24**

[1] Includes entire non-urban mule deer project from December 2015 through August 31, 2017.

Table 22: Rate of predation (as percent) of total mortalities and total collars deployed for both non-urban (n=96 collared) and translocated (n = 46 collared) mule deer.

Cause	Total Mortalities		% of Total Mortalities		% of Total Collars	
	Non-Urban	Translocated	Non-Urban	Translocated	Non-Urban	Translocated
Predation	27	11	67.5	45.8	28.1	24.9
Human	5	6	12.3	25.0	5.2	13.0
Other*	2	4	5.0	16.7	2.1	8.7

* excludes unknown mortality causes, thus % columns do not sum to 100%.

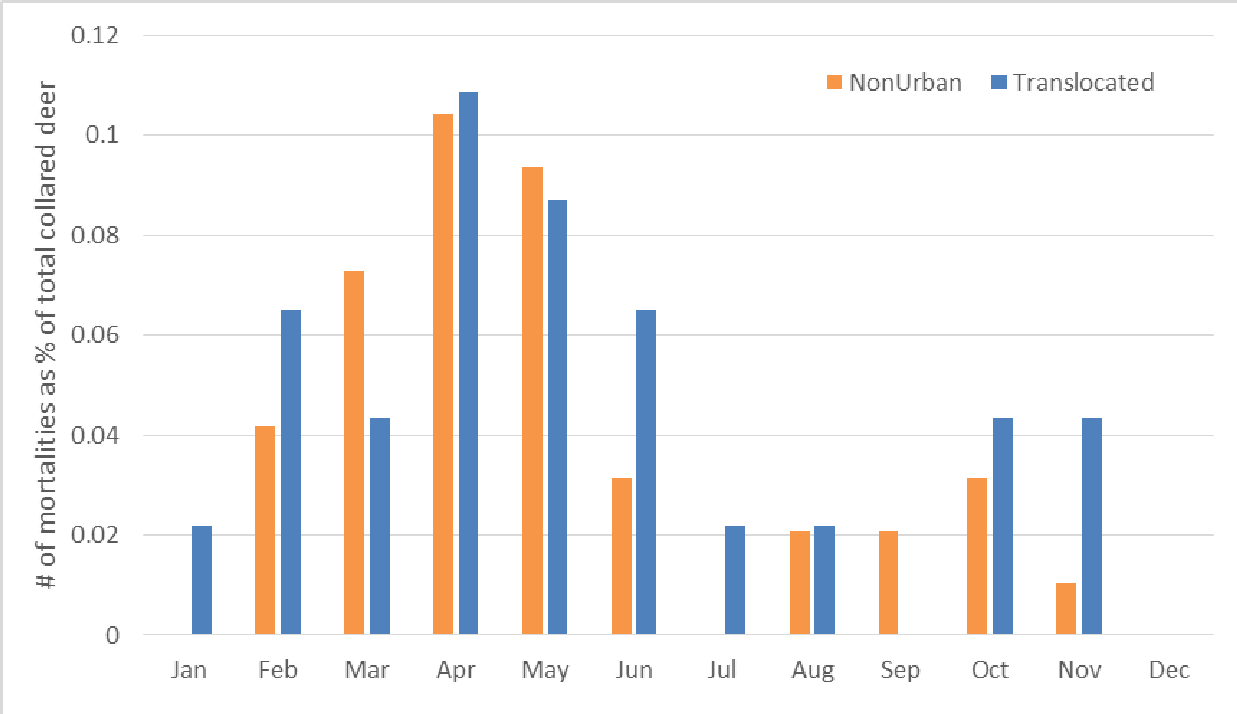


Figure 14: Number of mule deer mortalities per month expressed as a percent of total collared individuals for translocated (blue) and non-urban (orange) mule deer, respectively, in the East Kootenay region, Feb 2016 through Aug 2017.

Health

Testing and analysis of samples from translocated and non-urban mule deer is ongoing. Detailed results are part of graduate work by Dr. A. Mathieu and currently are not available. Preliminary results for adenoviral hemorrhagic disease virus, bluetongue virus, epizootic hemorrhagic virus and *Neospora caninum* did not differ in exposure between urban and non-urban deer (A. Mathieu pers. comm.). Further analysis is required before any recommendations based on these data can be provided.

Summary

Translocated mule deer moved in different ways from non-urban mule deer over the same time period. Although non-urban mule deer maintained, on average, larger home ranges, their locations within those home ranges were more seasonally discreet and none exhibited the wandering behaviour shown by close to one-third of the translocated deer. Translocated deer were much less likely to migrate. However, whether translocated deer exhibit typical migratory behaviour is inconsequential so long as they settle in a location that is away from where their potentially habituated behaviour may cause problems.

Mortality was 28% higher in translocated *vs* non-urban mule deer over the same time period. However, predation rate was slightly higher in non-urban deer. There was no *a priori* level of survival that was deemed necessary to call the translocation trial a success. Mortality rates are expected to be slightly higher in translocated individuals and our observed annual mortality was consistent with other recent mule deer translocation projects (see Section 3.7). However, survival alone should not the sole measure of whether translocation is acceptable as an option for managing overabundant urban deer populations. Death by predation, emaciation, or other causes related to the significant stress of translocation (note that stress was not measured in this study) should not be downplayed and raise legitimate concerns.

3.7 Comparison with other Mule Deer Translocations

Part of the impetus for initiating this trial was the reported success of other mule deer translocations in recent years, particularly in New Mexico and Utah. Both of these projects moved deer from urban areas with mule deer populations that were perceived to be too high. A primary objective for both projects, like the East Kootenay, was the conservation benefit of supplementing local non-urban mule deer populations that had suffered declines.

The Utah project captured 211 mule deer of all sexes and age classes from Bountiful City (just north of Salt Lake City) and moved them to two release sites, both >150 km from Bountiful to the northwest and southeast. Both release areas were typical of intermountain high desert and very scarcely populated, though with some very small communities nearby. Home ranges and movement distances have not been reported from the project, but no post-release conflicts or complaints of movement to other rural properties or communities were reported (C. Howard, Utah Div. of Wildlife Resources and Utah State Univ., pers. comm.).

The New Mexico project moved 230 mule deer (both sexes, all age groups) primarily from Silver City, NM to two areas in southwestern New Mexico: Peloncillo Mountains, 100 km to the southwest, and San Francisco River Valley, 100 km to the northwest. Both areas are primarily public land with some private ranching and agriculture, particularly the Peloncillo area. The New Mexico project also reported no large movements of translocated deer that would be consistent with the wandering behaviour observed in the East Kootenay study. Neither did the New Mexico project report any post-release conflicts with habituated deer moving into other communities or private lands.

Survival of translocated deer in East Kootenay was similar to the two American projects. Annual survival in the Utah translocations was approximately 50% (C. Howard, pers. comm.). Mule deer translocated in New Mexico had slightly higher survival, between 60 and 65% in their first year, but one of the release areas had cougar populations reduced prior to translocation (Ashling 2015). Cougars (aka Mountain Lions) were responsible for most of the confirmed predator kills in New Mexico

Ortega-Sanchez (2013) translocated 130 mule deer (primarily does) over two years from southern Texas to a private ranch in the Chihuahuan Desert of Coahuila, Mexico in 2007 and 2008. He was testing differences between hard-release and soft-release translocations. His reported 95% adaptive kernel home range sizes of 30 to 40 km^2 after release, with hard released deer having slightly higher home ranges than soft-released deer. These compare to the home ranges reported in this study ranging from 30 to 315 km^2 (median = 115.5, mean = 128.4, SD = 12.4). Ortega-Sanchez (2013) reported linear distances traveled from point of release of approximately 1 to 20 km. By comparison, the maximum linear distance of GPS collar locations on individual translocated mule deer surviving > 60 days in the East Kootenay study ranged from 5.2 to 95.3 km (median = 26.1, mean = 35.9, SD = 27.4 km).

There is no immediate explanation for why translocated mule deer in the East Kootenay had such large, dramatic movements in search of human developments when mule deer translocated elsewhere did not exhibit such behaviour. Mule deer in Utah and New Mexico were moved to areas largely devoid of human settlement and development, but results from the East Kootenay translocation trial suggest that no distance is too great for mule that are naturally capable of moving great distances.

4 CONCLUSIONS

Over 95% of deer captured (85 of 88) were translocated with only one mortality and two that escaped the trailer. The BAM-II drug combination was a very effective and safe method of immobilizing deer. With a few basic precautions (including, but not limited to, darkened trailer, effective tarp blind inside trailer, avoiding a lone deer in the trailer and maintaining quiet conditions around the trailer), transferring immobilized deer to the trailer was an efficient means to accumulate individuals throughout the day. Deer transported well with no documented injuries. They were calm upon arrival at the release site and casually moved out of the trailer and into surrounding areas.

Post-release results, especially movement-related, were highly individualized. Deer were classified as either migratory, non-migratory or wandering based on their post-release movement pattern. Similar numbers of deer were in each category: 13 migratory, 15 non-migratory and 12 wandering.

The propensity of some individuals to wander, at times great distances, until they found a community presented a challenge to the translocation trial. From the outset, a key objective of this trial was to not disperse habituated urban deer to other communities. Once in a community, "wandering" deer often demonstrated highly habituated behaviour, albeit abetted by residents feeding them in some instances, and occasionally showed aggressive behaviour. Resolving habituated deer moving to other communities presents a significant challenge to wildlife managers.

Twelve of 40 collared deer (30%) moved to and stayed in a community; seven of those 12 generated formal complaints. Another two deer returned to Invermere during the 2016-17 winter but migrated again to summer range in spring 2017. A similar number (15) of deer were never located in a community or rural area. Six deer resided primarily around rural properties, but deer in rural areas generated only one complaint and at least one response from landowners that they enjoyed and appreciated the deer's presence. The most common comment from landowners is that the translocated deer are "different" from resident deer. They lack fear of humans and other animals (e.g. dogs), eat plants that other deer have never touched and are occasionally aggressive. This movement of deer, both long distance wandering and moving to other communities appears to be unique to East Kootenay compared to other recent mule deer translocation studies.

The East Kootenay study observed survival rates similar to that reported from Utah and only slightly lower than reported from New Mexico. Survival of translocated deer was significantly lower than sympatric non-urban mule deer over the same timeframe but predation rates of translocated deer were slightly lower than non-urban mule deer. The higher overall mortality resulted from emaciated deer in poor condition and individuals having to be destroyed due to injury or aggressive behaviour.

A major challenge resulting from this study is identifying locations to which deer can be translocated that minimize the probability of moving them to other communities and generating potential conflict. Predicting, at point of capture, which deer make better candidates for translocation is not possible without more detailed study of individual behaviour prior to translocation. Deer captured in the "urban core" of municipalities were more likely to adopt wandering behaviour and seek out a community, but these are the deer that should be targeted to reduce urban populations. This is a difficult contradiction to overcome without further study.

The constraint of moving deer in late winter means winter range habitats are the only opportunity for release sites. Moving deer at other times of the year is not an option due to late-term pregnancy (post March 15) and care of young in the summer / early fall. Moving deer in late fall / early winter is not an option for animal welfare considerations as deer would not have enough time to learn where suitable forage and cover exists to survive the winter. Most mule deer winter range is in close proximity to human communities and developments and therefore moving deer to winter range increases the probability of translocated deer “discovering” these communities. This project has demonstrated that mule deer are willing and able to move very long distances in order to find the conditions they seek.

Deer were released to three primary areas away from the main Rocky Mountain Trench: Lavington Flats, Upper Kootenay River (Gibraltar) and Ram/Mt. Broadwood. Half of the deer surviving >60 days wandered away from Gibraltar in search of a community, in some cases moving more than 100 km. Similarly deer from Mt. Broadwood also wandered significant distances (one deer moved over 80 km almost to Yahk, BC before being killed by a bear). More remote release options with low human densities similar to sites utilized in Utah and New Mexico are not available in the East Kootenay at the time of year that we can ethically translocate deer.

Specific conclusions include:

1. Capture and translocation process worked very well. The BAM-II drug combination and free-range darting was efficient, effective and safe for deer, handlers and public. However, because it includes a restricted drug, it can only be administered by a veterinarian.
2. Clover trapping was not efficient. Capture rates were low and species, sex and age classes cannot be targeted.
3. All translocated deer must be identifiable with a visible ear tag (also a provincial requirement).
4. Transporting deer by modified stock trailer worked well. Specific modifications are necessary to maintain calm deer (primarily dark conditions inside, no sharp edges) and facilitate adding deer during captures throughout the day. There were no significant injuries attributed to deer being in the trailer.
5. Release sites must be as far from other communities as possible. Given the distance moved by some individuals post-release, distance may ultimately not matter. However, minimizing the number of individuals that may start wandering and continue until they find a community by maximizing the distance between release site and communities is essential.
6. No single factor can predict individual deer response to translocation. A multi-factorial analysis of various traits including: originating municipality, urban vs interface home range, age, body condition score may help identify which individuals are most likely to succeed with translocation.
7. Release sites around Lake Koocanusa are not suitable for translocation. None of the deer released to the two release sites near Koocanusa showed significant migratory behaviour. One deer has migrated, but it is a short north-south migration at similar elevations that is completely at odds with the migratory pattern of all collared non-urban mule deer in this area. All but one deer (who died right at the 60 day survival censor threshold) released to the two Koocanusa area release sites encountered either a community or rural property and only two moved on. These deer also generated a disproportionate amount of complaints.
8. There is evidence that deer from different communities responded differently to translocation. None of the Invermere deer generated complaints and all of them exhibited migratory behaviour. Conversely, only one of 14 Kimberley deer showed migratory behaviour while half of all deer that wandered long distance in search of a community originated from Kimberley.

9. Translocated deer did not necessarily move farther than non-urban deer, but did move in different ways. No non-urban deer showed the “wandering” behaviour and were far more likely to migrate than translocated deer. Mule deer translocated from Invermere were most like non-urban mule deer with respect to movement.
10. Translocated deer suffered higher mortality than non-urban deer. Predation rates were similar between the two groups suggesting translocated deer were not predator-naïve and at greater risk. Higher mortality of translocated deer arose from deer being killed for being overly aggressive as well as several dying in emaciated conditions for unknown reasons.
11. The major issue arising from this study is where deer can be released that minimizes probability of moving to other communities and creating habituated deer issues where none previously existed. Note that with the high twinning rate in urban deer, one translocated doe can multiply to seven deer within just over 12 months of translocation.

4.1 Management Recommendations

1. Release sites should not be considered within the main part of the Rocky Mountain Trench (elevations below 1100m).
2. Invermere deer appear to be the most suited to translocation. All exhibited migratory behaviour post-release and showed reasonable survival. None moved to other communities (two returned to Invermere to overwinter) and none generated complaints.
3. Kimberley deer showed either very low movement (non-migratory), or wandering behaviour, moving long distance in search of urban areas. Why Kimberley deer would behave differently is unknown, but few seemed to be suitable candidates for translocation.
4. Cranbrook and Elkford deer showed a broader range of behavioural response to translocation. Deer from these communities tended to gravitate to communities or private rural properties, but were more likely to move on and not stay.
5. If future translocations are to take place from Elkford, consideration must be given to length of travel time. Distance from Elkford to Canal Flats is a 2.5 hour drive, plus additional 30 minutes or more to release sites at either Findlay / Lavington and Gibraltar / Upper Kootenay River. This is a very long drive for deer in the trailer and in order to release deer during daylight hours in March, a capture cutoff time of 1:00 pm at the latest much be observed. This will reduce the efficiency of captures per day and therefore increase costs.
6. Given the imperative to not redistribute habituated deer to other communities in East Kootenay and Montana, continuing to use translocation as an option to manage overabundant urban deer populations in the region requires a detailed, costed plan to respond to complaints of habituated deer colonizing other communities where none previously existed.
7. Communities may be required to assume responsibility for the deer who move into another community. They should be available to work with the communities that are unwitting recipients of habituated deer and implement a plan to remove these deer if conflicts arise.

4.2 Logistical recommendations for capture and translocation

1. Free-range darting of deer was effective for capture. Having better access and preapproval from landowners to access deer on private property would greatly increase efficiency. An option is for municipalities to offer landowners an option to approve darting on their property (e.g. opt-in box to check off on property tax form). A map could easily be generated showing which properties allow

darting, which do not approve and which properties have not responded. In many instances, an opportunity to dart deer was lost while knocking on a door, having no one home to approve darting, or disturbing deer while attempting to confirm approvals.

2. Physical capture by Clover trap was not an efficient method to capture deer for translocation in 2016. Low snow levels and an early spring allowed good access to forage for mule deer in February, 2016, so there was little incentive for mule deer to enter traps. Further, there is no control over which deer are trapped, their sex or which species. Several white-tailed deer were captured in Clover traps and released. We avoided mixing bucks and does in a trailer due to the chance of aggression or injury.
3. Capture crews must include: wildlife veterinarian, darter experienced in wildlife immobilization (can be the wildlife vet), experienced wildlife biologist, two handlers
4. A shuttle vehicle from point of capture to the transport trailer was useful for some capture sites. A wide tailgate opening and low rear entry facilitate moving deer into the vehicle. The shuttle avoided moving the stock trailer while deer were inside and reducing disturbance. A small vehicle is also much more maneuverable in urban areas including narrow streets, alleys, and driveways. A minivan was used each year and worked well for this purpose.
5. Single deer loaded in the trailer were much more likely to become agitated. Darting two deer (typically a doe and her fawn) at the same time for at least the first captures each day resulted in more calm and inactive deer in the trailer. Sedative effects of BAM-II components that were not reversed also likely helped with this.
6. Six to eight deer was the maximum number for a one day capture and release and was considered a maximum number of deer than can likely be safely added to a typical 2 to 3 horse stock trailers. In an operational program where the objective is to move as many deer in the shortest time possible, handling time should be reduced to simple ear-tagging and transfer to trailer. Provided suitable deer for translocation can be quickly, reliably and safely located, two trailer trips may be possible in one day. This would be optimistic and may require additional crew members.
7. Trailers must be darkened to the maximum extent possible with several inches of clean straw as bedding on top of rubber matting floor. An effective canvas curtain must be hung near the back to allow a buffer to reverse the deer. Allow approx. 1 metre between door and curtain to rest incoming deer. All sharp fittings in the trailer must be padded to prevent injury as well as loops or hooks in which a deer might catch a hoof or leg. There's very little control over the activity of the deer once they are reversed in the trailer, so all precautions must be taken in advance.
8. Trailers should be parked in a cool, shaded, quiet, private and secure area while captures are proceeding. Ensuring they are in the shade if sun is shining is also important as stock trailers can quickly heat up, even in cool late winter weather. Keeping conversation and activity to a bare minimum close to the trailer is key to helping deer stay calm and relaxed in the trailer.
9. Ensure deer are released at least one hour prior to dusk. This gives deer at least a short time to learn their immediate surroundings before dark. It also permits suitable light conditions for crew to observe deer on release to ensure deer they are uninjured following transport. Release sites should be well away from potential water hazards – large rivers and lakes.
10. Although no injuries occurred to deer in the trailer during capture and transportation, at least one person attending the release should be a licensed and experienced hunter with a firearm present to euthanize any injured deer if necessary.

4.3 Budget for future translocations

In the event that future translocations are approved, a projected budget based on translocation of 30 urban mule deer is included to assist municipalities with planning for such events. The estimated cost for translocation is $1,050 per deer (Table 23; see Appendix G: Detailed Budget Estimate) for full budget details). This assumes a crew of four people working for five days to capture six deer per day. If more deer can be captured per day, per deer costs may decrease slightly. If a larger trailer is utilized that can carry more deer, additional deer per day would slightly reduce per deer costs. A second crew (if available) working simultaneously could also reduce per deer costs, especially if one veterinarian was able to cover both crews.

Volunteer labour has been included in the budget. In 2017, a crew of four or five paid technicians were used without volunteer assistance and this worked very well. Local volunteers could potentially replace one of the paid technicians (see Appendix G: Detailed Budget Estimate); however, this should be considered with caution. While local citizens (primarily Rod & Gun club members) were very generous with time and knowledge, they should not be expected to provide pro bono services for ongoing urban deer population reduction. One significant reason is the insurance coverage (Worksafe BC) for risks involved with the capture and handling of large wildlife.

Costs for Elkford will be higher. As noted above, a longer distance from Elkford to release sites would be required, increasing mileage costs. Also accommodation and per diem costs for the lead technician, darter and veterinarian will be higher for any community where these crew members are not available locally.

A potentially significant additional costs has *not* been included. Results from this study suggest that some translocated deer will move to other communities (or possibly return to their home community) and potentially cause conflicts. If those deer are deemed to be a risk to public safety they may be required to be removed from that community, possibly lethally.

Table 23: Summary of budget estimate for five field days of capture and release of urban mule deer for translocation.

Item	Cost Estimate
Services:	**$25,130.00**
Planning	$4,740.00
Field Work	$18,190.00
Reporting	$2,200.00
Post-Release Conflicts	unknown
Disbursements	**$6,370.00**
TOTAL PROJECT:	**$31,500.00**
In kind value (optional):	*$2,000.00*
cost per deer[1]:	**$1,050.00**

[1] assumes 30 deer (6 translocated per day over 5 days)

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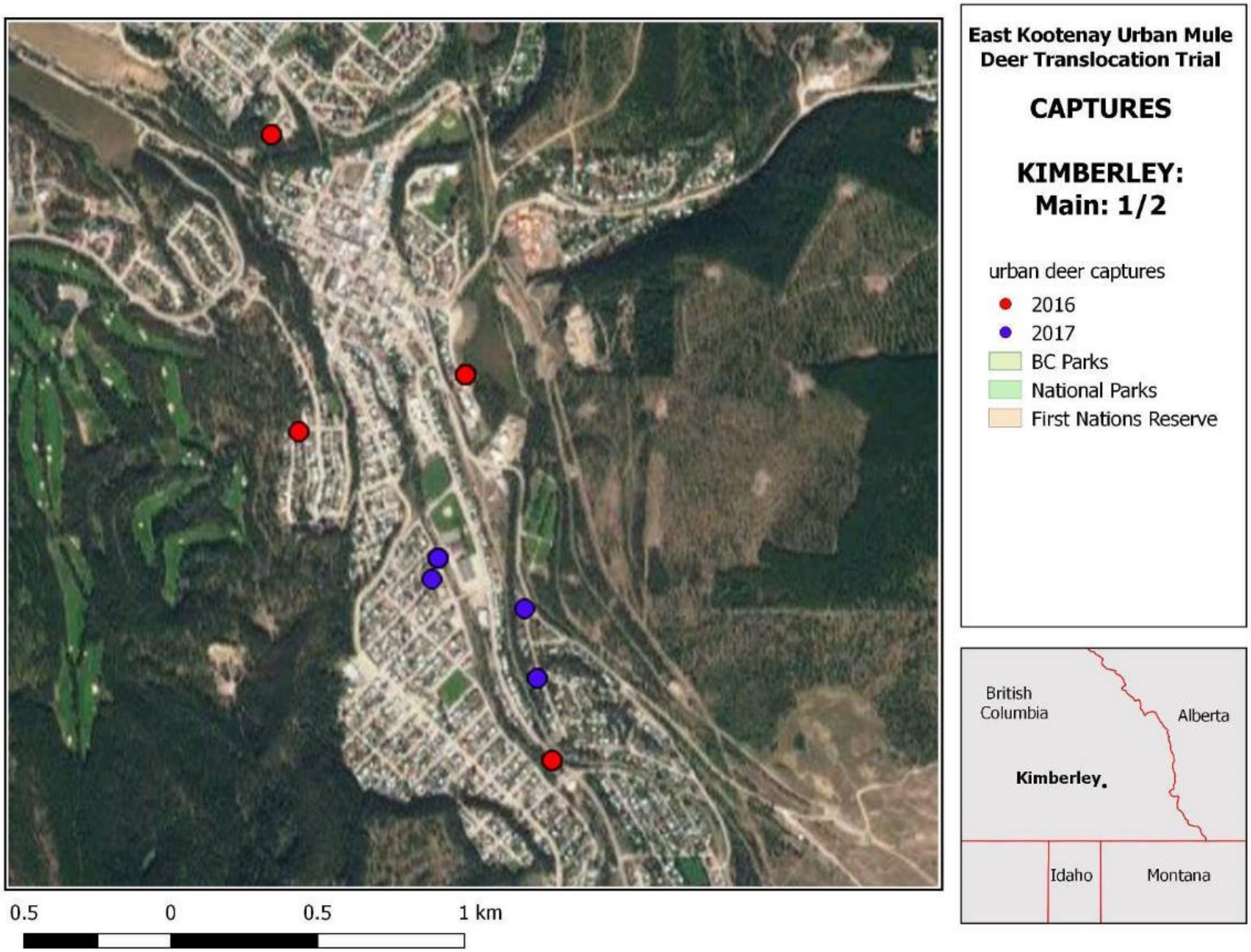
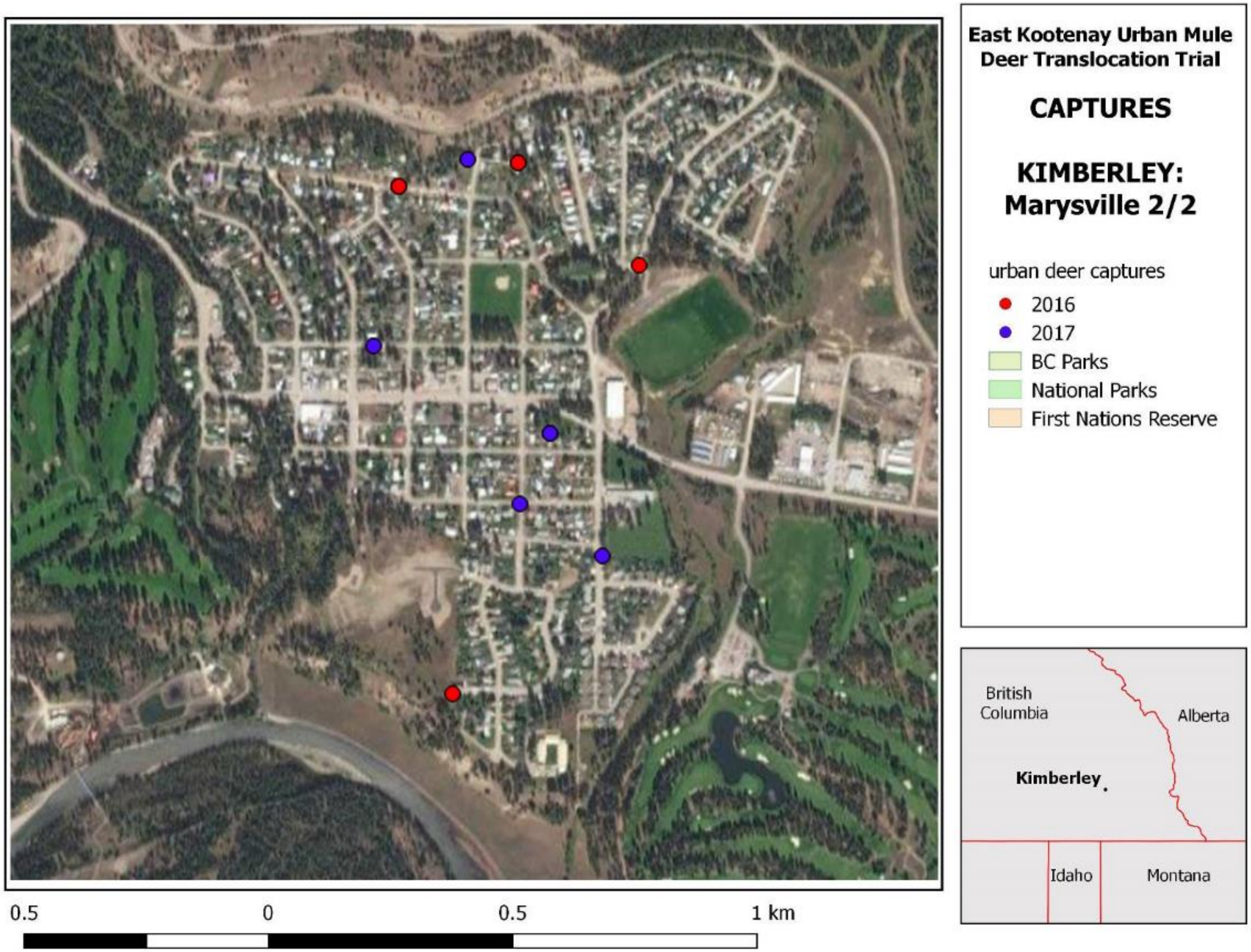
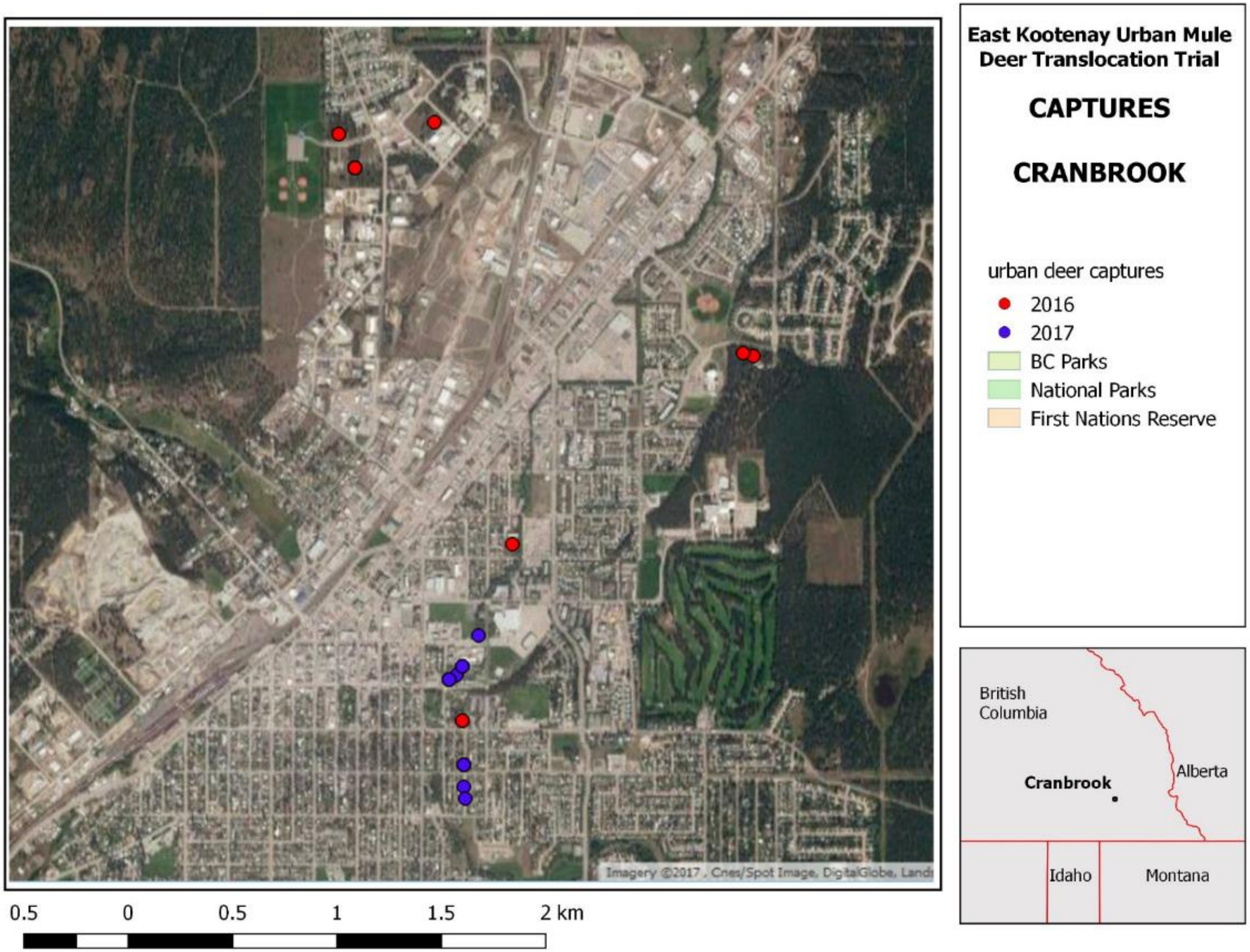
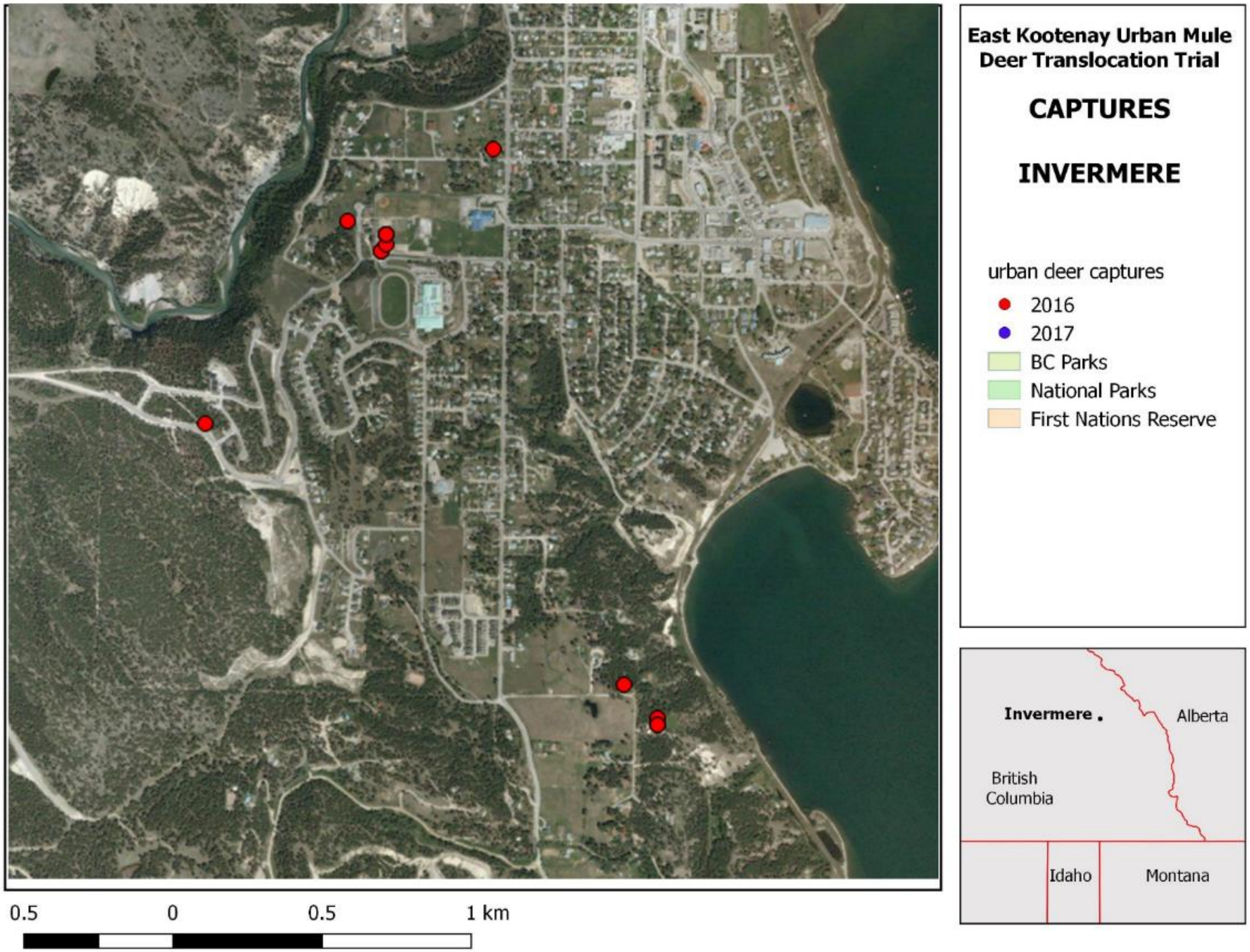
Appendix A: Capture Sites

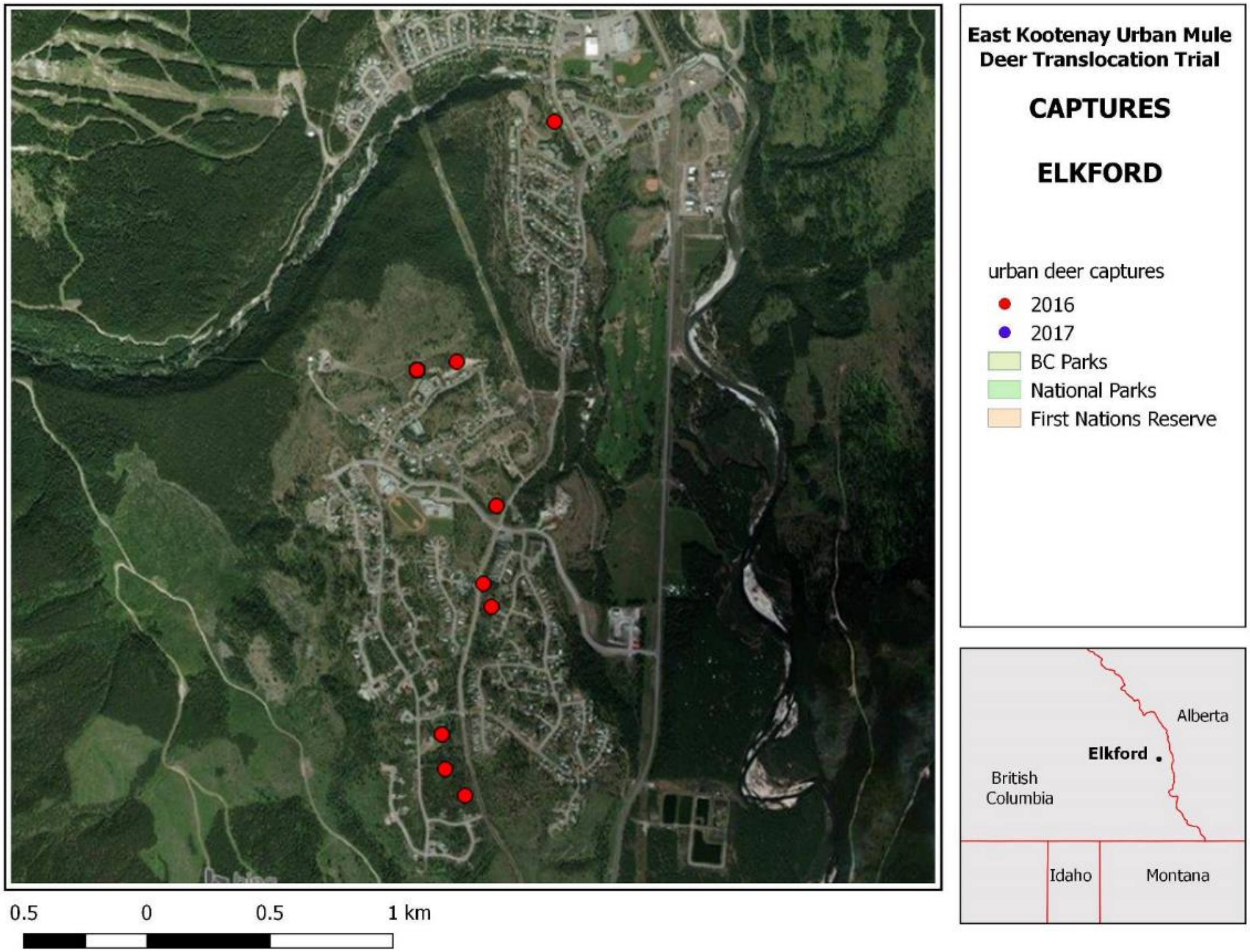
Location of capture sites for urban mule deer in Kimberley and Cranbrook (2016 and 2017) and Invermere and Elkford (both 2016 only). Multiple deer were captured at some locations so number of "dots" does not necessarily correspond to number of deer captured.




East Kootenay Urban Mule Deer Translocation Trial
CAPTURES
KIMBERLEY: Marysville 2/2
urban deer captures
2016
2017
BC Parks
National Parks
First Nations Reserve
British Columbia
Alberta
Kimberley
Idaho
Montana
0.5
0
0.5
1 km


East Kootenay Urban Mule Deer Translocation Trial
CAPTURES
CRANBROOK
urban deer captures
2016
2017
BC Parks
National Parks
First Nations Reserve
British Columbia
Cranbrook
Alberta
Idaho
Montana
0.5 0 0.5 1 1.5 2 km
Imagery ©2017 , Cnes/Spot Image, DigitalGlobe, Lands


East Kootenay Urban Mule Deer Translocation Trial
CAPTURES
INVERMERE
urban deer captures
2016
2017
BC Parks
National Parks
First Nations Reserve
Invermere
Alberta
British Columbia
Idaho
Montana
0.5
0
0.5
1 km


East Kootenay Urban Mule Deer Translocation Trial
CAPTURES
ELKFORD
urban deer captures
2016
2017
BC Parks
National Parks
First Nations Reserve
Alberta
Elkford
British Columbia
Idaho
Montana
0.5
0
0.5
1 km

Appendix B: Monthly Movement

Mean monthly distance (km) moved per day based on distance between consecutive 13 hour GPS collar fix intervals for translocated mule deer surviving at least 60 days. Also mean distance (km) moved per month for each individual.

	2016											2017						mean total
Collar	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	km/month
20652		1.5	1.7	1.1	0.5	1.2	1.0	1.0	2.0	0.9	0.5	0.6	0.3	0.8	0.9	1.5	0.5	25.3
20653	0.5	0.5	1.1	2.5	0.5	1.8	1.1	1.3	3.9	1.6	0.8	0.5	0.3	0.8	0.9	2.1		28.6
20654		1.1	1.9	2.5	1.5	1.9	1.6	1.1	0.6	1.6	1.1	1.2	0.7	1.5	1.4	1.8	1.4	39.2
20655	0.9	1.3	2.7	3.7	1.7	1.2	1.7	2.1	0.4	1.3								44.3
20656	0.4	1.2	1.3	1.6	0.6	1.0	1.6	1.0	2.0	0.7	0.7	0.7	0.4	0.6	1.0	1.1	0.8	24.0
20657	1.7	1.2	1.3	2.8	2.3	0.8	1.0	2.2	2.4	1.1	1.1	0.7	0.4	0.9	1.0	1.2	0.6	32.3
20658	2.5	1.1	1.2	2.1	2.2	0.7	1.0	1.1	1.0									35.8
20659	0.4	0.5	1.5	2.9	1.7	1.7	1.1	0.9	0.8	0.6	1.1	0.7	0.7	0.9	0.6	1.0	1.1	21.6
20662	2.2	1.1	1.2	2.0	0.7	0.5	0.8	0.7	0.5	0.7	1.2	1.6	0.5	0.7	1.0	1.5	1.2	27.8
20664	1.2	1.4	1.8	4.8	1.1	1.5	2.2	1.0	0.6									41.6
20665		2.3	2.1	3.3	0.8	0.6	0.9	0.8	1.6	0.8	0.7							32.9
20667	0.4	0.5	0.5	0.8	1.0	0.9	1.3	2.2	2.0	1.0								19.4
20668	0.6	0.7	0.6	2.4	1.1	2.4	1.4	1.2	1.3	0.8	0.8	0.9	0.7	0.7	0.8	0.8	1.5	23.3
20669	0.4	1.1	0.5	1.3	1.1	1.0	1.2	1.6	1.3	1.0	1.2	1.0	0.9	1.0	1.2	2.0	2.1	25.9
20670		1.9	1.8	4.3	1.8	0.6	2.4	4.2	1.5	2.0	0.6	0.6	0.5	0.7	0.7	2.5	3.9	39.5
20671	0.4	0.5	1.2	2.1	3.5													25.6
20834		2.0	2.8	5.6	1.6	3.6	5.6	5.5	4.4	1.4	1.0	1.1	0.4					78.0
20835		2.0	2.4	4.3	1.2	1.4	1.6	2.5	1.8	1.2	1.1	1.5						39.9
20836		0.5	0.8	2.1	1.1	1.3	1.3	0.7	0.7	0.5	0.6	0.3	0.2	0.1				15.2
20838		1.2	1.5	2.3	1.0	0.8	0.6	0.4	0.5	0.9	0.9	1.0	0.5	0.6	0.8	1.2	1.1	24.5
20839		1.9	2.3	4.9														54.0
20840		1.6	1.5	3.3														56.0
20841		1.1	1.5	1.3	0.6	0.9	1.4	0.6	0.6	0.7	0.6	0.4	0.3	0.3	0.7	0.7	1.9	21.2
20655-17														0.5	0.7	1.4	0.8	20.8
20658-17														0.5	1.2	1.9	0.9	23.0
20660-17														0.8	1.1	3.9	0.8	44.2

	2016											2017						mean total km/month
Collar	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
20661-17														1.0	1.2	2.0	1.5	30.6
20663-17														0.5	1.1	3.7	1.2	39.8
20664-17														0.9	1.1	3.5	0.9	35.6
20666-17														0.4	0.6	2.1	1.2	20.3
20834-17														1.6	1.0	2.5	0.5	33.4
20835-17														0.4	1.0	1.3	0.6	17.7
20839-17														0.5	1.5	1.5	2.5	21.9
20840-17														1.4	1.0	1.3	1.8	25.8
Mean:	1.0	1.2	1.5	2.8	2.1	1.3	1.6	1.6	1.5	1.1	0.9	0.9	0.5	0.8	1.0	1.8	1.3	**31.8**
SD:	0.8	0.6	0.6	1.3	3.5	0.7	1.1	1.3	1.1	0.4	0.2	0.4	0.2	0.4	0.2	0.9	0.8	**12.8**

Appendix C: Migration & Range in Elevation

Maximum and minimum recorded elevation (metres) of translocated mule deer fitted with GPS collars surviving at least 60 days through June 30, 2017. Order is increasing elevation range value.

			Migratory?		Elevation		
Collar	Municipality	Release Site[1]	2016	2017	Max	Min	Range
20654	Cranbrook	Dorr Rd	No	No	896	725	171
20840	Elkford	Newgate T.S.	No	-	948	737	210
20657	Kimberley	Newgate T.S.	No	No	953	721	232
20658	Kimberley	Newgate T.S.	No	-	1024	696	328
20662	Kimberley	Newgate T.S.	No	No	1014	685	330
20838	Elkford	Newgate T.S.	No	No	940	578	361
20658-17	Cranbrook	Gibraltar	-	Wandering *	1489	881	608
20661	Cranbrook	Dorr Rd	No	-	1370	740	629
20660-17	Kimberley	Gibraltar	-	Wandering *	1498	800	698
20663-17	Kimberley	Gibraltar	-	Wandering *	1509	798	711
20664-17	Kimberley	Gibraltar	-	Wandering *	1504	793	711
20652	Cranbrook	Dorr Rd	Yes[2]	Yes[2]	1469	726	743
20834	Cranbrook	Dorr Rd	Wandering *[3]	-	1481	732	750
20835-17	Cranbrook	Gibraltar	-	No	1676	906	770
20670	Cranbrook	Dorr Rd	Wandering *[4]	Wandering *[4]	1494	703	791
20666-17	Kimberley	Gibraltar	-	No ƚ	1707	901	806
20664	Kimberley	Newgate T.S.	Wandering *	-	1440	617	823
20655-17	Kimberley	Gibraltar	-	No	1709	883	826
20655	Kimberley	Newgate T.S.	No	-	1656	719	936
20837	Elkford	Ram / B'wood	-	-	1943	956	988
20661-17	Kimberley	Gibraltar	-	Wandering *	1799	789	1011
20834-17	Cranbrook	Gibraltar	-	Wandering *	1825	802	1022
20839-17	Cranbrook	Gibraltar	-	No ƚ	1996	933	1063
20836	Elkford	Ram / B'wood	Yes	-	2033	963	1070
20840-17	Cranbrook	Gibraltar	-	Yes	1973	897	1076
20665	Elkford	Ram / B'wood	Wandering *	-	1911	784	1127
20839	Elkford	Ram / B'wood	Wandering *	-	1890	747	1143
20671	Invermere	Lavington	Yes	-	2461	1147	1314
20841	Elkford	Ram / B'wood	Yes	Yes	2095	777	1318
20656	Invermere	Lavington	Yes	Yes	2427	1102	1325
20835	Elkford	Ram / B'wood	Yes ƚ	-	2143	812	1331
20653	Invermere	Lavington	Yes	-	2191	839	1352
20667	Invermere	Lavington	Yes	Yes	2507	1027	1481
20668	Invermere	Lavington	Yes	Yes	2452	795	1657
20659	Invermere	Lavington	Yes	Yes	2477	782	1695
20669	Invermere	Lavington	Yes	Yes	2720	835	1885

[1] Newgate T.S. = Newgate Transfer Station; Ram/B'wood = Ram / Mt. Broadwood

[2] Deer 20652 showed short distance north-south migration with minimal elevation change in fall 2016 and returned in spring 2017.

[3] Deer 20834 showed significant movement through summer of 2016, swam across Lake Koocanusa >15 times. Killed by cougar close to release site in February, 2017. Never showed consolidated summer range.

[4] Deer 20670 frequently moved long distances in the Koocanusa area, mostly residing near Rexford Bridge south of Rexford, Montana, living outside of communities. Crossed Lake Koocanusa at release point 4 times: immediately after release in March, 2016, May, 2016, September 2016 and July 2017. Never more than 1 week on west side of Koocanusa before crossing back to east side at release point, then returning to Montana. Since last “excursion” to release site and west side of Koocanusa, all locations have been in and around Rexford townsite.

* “Wandering” deer had a significant (>50 km) one-way movement within 3 months of translocation then usually settled in a community.

ƚ Deer showed partial seasonal range differences but not did not consistently remain on discreet ranges. Often moved back and forth between areas.

Appendix D: Settlement and Complaints

Details of whether individual translocated mule deer occurred in a town, rural area or neither; if a complaint was received and their fate as of August 31, 2017. Deer surviving <60 days are excluded. See Table 14 for details on cause of death for dead deer.

Municipality Deer	In town?	Where?	Details	Complaint Received? [1]	Fate[2]
Cranbrook					
20652	rural	Roosville / Grasmere	Moved on		Alive
20654	town	Baynes Lake	Stayed	yes	Still there
20661	never		Died on day 60.		Dead
20670	rural	Rexford, MT	Moved to Rexford 17 months after translocation		Still there
20834	town	In Eureka, MT 3 separate times; swam Koocanusa at least 15 times	Never stayed more than 48 hours		Dead
20658_17	town	Wasa	Stayed		Still there
20834_17	town	Canal Flats; Fairmont Hot Springs	In Canal Flats for 68 days; Now in Fairmont	yes	Still there
20835_17	never				Alive
20839_17	never				Alive
20840_17	never				Alive
36092_17	never				Dead
36096_17	rural	Fort Steele	Stayed		Dead
Elkford					
20665	town	Baynes Lake; Yaak, MT	Recaptured in Baynes, stayed in Yaak	yes	Dead
20835	rural	North Galtons	Came and went		Dead
20836	never				Dead
20838	rural	West Kootenai, MT	stayed		Still there
20839	town	Baynes Lake	Left eventually	yes	Dead
20840	town	Eureka, MT	Aggressively chasing people; put down by Montana wardens	yes	Dead
20841	rural	Rosen / Jaffray	Mostly out of town		Alive
Invermere					
20653	never				Dead
20656	never				Dead
20659	town	Invermere	Returned in May 2016, left for summer then overwintered. Migrated to backcountry in summer 2017		Alive

Municipality Deer	In town?	Where?	Details	Complaint Received? [1]	Fate[2]
20667	never				Dead
20668	town	Invermere	Returned in Oct 2016, overwintered. Migrated to backcountry in summer 2017		Alive
20669	never				Alive
20671	never				Dead
Kimberley					
20655	town	Baynes Lake	Stayed. Injured and euthanized in fall 2016	yes	Dead
20657	rural	Newgate / West Kootenai, MT	Stayed (nicknamed "Juliet" by residents)		Still there
20658	rural	West Kootenai, MT	Stayed		Dead
20662	rural	RV Campground / West Kootenai, MT	Summer at Koocanusa area campground (at time very aggressive); to West Kootenai in winter and stayed	yes	Dead
20664	town	Libby, MT	Stayed		Dead
20655_17	never				Alive
20660_17	town	Cranbrook	Stayed		Still there
20661_17	town	Kimberley	1 month on Bootleg Gap golf course (Marysville), then returned to Kimberley		Still there
20663_17	town	Cranbrook	Stayed		Still there
20664_17	town	Cranbrook	Stayed		Still there
20666_17	never				Alive
35829_17	town	Canal Flats	Stayed	yes	Still there
35831_17	never				Dead
36107_17	never				Alive

[1] Blank cell indicates no complaint received
[2] As of August 31, 2017

Appendix E: Home Range Maps

A PDF file with individual maps for each collared mule deer showing release site, location data by season, morality location and date (if applicable), and 95% and 100% Brownian Bridge home range area is available at: www.vastresource.com Data are for release dates through June 30, 2017.

Contact VAST Resource Solutions, info@vastresource.com, for assistance if necessary.

Appendix F: Mortality and Individual Fates through August 31, 2017

Number of GPS-collared mule deer translocated in 2016 and 2017 that are alive and dead as of Aug 31, 2017. Parentheses are percentages of total collared deer translocated in that year.

	2016			2017		Combined		
Municipality	Alive	Dead	Unknown	Alive	Dead	Alive	Dead	Total
Cranbrook	3	4		5	3	8	7	15
Elkford	2	5	1			2	5	7*
Invermere	3	4				3	4	7
Kimberley	1	6		8	2	9	8	17
Total	**9** (32.1%)	**19** (67.8%)	**1**	**13** (72.2%)	**5** (27.8%)	**22** (46.8%)	**24** (51.1%)	**46**

* excludes 1 fate unknown.

Fate and number of days survived through August 31, 2017 and mortality cause (if applicable) of radio-collared mule deer translocated in 2016 and 2017.

Collar	Municipality	Capture	Age Class at capture	BCS at capture	Fate at 2017-08-31	# days survived[2]	Mortality Date	Mortality Cause	Cause Certainty
20652	Cranbrook	2-Mar-16	Young adult	Fair	alive	547			
20653	Invermere	22-Feb-16	Young adult	Good	dead	451	18-May-17	wolf	confirmed
20654	Cranbrook	29-Feb-16	Adult	Fair	alive	549			
20655	Kimberley	17-Feb-16	Young adult	Fair	dead	278	21-Nov-16	euthanized[1]	confirmed
20656	Invermere	22-Feb-16	Young adult	Good	dead	474	10-Jun-17	drowned	probable
20657	Kimberley	18-Feb-16	Adult	Fair	alive	560			
20658	Kimberley	16-Feb-16	Adult	Fair	dead	255	28-Oct-16	emaciated	confirmed
20659	Invermere	23-Feb-16	Adult	Good	alive	555			
20660	Cranbrook	29-Feb-16	Young adult	Fair	dead	7	7-Mar-16	unknown	
20661	Cranbrook	29-Feb-16	Adult	Poor	dead	60	29-Apr-16	cougar	confirmed
20662	Kimberley	16-Feb-16	Young adult	Good	dead	554	23-Aug-17	road kill / emaciated	probable
20663	Cranbrook	29-Feb-16	Adult	Good	dead	32	1-Apr-16	wolf	probable
20664	Kimberley	17-Feb-16	Adult	Excellent	dead	253	27-Oct-16	road kill	confirmed
20665a	Kimberley	16-Feb-16	Aged	Emaciated	dead	6	22-Feb-16	cougar	confirmed
20665	Elkford	9-Mar-16	Adult	Good	dead	331	3-Feb-17	destroyed[1]	confirmed
20666	Kimberley	17-Feb-16	Adult	Fair	dead	50	7-Apr-16	cougar	confirmed
20667	Invermere	22-Feb-16	Young adult	Excellent	dead	276	24-Nov-16	emaciated	probable
20668	Invermere	22-Feb-16	Young adult	Excellent	alive	556			
20669	Invermere	22-Feb-16	Adult	Excellent	alive	556			
20670	Cranbrook	1-Mar-16	Adult	Good	alive	548			
20671	Invermere	23-Feb-16	Young adult	Good	dead	108	10-Jun-16	wolf	probable
20834	Cranbrook	2-Mar-16	Adult	Fair	dead	350	15-Feb-17	cougar	probable
20835	Elkford	8-Mar-16	Adult	Fair	dead	303	5-Jan-17	emaciated	probable
20836	Elkford	8-Mar-16	Adult	Fair	dead	372	15-Mar-17	unknown	
20837	Elkford	9-Mar-16	Adult	Fair	unknown		Last signal: 3-Jun-16		
20838	Elkford	10-Mar-16	Young adult	Fair	alive	539			
20839	Elkford	8-Mar-16	Adult	Fair	dead	74	21-May-16	bear	probable
20840	Elkford	10-Mar-16	Adult	Fair	dead	81	30-May-16	destroyed[1]	confirmed
20841	Elkford	9-Mar-16	Adult	Fair	alive	540			

Collar	Municipality	Capture	Age Class at capture	BCS at capture	Fate at 2017-08-31	# days survived[2]	Mortality Date	Mortality Cause	Cause Certainty
20655_17	Kimberley	6-Mar-17	Adult	Poor	alive	178			
20658_17	Cranbrook	8-Mar-17	Young adult	Poor	alive	176			
20660_17	Kimberley	6-Mar-17	Adult	Fair	alive	178			
20661_17	Kimberley	6-Mar-17	Adult	Poor	alive	178			
20663_17	Kimberley	6-Mar-17	Young adult	Fair	alive	178			
20664_17	Kimberley	6-Mar-17	Young adult	Poor	alive	178			
20666_17	Kimberley	6-Mar-17	Adult	Poor	alive	178			
20667_17	Cranbrook	8-Mar-17	Aged	Fair	dead	31	8-Apr-17	cougar	confirmed
20834_17	Cranbrook	7-Mar-17	Adult	Good	alive	177			
20835_17	Cranbrook	7-Mar-17	Young adult	Fair	alive	177			
20839_17	Cranbrook	7-Mar-17	Young adult	Fair	alive	177			
20840_17	Cranbrook	7-Mar-17	Young adult	Fair	alive	177			
35829_17	Kimberley	9-Mar-17	Young adult	Fair	alive	175			
35831_17	Kimberley	9-Mar-17	Aged	Poor	dead	91	8-Jun-17	unknown	
36092_17	Cranbrook	8-Mar-17	Young adult	Fair	dead	68	15-May-17	unknown	
36093_17	Kimberley	9-Mar-17	Aged	Fair	dead	43	21-Apr-17	predation	confirmed
36096_17	Cranbrook	8-Mar-17	Young adult	Fair	dead	136	22-Jul-17	railway	confirmed
36107_17	Kimberley	9-Mar-17	Young adult	Poor	alive	175			

[1] “Euthanized” indicates deer was injured and put down to avoid further suffering. “Destroyed” deer were killed, usually following public complaints of aggressive behaviour.

[2] Number of days from translocation to either death or August 31, 2017, whichever came first.

Appendix G: Detailed Budget Estimate

Services	Bio/Proj Mgr	Technician	Technician	Darter/Tech	Veterinarian	Total Billable Hours	Total Cost	Volunteer (in kind)	Volunteer (in kind)	Total in kind Hours	Total in kind Value
Planning							**$4,740.00**				**$0.00**
Permit / Animal Care	4					**4**	$360.00			0	$0.00
organize crew	8					**8**	$720.00			0	$0.00
order supplies	4			2	2	**8**	$710.00			0	$0.00
release site background	4					**4**	$360.00			0	$0.00
project coordination/admin	16	4	2	2	4	**28**	$2,410.00			0	$0.00
Safety	2					**2**	$180.00			0	$0.00
Field							**$18,190.00**				**$2,000.00**
Field mobilization	2	2	2	2	2	**10**	$810.00			0	$0.00
prep trailer		4	4			**8**	$560.00			0	$0.00
Capture	10	30	30	30	30	**130**	$10,350.00	30	30	60	$1,500.00
Translocation / Release		20	20		20	**60**	$4,800.00	20		20	$500.00
Post-field cleanup		8	8	2	4	**22**	$1,670.00			0	$0.00
Reporting							**$2,200.00**				**$0.00**
Data entry and reporting	16	8			2	**26**	$2,200.00			0	$0.00
Post-Release											
conflicts						**0**				0	**$0.00**
Total Hours	**66**	**76**	**66**	**38**	**64**	**310**		**50**	**30**	**80**	
Subtotal Services	**$5,940.00**	**$5,320.00**	**$4,620.00**	**$2,850.00**	**$6,400.00**		**$25,130.00**	**$1,250.00**	**$750.00**		**$2,000.00**

Disbursements	Item	#	price per	Total Cost
permit	permit	1	$130.00	$130.00
capture supplies	BAM	5	$360.00	$1,800.00
capture supplies	kits/ear tags	30	$7.00	$210.00
capture supplies	blanket	5	$10.00	$50.00
capture supplies	darts	5	$50.00	$250.00
trailer	rental	5	$400.00	$2,000.00
trailer	supplies	1	$20.00	$20.00
trailer	straw	2	$10.00	$20.00
mileage-capture	mileage	300	$0.55	$165.00
mileage-translocation vet	mileage	1000	$0.55	$550.00
mileage-translocation tech	mileage	500	$0.55	$275.00
vet travel	per diem	5	$60.00	$300.00
vet travel	accomm.	5	$120.00	$600.00
			Subtotal Disbursements	**$6,370.00**

Budget Summary	
Services:	$25,130.00
Disbursements	$6,370.00
Post-release conflicts*	unknown
TOTAL PROJECT:	**$31,500.00**
Total deer moved:	30
Cost per deer:	**$1,050.00**

* does not include cost of addressing potential post-release conflicts. Likely assume at least $5,000 for post-release actions to address conflicts and deer in non-target communities.