Olympic National Park Mountain Goat Removal and Translocation to the North Cascades

Progress Report II

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1. Introduction

On June 18, 2018, after years of planning and extensive public review, the regional director of the U.S. National Park Service (NPS) signed a Record of Decision, authorizing the beginning of a plan to remove mountain goats (*Oreamnos americanus*) from Olympic National Park (as well as adjacent portions of the Olympic National Forest). For the first few years of this work, the approved plan called for most mountain goats to be captured live and transported to staging areas on the Olympic Peninsula where they would formally become the responsibility of the Washington Department of Fish and Wildlife (WDFW). From these staging areas, mountain goats would then be transported to pre-selected staging areas in the North Cascades, and then brought to release locations where they would be returned to the wild.

Details of the rationale and plans are contained in the Final Environmental Impact Statement and the Record of Decision (both available at https://parkplanning.nps.gov/projectHome.cfm?projectId=49246). This report provides an overview of the capture and translocation efforts during the first 3 bouts (September 2018, July 2019, and August 2019). Because a previous progress report reviewed work accomplished during September 2018 (Happe and Harris 2018), this report focuses on work conducted during 2019. Future progress reports will cover activities during 2020. Technical reports for the scientific literature will follow as appropriate.

2. Capture and processing

In the mountain goat management plan/ EIS (NPS 2018), the selected alternative included 2 capture and translocation operations a year, with each operation lasting 2 weeks (one in mid-late July and the second in late August – early September). Each capture bout was to include up to 12 days of flying, and occur over only one weekend on the Olympic Peninsula. The plan included having 2 staging areas in operation simultaneously (one in the north on NPS lands and one in the southeast on U.S. Forest Service ([USFS] lands) to minimize goat ferry time and hence increase capture efficiency and goat survival. We estimated that it would take approximately 2 years, or 4 capture bouts, to reach capture and translocation objectives.

In the EIS we estimated that by the end of the second year of operation, we would have completed 4 capture bouts, flown a maximum of 384 hours over up to 48 days, and caught between 189 and 432 goats (mean =310) (Table 1).

Table 1. Estimated helicopter use and goat captures in the EIS.

		Number of flyable days per capture bout		Estimated number of flight hours		Number of goats caught per day		Number of goats caught (# goats/day * flyable days)		
Year		Min	Max	Min[1]	Max[2]	Min	Max	Min	Max	Mean
1	July	9	12	54	96	8	12	72	144	108
	Aug/Sept	8	12	48	96	5	10	40	120	80
2	July	9	12	54	96	5	8	45	96	70.5
	Aug/Sept	8	12	48	96	4	6	32	72	52
Total		**34**	**48**	**204**	**384**			**189**	**432**	**310.5**

1: minimum flight hours= 6 hours/ day * minimum number of flyable days
2: maximum flight hours= 8 hours/day * maximum number of flyable days

Due to a delay in the completion of the EIS process, were only able to have one capture bout in 2018, conducted from 10-23 September. In that effort we were able to only use one staging area on NPS lands, at the Hurricane Hill (HHill) trailhead and nearby picnic areas. We were not able to operate in USFS wilderness for either capture or release, or have a staging area on USFS land. Results of the 2018 captures are reported in Happe and Harris 2018.

The final compliance for the project was completed in December 2018. Consequently, in the summer of 2019 we were able to fully implement the capture and translocation plans laid out in the EIS; we used 2 staging areas to process goats, HHill on NPS lands in the north and the Hamma Hamma pit (Hamma) on USFS lands on the southeastern Olympics (Figure 1). We

conducted two capture bouts in (#2 and #3 for the project): 8-19 July and 16-29 August (Table 2). We selected the end of August for the second capture bout due to the weather challenges we encountered catching goats in September 2018; we historically receive less rainfall in August than in September.

During July 2019 we were unable to operate aerial capture operations for 2 of the 12 planned days due to unfavorable weather (Table 2), and 4 of the 10 days we were able to operate were cut short due to weather. Also in July, we did not attempt to capture goats from Mount Ellinor, Mount Washington, Mount Pershing, or Jefferson Ridge area to reduce impacts to hikers. Following the completion of the July 2019 bout, we moved up the start date of the August operation from August 19 to August 16 to allow for a potentially wider operational window. As a result of that change, we were able to implement capture operations during 11 days, and due to better weather conditions in August, fly for longer periods each day (Table 2). In August, the USFS closed the Mount Ellinor trailhead to hiking, allowing capture operations on Mount Ellinor, Mount Washington, Mount Pershing, and the Jefferson Ridge area.

During the field work periods in 2019 we removed a total of 211 mountain goats from the Olympic Range and translocated 177 to the Cascades. Including work completed in September 2018, (i.e., accounting for all 3 capture bouts), we have removed 326 mountain goats from the Olympics and moved 275 of them to the North Cascades (see below). We have used fewer than maximum number of flight days (36) and hours (288) estimated in the FEIS for 3 capture bouts. However, the total number removed to date is similar to the mean of the estimated number that the EIS anticipated would be removed in 4 bouts. (Table 2). The difference between removed and translocated totals will be discussed below.

Table 2. Actual number of capture days, flight hours, and goats removed and translocated, 2018 and 2019.

		Flyable days/ *capture bout length*	**Flight hours/day**			**Number goats removed/ day**			**Total number of goats**	
Year	**Dates**		Min	Max	Total	Min	Max	Mean	Goats removed	Goats released
2018	9-23 Sept	10/*14 days*	1.6	8	61.1	4	16	11.5	115	98
2019	8-19 July	10/*12 days*	2.5	8	61.7	3	15	8.9	89	76
2019	16-29 Aug	11/*14 days*	5.9	8	80.3	2	16	11.1	122	101
Total		**31**			**203.1**				**326**	**275**

Capture and processing methods in 2019 were similar to those used in 2018 (Happe and Harris 2018), with a few modifications. Goats were again caught under a full service contract that was let to Leading Edge Aviation, Clarkston, Washington. The capture team caught goats by either net gun, chemical immobilization (administered via capture dart), or a combination of both methods; some kids were caught by hand. In 2019 we used Thiafentanil as the capture drug. In addition, the capture crew were directed to lethally remove a limited number of goats that, based on their experience, were in inaccessible terrain (remote and steep) where capture or ground-based removal would not be possible, or exhibiting elusive behavior indicating that the goat would not be catchable.

Prior to each day's operation, the pilot and the project lead integrated information on weather, field conditions, goat distribution, and previous day's results to choose areas to target for captures and, in 2019, prioritize which staging area would be operational and for how long. The Hamma staging area was operational from 8-15 July and 19-29 August, and was not usable on some of the days that HHill was open, due to poorer weather in the southeast.

After securing a goat onsite, the capture team reversed the capture drug immediately (if chemical immobilization was used) and administered the sedative Midazolam to all goats except kids. The capture team hobbled, blindfolded, and secured captured goats in special sling bags until they were ready for transport. The helicopter pilot then transported goats in loads averaging 2 goats (range 1- 5): loads with larger numbers of goats included kids accompanying their nanny. When both staging areas were open, goats were taken to the closest helibase (Figure 1). Mean time between darting or netting and delivery to the helibase was 36 minutes (range 9-76 minutes), and was similar for both staging areas (34 minutes to Hamma and 35 to HHill). The capture and helicopter operations were managed by NPS staff at both sites.

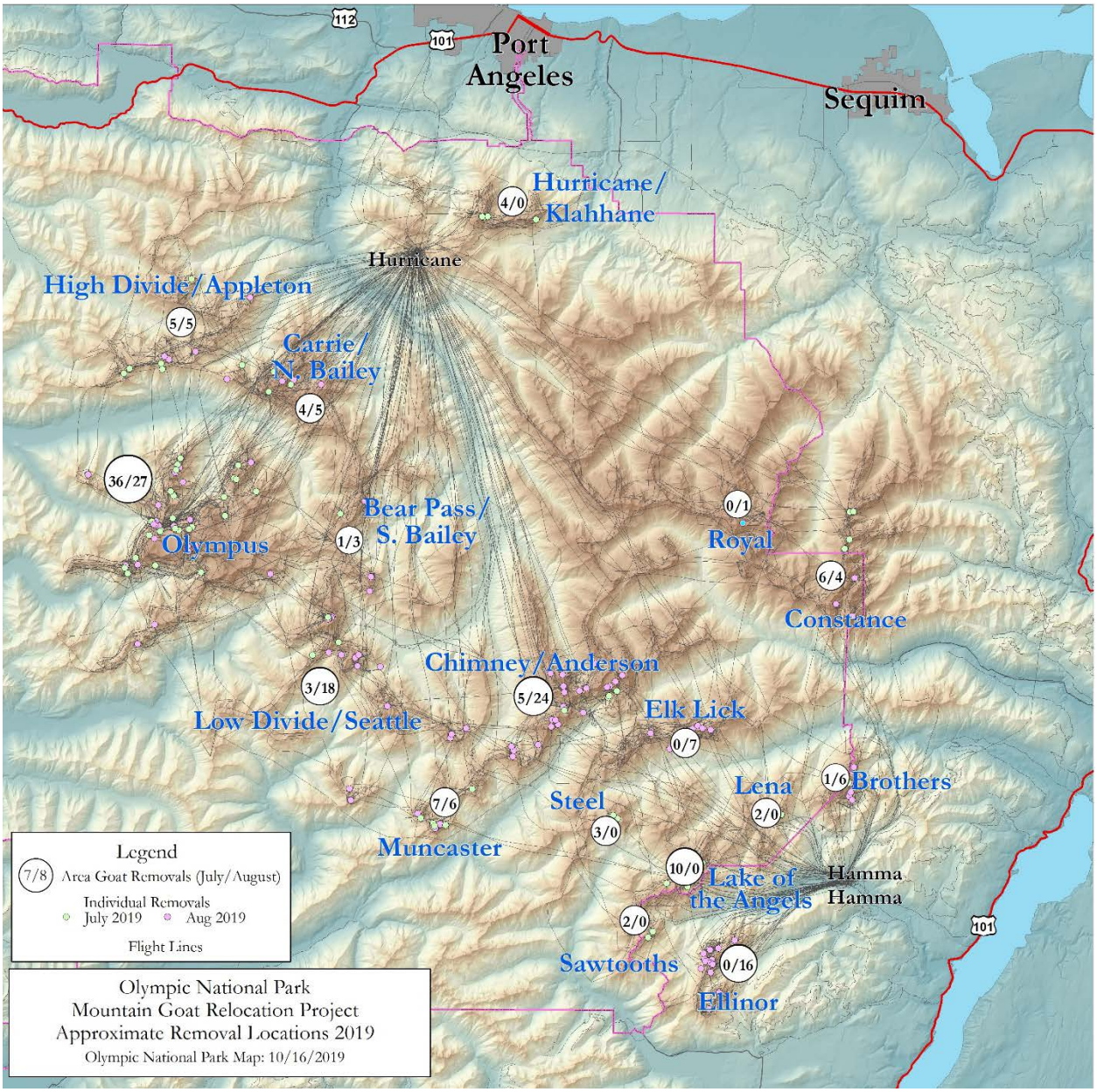

Figure 1. Flight lines, capture locations, and regional totals of goats removed in July (green) and August (pink) 2019, Olympic Peninsula, WA.

Two hundred and eleven goats were removed from the Olympics in 2019: 89 in July and 122 in August (Table 3). Only 4 goats were removed from Klahhane ridge in 2019 (Figure 1, Table 4); we removed 31 goats from that area in 2018 (Happe and Harris 2018), and there were very few catchable goats left there in 2019. With the addition of the Hamma staging area in 2019, we were able to expand capture operations into the southern and eastern Olympics, including lands managed by the USFS, and more efficiently capture goats in the Mt. Anderson

Table 3. Number of goats removed and goat fate, by capture bout, 2018-2019.

Date	**Total removed**	Lethal removal[1]	Capture mortality[1]	Delivered to staging area	Capture mortality[2]	Euthanized[3]	Provided to Zoo Community	Translocated	Transport mortality	**Released**
Sept. 2018	115	0	1	114	5	3	6	100	2	98
July 2019	**89**	**4**	**2**	**83**	**3**	**3**	**0**	**77**	**1**	**76**
Aug. 2019	**122**	**4**	**3**	**115**	**4**	**0**	**10**	**101**	**0**	**101**
Total	**326**	**8**	**6**	**312**	**12**	**6**	**16**	**278**	**3**	**275**

1: Goat carcass was not retrievable, and was left in the field.

2: Goat died from injuries sustained during capture, or was euthanized due to severity of injuries

3: Disease or poor condition made goat unsuitable for translocation.

area in the central Olympics. As was the case in 2018, however, the most goats came from the area around Mt. Olympus (Figure 1, Table 4).

During 2019, 13 goats were left in the field (either lethal removal or capture mortalities) and 198 were brought to the staging areas by the capture crew (126 to HHill and 72 to Hamma). Of those goats, 177 were released in the Cascades. Transferred goats that were not released were either kids transferred to zoos (10), capture-related mortalities (7), euthanized due to illness (3), or died in transport (1). Thirty one goats (14.7%) were captured from USFS lands, with over 50% of those coming from the Mt. Washington/ Mt. Ellinor area (Table 4). No goats were lethally removed on USFS lands.

Of the 211 goats removed in 2019, 147 were adults (74♀F, 73♂), 26 were yearlings (14♀, 12♂) and 33 were kids (11♀F, 22♂) (Table 4). We also captured one inter-sex (hermaphroditic) individual, having characteristics of both sexes. The sex and ages of 4 goats that were lethally removed and left in the field are unknown. Capture crews caught 145 goats using nets, 40 using immobilizing darts, and 5 using a combination of darts and nets. Fourteen of the 33 kids were caught by hand. Mean induction time (elapsed time to full immobilization

following darting or netting) was 2:09 minutes for darted goats and 1:10 minutes for netted goats.

Table 4. Mountain goats removed from the Olympics, by capture area, sex and age class, 2019

Sex	Age	High Divide/ Appleton	Bear Pass/ S. Bailey	Brothers	Carrie/ N. Bailey	Chimney/ Anderson	Constance	Elk Lick	Ellinor	Hurricane/ Klahhane
Female	Adult	5		1	2	11	3	3	6	1
Female	Yearling			1		1	1	1	1	
Female	Kid			1		4				
Male	Adult	3	4	4	6	10	4	2	4	1
Male	Yearling	1				1			2	1
Male	Kid	1			1	1	2	1	3	
Intersex	Adult									
Unknown						1				1
Total		**10**	**4**	**7**	**9**	**29**	**10**	**7**	**16**	**4**
NPS		*10*	*4*		*9*	*29*	*4*	*7*		*4*
USFS				*7*			*6*		*16*	

Table 4 (continued. Mountain goats removed from the Olympics, by sex and age class, 2019

Sex	Age	Lake of the Angels	Lena	Low Divide/ Seattle	Muncaster	Olympus	Royal	Sawtooths	Steel	Total
Female	Adult	3		6	4	28		1		**74**
Female	Yearling	2		2	2	3				**14**
Female	Kid			1	1	4				**11**
Male	Adult	4	2	5	3	17	1	1	2	**73**
Male	Yearling			4	1	1			1	**12**
Male	Kid	1		2	2	8				**22**
Intersex	Adult					1				**1**
Unknown				1		1				**4**
Total		**10**	**2**	**21**	**13**	**63**	**1**	**2**	**3**	**211**
NPS		*10*	*2*	*21*	*13*	*63*	*1*		*3*	**180**
USFS								*2*		**31**

Capture mortality rates were 5.9 % in both July and August 2019, a slight increase from the capture mortality rate of 5.2% in September 2018. Five goats dying during capture in 2019 had been darted, 6 had been netted, and one had been captured with a combination of methods. Most of the mortalities were due to serious injuries sustained following a fall during capture, however 2 were from dart injuries and one was unknown cause. Capture efficiency (hours/goats captured) was 0.81 in July 2019 and 0.72 in August 2019 (capture efficiency was 0.59 in September 2018).

At HHill, we quickly evaluated all goats upon delivery at the helibase, gave additional Midazolam if needed, and put them in a sternal position to maintain their airway during transport by truck to the processing area (Fig. 2) . At Hamma, we transferred all goats from sling to animal

stretcher and moved them to the processing area immediately following arrival at the helibase (Fig. 3). Mean time between delivery to the helibase and initial treatment at the processing area was 5 minutes at Hamma and 10 minutes at HHill. More time was required between arrival and the beginning of processing at HHill than at Hamma because the distance between the helicopter landing and processing site was greater at HHill. NPS Staff led goat processing at HHill, and WDFW staff led goat processing at Hamma (with USFS coordinating overall site management and security).

Upon arrival at the processing area, staff removed the goat from the capture sling bag and placed it on a stretcher, weighed it, and transferred it to a processing table, where it was cared for by goat processing teams. Blindfolds, hobbles, and horn guards remained in place until the goat was put into a transport crate unless removal was necessary for treatment by the processing team. Processing teams were led by veterinarians, vet techs, and experienced animal handlers, and were assisted by volunteers. There were at least 4 people (often more) processing each goat.

Upon arrival, the processing team immediately evaluated each goat for emergency medical conditions and treated it appropriately, if necessary. Teams recorded each goat's weight, condition score, morphometric measurements, sex, age and lactation status. In July 2019, teams also recorded horn dimensions but discontinued doing so in August to increase safety of staff and reduced processing time. Samples taken included: nasal swab, tissue for DNA analysis, blood, hair, and fecal samples. Teams administered BoSe, Fluxinin, Ivermectin, Albendazol, Oxytetracycline, and Vitamine E to all animals. All adults and yearlings were also given Haliperidol as an additional sedative. In addition, most received 1 L fluids subcutaneously. Teams monitored each goat's temperature, respiration and capillary refill time throughout the process.

After evaluation by a veterinarian, each goat was assigned a body condition score of 1 to 5, where 1 was very poor condition and 5 was very good condition, and largely reflected the fat layer depth over the vertebrae and ribs (Iowa State University, 2011). Rump-fat depth was also measured by ultra-sound for a sub-sample of goats by Dr. Tom Stephenson (California Department of Fish and Game); those data will be reported separately.

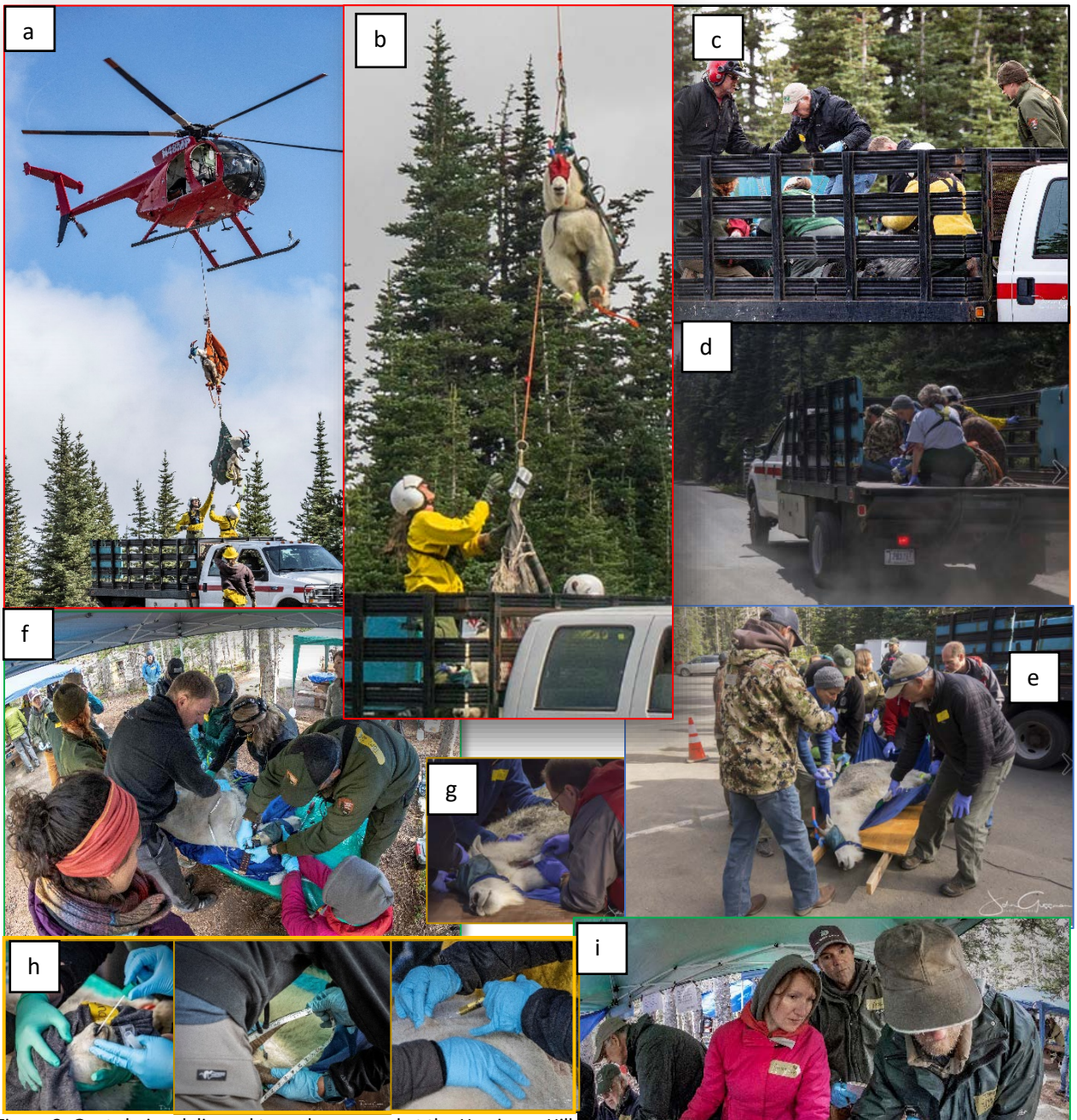

Figure 2. Goats being delivered to and processed at the Hurricane Hill staging area. Shown are goats being loaded into a transport truck by the capture crew (a and b), evaluated prior to transport to the processing area (c), transported to the processing area (d), and weighed as the first step in processing (e). Steps taken during processing included placement of radio collar (f), collecting blood (g) and nasal samples, measuring horn size, giving animal care injections (h), and evaluation of condition – including ultra-sound assessment of body fat by teams from California Fish and Game and Alaska Fish and Game (i). Photo credits: John Gussman (b,d,e,g) and Darryn Epp (a,c,f,h,i).

Figure 3. Goats being delivered to and processed at the Hamma Hamma staging area. Shown are goats being delivered (a and b, kids flew inside the helicopter), the short ride to the processing area (c), goats being evaluated (d) and processed (e), and after action review by attending veterinarians. Photo credits Matt Ackerman NxNW Studions (a,c,d,e,f) and Scott McCorquodale (b).

Teams affixed each goat with a small ear tag with a unique 4-digit number; this became the animal's identifying number thereafter. All adult goats transported to the North Cascades were equipped with a GPS radio-collar. Translocated yearlings received either a juvenile GPS collar (14 yearlings), an adult GPS collar (one yearling), or released without collars (9 yearlings). Released kids received either a juvenile GPS collar (6), juvenile VHF only collar (9), or released without a collar (8). All juvenile collars were equipped with break-away features. Teams spent an average of 37 minutes to process each goat (range 15-88 minutes). Goats with long processing times either had health issues that required more time for the veterinarians to treat, or were delivered with a group of 5 goats, and had to wait until a processing team was available; all goats that teams were not able to process immediately were monitored by a team of 2 while waiting.

After processing, staff moved goats into individual transport crates (Fig. 4). All crates were kept in a secluded and shaded area until they were ready to be loaded into the transport trucks. When ambient temperatures were warm, goats were kept cool with ice in the crates, using misters in the crate waiting area. At the Hamma, a large fan was used to circulate air and mist around crates. Mean time between darting in the field and placement in the crate was 74 minutes (range 37-191 minutes).

Table 5. Sex, age, weight, and condition score of goats transported to the staging area in 2019, by month of capture. Data was not recorded for all goats received at the staging area.

Cohort		Mean Weight (kg) (*n*)		Mean Condition Score (1-5) (*n*)		Mean Adult Age	
Sex	Age	July	August	July	August	July	August
Female	Adult	60.4 (*33*)	68.3 (*41*)	2.3 (*30*)	2.7 (*41*)	4.3	3.4
	Yearling	34.6 (*6*)	42.8 (*8*)	1.9 (*6*)	2.6 (*7*)		
	Kid	12.4 (*4*)	22.4 (*7*)		2.7 (*6*)		
Male	Adult	101.3 (*27*)	111.1 (*37*)	3.2 (*26*)	3.8 (*36*)	5.2	4.8
	Yearling	41.3 (*4*)	47.6 (*7*)	2.1 (*4*)	2.4 (*8*)		
	Kid	11.9 (*8*)	21.3 (*14*)		2.3 (*12*)		

Figure 4. The process of placing goats in crates and preparing for transport. Shown are placing goats into a crate (a and b), moving crates into the refrigerator truck (c), a goat in the crate (d), and a truck in the process of loading (e). Photo credits: John Gussman (a), Matt Ackerman NxNW Studios (b); Darryn Epp (c,d,e).

Sixty-three percent of females caught in July 2019 were lactating, and 4 of these scored < 2. In August 2019, 74% of adult females were lactating, and 2 were scored <2. Mean weights of goats of all sex/age categories increased from July to August (Table 5). The intersex goat (i.e., hermaphrodite with physical characteristics of both genders), caught in July, weighed (89.3kg).

Three goats were euthanized because they were unsuitable for transport; 1 had pneumonia, 1 was in poor condition and had extensive skin lesions of unknown cause, and 1 had a diseased hoof. The hoof was sent to the Veterinary Diagnostic Laboratory at Colorado State University (Fort Collin, CO) and diagnosed as coronary and interdigital dermatitis. Bacteria associated with the dermatitis were not of the genus *Treponema* (i.e., the bacteria causing

Treponeme Associated Hoof Disease [TAHD] currently affecting elk in Washington), nor were lesions in the hoof grossly or histologically suggestive of TAHD.

One female goat died in transport. Upon performing a necropsy it was discovered she had a broken neck. In the fall of 2018 we had 2 large male goats die in transport due to capture myopathy, which we suspected was due to them being too large for the crates. Over the winter volunteers built 10 large crates that were designated for large males. In 2019 all males over 110 kg were placed only in the larger crates, and we had no large males die in transport in 2019.

3. Transportation and Release

3. a. Methods

Because we knew from previous experience (Harris and Steele 2016) that mountain goats cannot be safely moved *en* masse, each animal to be translocated was placed in its own, specially-built crate (Fig. 4). When ambient temperatures were cool, goats awaiting transport were placed in a shady area near the processing area until ready to be transported. If temperatures rose to a point where over-heating was a concern, goats were placed in refrigerator trucks where the ambient temperature could be adjusted to approximately 10°C (50° F).

Over 150 volunteer drivers participating in the translocation effort (about 70 in 2018, about 110 in 2019, some in both years) were responsible for transporting goats to release sites following pre-determined routes. Goats were transported in fridge trucks, up to nine goats in each truck, or by pick-up trucks carrying up to two goats. Pick-up trucks were only used to move goats when ambient temperatures were cool enough to allow safe transport without the use of additional controlled cooling. Each vehicle transporting goats had a team of two volunteers, which took turns driving, or navigating and in communication with other transport vehicles and WDFW or ONP staff. Additionally, volunteers in personal vehicles accompanied the goat transport vehicles to provide any support needed. Communication was accomplished with personal cellular phones as well as InReach GPS units (Garmin Ltd, Olathe, KS).

During transport, drivers were instructed to drive at safe speeds, and stop at regular intervals (about hourly) to open the rear door for 5-10 minutes allowing additional ventilation in the back of fridge trucks. Most routes to release sites included the Kingston-Edmonds ferry. Transport from capture to release sites typically took 4-5 hours.

For releases that occurred at the planned (helicopter-accessed) sites, we first flew to the release site to confirm that it was safe to land. We then flew to the staging area to confirm plans with the crews who had been tending the goats overnight. We ferried the release crews (usually numbering 6 individuals) along with snow-fencing materials and other gear to and from the release-staging areas to the release sites prior to slinging goats (in their crates) to the release sites. In 2018 we used a Bell Jet Ranger that can safely accommodate 3 passengers, thus requiring 2 round-trips for personnel. In 2019, we used a Bell 407 that allowed us to accomplish the ferrying in a single trip. All helicopter services were provided by HiLine Helicopters, Darrington, WA.

In 2018, we set up snow-fencing in 2 roughly parallel rows, forming a chute that would encourage goats to run off in the desired direction immediately following release Crates containing goats were then delivered 2 at a time (except the larger 'billy crates', see below, which were delivered individually) to the release site. Crates were arranged in a side-by-side row, and doors were only opened once all crates had arrived. When we had known nanny-kid pairs, we always situated the 2 crates containing them adjacent to each other, releasing the kid shortly after the nanny (to increase the probability it would follow its mother). Otherwise, doors were opened as close to simultaneously as possible.

Based on the experience of 2018 that few goats remained together regardless of whether or not they were released together, we altered this protocol slightly in 2019. Instead of waiting for all goats to arrive prior to releasing them, we released each group of goats as they arrived (typically 2 or 3 together, occasionally 4), and used snow-fencing only where it seemed likely to help direct the initial movements of goats. This alteration reduced the number of helicopter round-trips, reduced the time goats spent in crates before release, and increased operation efficiency. In 2019, we also began holding onto any kids to be released until their mothers (if identified) or other females (if not) left their crates, to maximize the probability that nanny/kid pairs would stay together (Fig. 5). In 4 cases, we attempted to further increase the mothering instinct of the nanny by administering the neuropeptide Oxytocin (believed instrumental in enhancing social bonding) via aerosol and an additional dose of Midazolam (to reduce the nannie's flight response) subcutaneously approximately 20 minutes prior to release. In all but one case, we succeeded in having the kid follow closely behind its mother (in the other case, the kid remained near other goats). However, as is explained below, we were unsuccessful in having nanny/kid pairs remain together long-term.

Figure 5. Kid release protocol in 2019: Bottom right: WDFW staff holding kids in preparation for releasing them after their mothers. Upper left: A kid follows its mother, Upper Whitechuck release site. Left panel: A kid follows its (one-horned) mother, Mt. Index release site

3.b. Results

3.b.1. Transportation and release

As in September 2018, we frequently encountered weather conditions during July and August 2019 that required us to choose alternative destinations than had been planned for air-lifting goats. In some cases, none of our planned release sites was accessible to the helicopter; we choose the best available ground-release sites near our intended release sites in these cases (Table 6).

Most goats moved considerably after release, seemingly with the objectives both of escaping from their former captors (i.e., us), and of better understanding habitats, forage resources, and escape terrain not only at the release site but in the general vicinity. By September 2019, most goats could be categorized as having settled into 1 of 6 “population clusters” (Table 7, Fig. 6). No goats crossed Interstate 90; a handful of movements across US Highway 2 were recorded (in both directions). However, goats crossed relatively broad, low-elevation valleys we might have assumed would be unsuitable habitat during summer, including the Suiattle, Suak, and Middle Fork Snoqualmie Rivers.

Table 6. Mountain goats transported and released from Olympic National Park to sites in the North Cascades, September 2018, July 2019, and August 2019. Shown are dates captured, dates released, release site, general area (as shown in the FEIS), method of release, and number of goats.

Capture Date	Release Date	Release Site	Primary (P) or Alternate (A) release site	Translocation Area	Released by	Goats transported
9/10/2018	9/11/2018	Sutton Lake	A	Cedar River Drainage	Vehicle	13
9/11/2018	9/12/2018	Stillaguamish Peak	P	Stillaguamish Peak	Helicopter	5
9/11/2018	9/12/2018	Independence Lake TH	A	Stillaguamish Peak	Vehicle	5
9/12/2018	9/12/2018	Independence Lake TH	A	Stillaguamish Peak	Vehicle	2
9/13/2018	9/14/2018	Sutton Lake	A	Cedar River Drainage	Vehicle	8
9/14/2018	9/15/2018	Box Canyon (Kachess Lake)	A	Chikamin Ridge	Vehicle	9
9/17/2018	9/18/2018	Vesper-Sperry	P	Vesper-Sperry	Helicopter	12
9/18/2018	9/19/2018	Vesper-Sperry	P	Vesper-Sperry	Helicopter	14
9/19/2018	9/20/2018	Nugget Lakes	P	Tower Mountain	Helicopter	14
9/20/2018	9/21/2018	Stillaguamish Peak	P	Stillaguamish Peak	Helicopter	8
9/23/2018	9/24/2018	Nugget Lakes	P	Tower Mountain	Helicopter	8
		Total				98
Capture Date	**Release Date**	**Release Site**		**Targeted Translocation Area**	**Released by**	**Goats Released**
7/8/2019	7/8/2019	Box Canyon	A	Snoqualmie South	Vehicle	4
7/9/2019	7/9/2019	Chikamin	P	Snoqualmie South	Helicopter	4
7/9/2019	7/9/2019	Box Canyon	A	Snoqualmie South	Vehicle	9
7/11/2019	7/11/2019	Chikamin	P	Snoqualmie South	Helicopter	3
7/12/2019	7/12/2019	Box Canyon	A	Snoqualmie South	Vehicle	2
7/12/2019	7/12/2019	Preacher	P	Snoqualmie South	Helicopter	6
7/13/2019	7/14/2019	Chikamin	P	Snoqualmie South	Helicopter	9
7/14/2019	7/15/2019	Index	P	Index	Helicopter	13
7/15/2019	7/16/2019	Index	A	Index	Helicopter	6
7/16/2019	7/17/2019	Prairie-Whitechuck	A	Glacier Peak	Vehicle	7
7/18/2019	7/29/2019	Prairie-Whitechuck	A	Glacier Peak	Vehicle	8
7/19/2019	7/20/2019	Prairie-Whitechuck	P	Glacier Peak	Helicopter	5
8/16/2019	8/17/2019	Bald Eagle Trailhead	A	Glacier Peak	Helicopter	6
8/17/2019	8/18/2019	Cadet Creek	A	Cadet Ridge	Helicopter	10
8/18/2019	8/19/2019	Milk Lakes	A	Glacier Peak	Helicopter	10
8/19/2019	8/19/2019	Praire-Whitechuck	A	Glacier Peak	Vehicle	2
8/20/2019	8/21/2019	Vesper-Sperry	P	Vesper-Sperry	Vehicle	13
8/22/2019	8/23/2019	Cadet Ridge	P	Cadet Ridge	Helicopter	6
8/23/2019	8/24/2019	Pear Lake	A	Buckindy	Helicopter	14
8/26/2019	8/27/2019	Tower Mountain	P	Methow	Helicopter	12
8/27/2019	8/28/2019	Hardscrabble Ridge	P	Snoqualmie Central	Helicopter	5
8/28/2019	8/29/2019	Milk Lakes	A	Glacier Peak	Helicopter	12
8/29/2019	8/30/2019	Cadet Creek	A	Cadet Ridge	Helicopter	12

Table 7. Mountain goats released during all 3 release periods in each area, by sex and age. Each release site is organized by the 'population cluster' that roughly aligns with where goats had arranged themselves by autumn 2019 (Fig. 6). A yearling billy captured near North Bend and released at Pear Lake is included here (although not in Table 3).

		Nanny	*Billy*	*Nanny yrlg*	*Billy yrlg*	*Nanny Kid*	*Billy Kid*	*Intersex*	*Total females*	*Total males*	*Total*
Population Cluster	Release site										
Cedar	Cedar River	11	6	0	1	0	1	0	*11*	*8*	**19**
		11	**6**	**0**	**1**	**0**	**1**	**0**	**11**	**8**	**19**
Alpine Lake South	Chikamin	5	8	1	0	0	2	0	*6*	*10*	**16**
	Box Canyon	13	7	0	3	0	1	0	*13*	*11*	**24**
	Preacher	1	3	1	1	0	0	0	*2*	*4*	**6**
		19	**18**	**2**	**4**	**0**	**3**	**0**	**21**	**25**	**46**
Suak River South	Stillaguamish Peak	9	2	0	1	2	0	0	*11*	*3*	**14**
	Independence Lake	4	0	2	0	0	1	0	*6*	*1*	**7**
	Vesper-Sperry	18	5	5	9	0	2	0	*23*	*16*	**39**
	Cadet Ridge/Creek	8	13	2	2	0	3	0	*10*	*18*	**28**
	Bald Eagle TH	4	1	0	1	0	0	0	*4*	*2*	**6**
		43	**21**	**9**	**13**	**2**	**6**	**0**	**54**	**40**	**94**
Alpine Lakes North	Index	7	6	2	1	2	1	0	*11*	*8*	**19**
	Hardscrabble	1	3	0	0	0	1	0	*1*	*4*	**5**
		8	**9**	**2**	**1**	**2**	**2**	**0**	**12**	**12**	**24**
Glacier Peak/Sauk North	Glacier Pk Upper White	4	0	0	0	0	1	0	*4*	*1*	**5**
	Milk Lake	11	4	1	2	0	4	0	*12*	*10*	**22**
	Prairie Mtn-Whitechuck	7	4	0	0	2	3	1	*9*	*7*	**17**
	Pear Lake	7	5	0	1	0	1	0	*7*	*7*	**14**
		29	**13**	**1**	**3**	**2**	**9**	**1**	**32**	**25**	**58**
Upper Methow	Tower Mtn	19	6	3	0	4	3	0	*26*	*9*	**35**
		19	**6**	**3**	**0**	**4**	**3**	**0**	**26**	**9**	**35**
Total		**129**	**73**	**17**	**22**	**10**	**24**	**1**	**156**	**119**	**276**

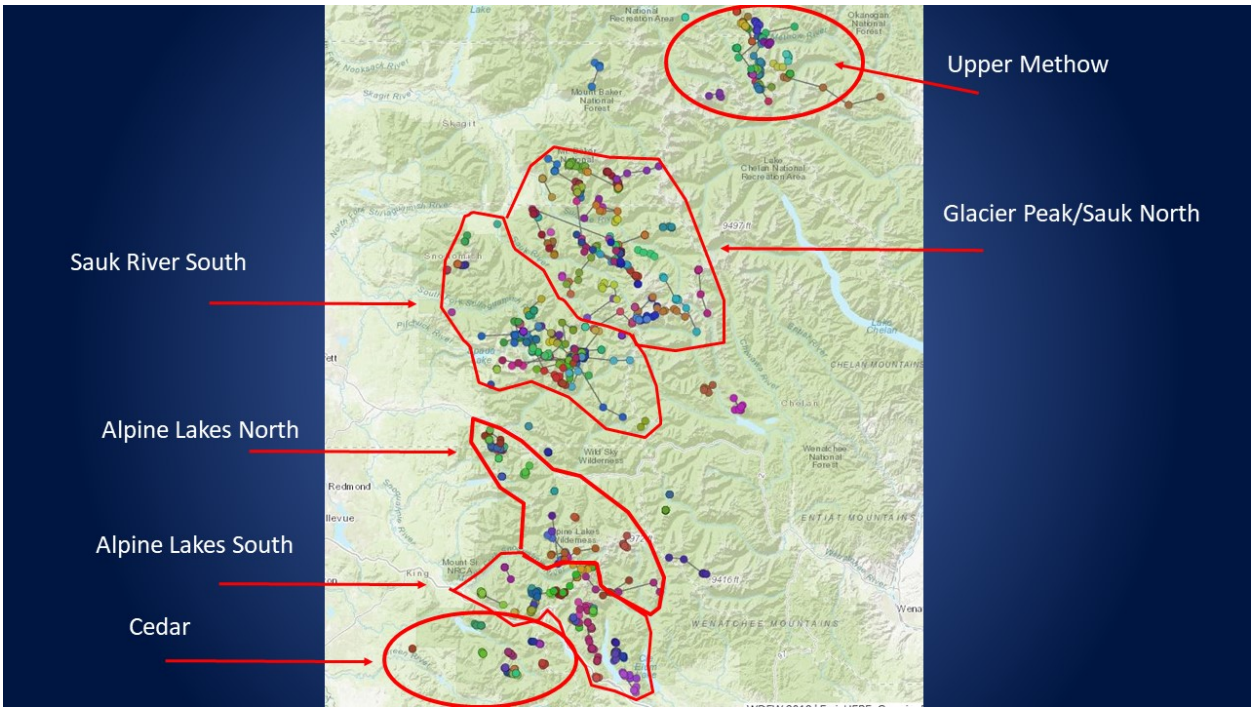

Figure 6. Aggregations of mountain goats as of September 2019, into 6 "population clusters" with larger areas than initially envisioned.

3.b.2. Survival of translocated adult mountain goats

Approximately 10% of translocated adults died during the first ~ 50 days post-release (Fig. 7). Survival improved slightly for the next 50 days, and approached what one would generally expect from a resident population following that. Forty-six adults are known to have died as of this writing (35 ♀, 11 ♂), at least 173 adults remain alive (Table 8). Although statistical analyses exist that would allow inference based solely on fate, a more rigorous analysis takes into account the number of days animals survived until death (and accounts for censoring of data if fate is unknown). We used Cox Regression, implemented in R ("res.cox" within the Survival library) to assess if selected attributes of goats (or their handling) hypothesized to effect survival were significantly associated with the number of days until death. A summary of results is provided in Table 9; raw survival by release site if shown in Table 10.

No covariates hypothesized to influence probably of mortality and under our control met the conventional threshold of significance ($P < 0.05$; Table 9.). However, results were suggestive of a true effect for 2 predictors: whether the animal sustained an injury during the capture process (Fig. 8), and whether the animal was released in wilderness or not (more likely to survive if released in wilderness than non-wilderness). There was a suggestion that individual goats

labeled as habituated survived better than those labeled as non-habituated (Fig. 9), but this may be misleading because the slope was not statistically significant.

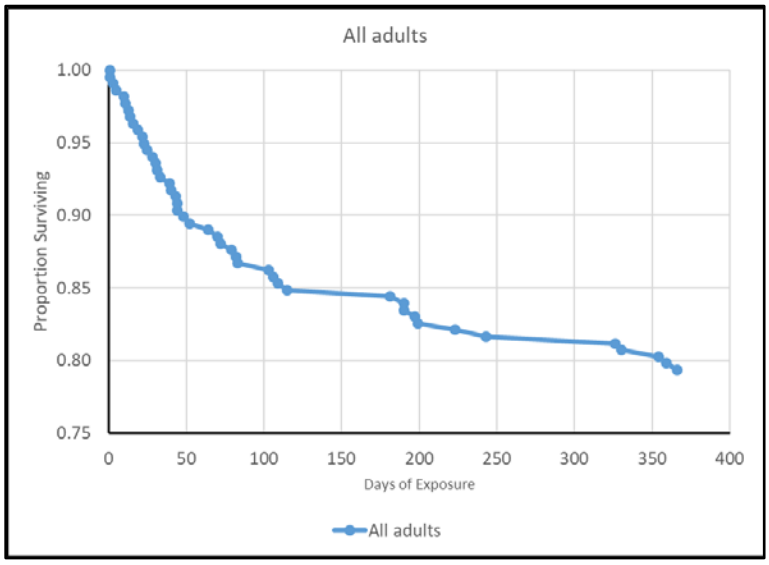

Figure 7. Kaplan-Meier type curve, showing proportion of translocated adult mountain goats surviving on days post-release (data from 2018 and 2019 included here).

Table 8. Summary of adult (age ≥ 1) mountain goats released during 2018 and 2019 that were alive as of early November 2019 (middle column) and were known to have died by early November 2019 (right-hand column).

Adults		
	Alive	Dead
Translocated	173	46
Males	70	11
Females	102	35
Interex	1	0
Mean age at capture	4.17	4.58
SE age at capture	0.15	0.35
Dart gun	48	15
Net gun	124	31
Same day release	19	1
Next day release	154	45
Habituated	61	9
Not Habituated	94	35
Proportion Injured	0.41	0.51
Mean Condition Index (SE)	3.01 (0.06)	2.42 (0.10)

*Table 9. Summary of Cox regressions of selected attributes on survival time of adult mountain goats, September 2018-November 2019. Shown for each variable are the slope, standard error, z score and its significance (positive slopes indicate more likely to die), as well as hazard ratios and their 95% confidence bounds (hazard ratios > 1 mean more likely to die). Values in **bold italics** significant at P < 0.01. Top panel: Exposure to mortality from release through death (or November 2019); Bottom panel: Exposure to mortality censored at 60 days post-release to emphasize hazards shortly after release.*

Variable	Slope	Standard error	*z*	*P*	Hazard ratio	Hazard ratio Lower bound (95%)	Hazard ratio Upper bound (95%)
Basic Animal							
Gender (reference = male)	**0.684**	0.346	1.978	**0.048**	1.982	1.006	3.902
Age	0.065	0.733	0.894	0.372	0.937	0.925	1.233
Capture/handling related							
Habituated (reference = no)	-0.023	0.783	-0.030	0.976	0.977	0.210	4.536
Capture (reference = net gun)	1.615	40.171	0.004	0.997	large	0.000	inf
Injured during capture	0.396	0.305	1.298	0.194	1.486	0.817	2.702
Day released (reference = same)	1.725	1.011	1.705	0.088	5.613	0.773	40.740
Elapsed time from crate to release	0.026	0.034	0.755	0.450	1.026	0.960	1.096
Elapsed processing time	-0.013	0.049	-0.269	0.788	0.987	0.896	1.087
How released (reference = ground)	0.149	0.346	0.431	0.666	1.161	0.589	2.288
Where released (reference = wilderness)	**1.545**	0.474	3.261	**0.001**	0.213	0.084	0.540
Animal health and condition							
Condition (numeric 1-4)	***-0.959***	0.215	-4.463	**<0.001**	0.383	0.252	0.584
With Kid (reference = no)	***0.668***	0.298	2.243	**0.025**	1.949	1.088	3.493
Condition * with Kid							
Condition	**-1.125**	0.332	-3.391	**<0.001**	0.325	0.169	0.622
with Kid	-0.912	1.213	-0.752	0.452	0.402	0.037	4.325
Condition X with Kid	0.404	0.494	0.818	0.413	1.498	0.568	3.939

Variable	Slope	Standard error	*z*	*P*	Hazard ratio	Hazard ratio Lower bound (95%)	Hazard ratio Upper bound (95%)
Basic Animal							
Gender (reference = male)	0.438	1.549	1.256	0.209	0.646	0.783	3.067
Age	0.000	0.077	0.002	0.998	1.000	0.859	1.164
Capture/handling related							
Habituated (reference = not)	-0.602	0.374	-1.604	0.109	0.548	0.263	1.143
Capture (reference = net gun)	1.511	30.093	0.005	0.996	>300	0.000	inf
Injured during capture	0.557	0.307	1.815	**0.070**	1.745	0.957	3.185
Day released (reference = same)	1.348	1.017	1.325	0.185	3.849	0.524	28.260
Elapsed time from crate to release	0.013	0.036	0.379	0.705	1.014	0.945	1.087
Elapsed processing time	-0.014	0.669	-0.207	0.836	0.986	0.865	1.124
How released (reference = ground)	0.450	1.568	1.283	0.199	1.546	0.789	3.118
Where released (reference = wildern	0.956	0.491	1.947	**0.052**	2.601	0.994	6.807
Animal health and condition							
Condition (numeric 1-4)	***-1.072***	0.232	-4.624	**<0.001**	0.342	0.217	0.539
With Kid (reference = no)	***0.628***	0.298	2.110	**0.035**	1.874	1.046	3.357
Condition * with Kid							
Condition	**-1.175**	0.345	-3.407	**0.001**	0.309	0.152	0.607
with Kid	-0.553	1.258	-0.439	0.661	0.575	0.489	6.777
Condition X with Kid	0.234	0.515	0.454	0.650	1.264	0.460	3.468
Condition * injured							
Condition	-0.946	0.321	-2.946	0.003	0.388	0.207	0.729
Injured	1.163	1.252	0.929	0.353	3.200	0.275	37.191
Condition X Injured	-0.257	0.501	-0.515	0.607	0.773	0.290	2.062

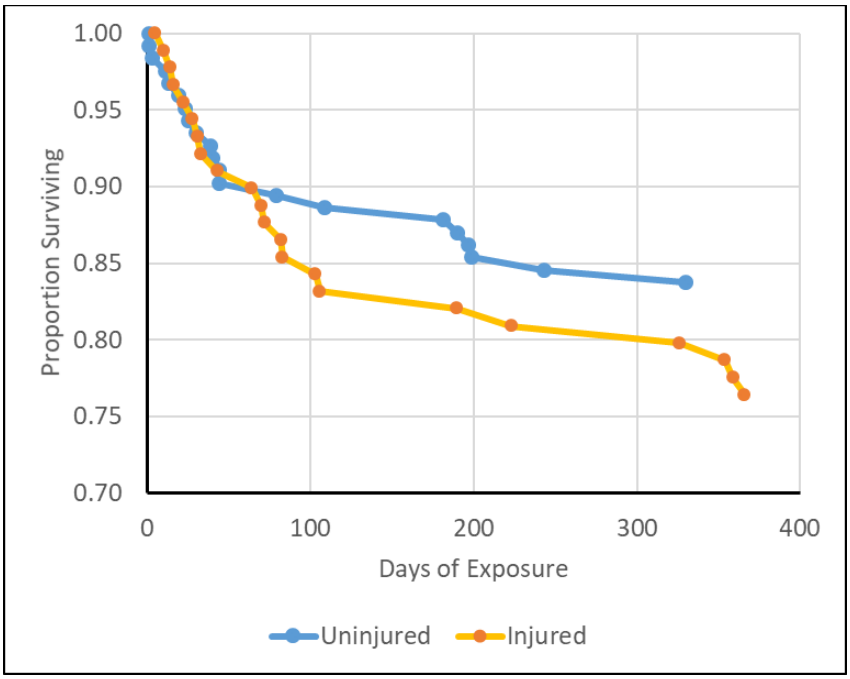

Figure 8. Kaplan-Meier type chart, proportion released adults survival on days of exposure: Orange line = animals with evidence of injury resulting from capture; Blue line = animals with no observable injury.

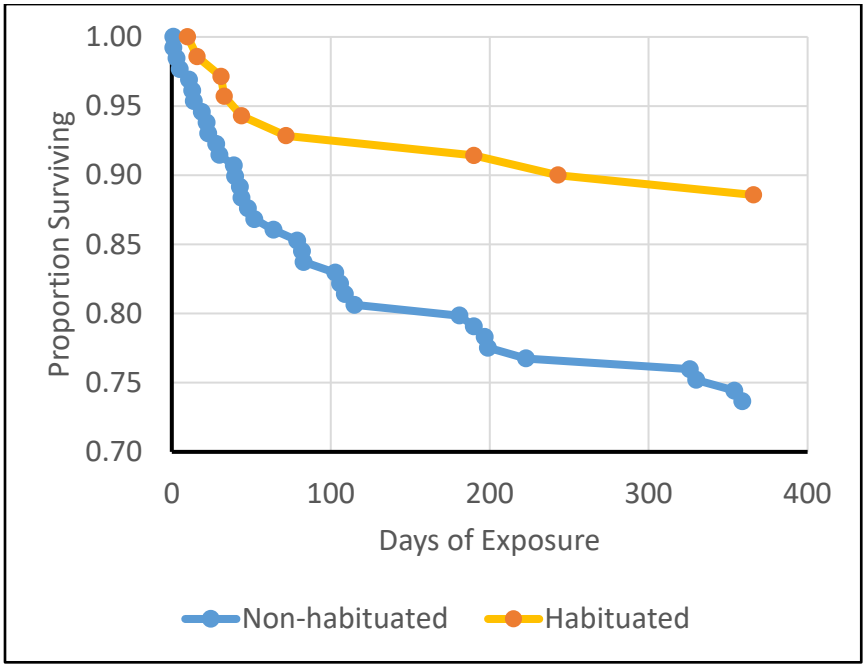

Figure 9. Kaplan-Meier type chart, proportion released adults survival on days of exposure: Orange line = animals defined as habituated by their location of capture, blue line = animals defined as non-habituated.

Animals in poor condition were more likely to die than those in good condition; females with kids (or that were documented as lactating when captured) were more likely to die than females without kids and/or not lactating (Table 9). These two characteristics, neither under management control, were by far the strongest signals from the analyses of time to mortality That nannies were more likely to die if accompanied by kids could reflect either their poorer body condition (mean [SE] body condition index for nannies without kids = 2.84 [0.06]; mean body condition index for nannies with kids = 2.37 [0.08]; males = 3.36 [0.09]), or some other stress or behavior associated with having kids. However, the interaction model including both predictors showed a continued association with body condition but not an association for being with a kid (or the interaction of the two predictors), suggesting that the association with having a kid was actually a proxy for being in poorer body condition. Females were more likely to die than males, but again, this may simply reflect their generally poorer body condition.

Table 10. Number of goats alive, dead, unknown, and raw survival by release sites. Sites in italic font are in designated wilderness areas.

	Alive	Dead	Unknown	Raw Survival
Bald Eagle	6	0	0	1.00
Box Canyon	16	6	2	0.73
Cadet Creek	*19*	*0*	*0*	1.00
Cadet Ridge	*5*	*1*	*0*	0.83
Cedar	15	2	1	0.88
Chikamin	*13*	*1*	*0*	0.93
Hardscrabble Ridge	4	0	*0*	1.00
Independence Lake	2	1	*3*	0.67
Index	10	6	*0*	0.63
Milk Lakes	*14*	*2*	*2*	0.88
Pear Lake	*12*	*1*	*0*	0.92
Prairie-Whitechuck	10	2	*0*	0.83
Preacher	*6*	*0*	*0*	1.00
Stillaguamish Peak	5	6	1	0.45
Tower Mountain	19	8	1	0.70
Upper Whitechuck	*4*	*0*	*0*	1.00
Vesper-Sperry	13	10	14	0.57
	173	46	24	0.79

The higher likelihood of dying if released in a non-wilderness area is more difficult to interpret (in Table 9, the reference being "in wilderness" means "more likely to die compared with the reference, i.e., not in wilderness). The proportion of lactating females released in wilderness (21 of 41) was similar to the proportion released in non-wilderness (50 of 96); thus being in poor condition as a result of recent pregnancy and lactation was unlikely to explain lower survival outside of wilderness. Body condition of females released in wilderness was slightly higher ($\bar{X}$ = 2.71, SE 0.11) than of females released in non-wilderness ($\bar{X}$ = 2.57, SE = 0.06), but this would seem capable of explaining only part of the difference in survival. It is possible that "wilderness" per se was not responsible, but rather that more of the selected non-wilderness release sites happened to have characteristics less amenable to mountain goat survival than wilderness sites. (Survival was notably lower in in Index, Tower, and Stillaguamish Peak areas than average, but the highest survival was also in a non-wilderness site, Cedar River, Table 10).

3.b.3. Movements of translocated adult mountain goats

Immediately post-release, female goats moved more on a daily basis than males for the first ~ 40 days on average, after which point movements rates were similar for the sexes (Fig. 10). Mean daily movement rates declined with time since release, although how much that reflected "settling down" and how much reflected the onset of winter (when movement rates of resident goats generally decline) cannot be distinguished with these data.

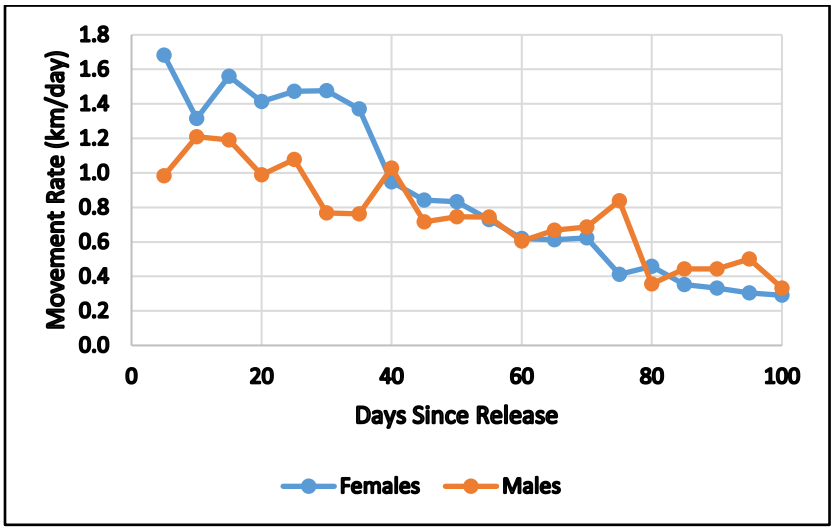

Figure 10. Rates of movement (km/day) of translocated female (blue) and male (orange) mountain goats by 5-day periods after release. Movement rates are underestimated because most collars provided locations only every 23 hours.

Within 2 days after release, female locations averaged 3.9 km and males 2.4 km from their site of release. Mean distances from release sites increased to 6.5 km (females) and 3.7 km (males) on day 5, 8.8 km (females) and 6.9 km) males) on dy 10, 13.5 km (females) and 9.1 km (males) on day 20, and 14.0 km (females) and 11.5 km (males) on day 60 (Fig. 11).

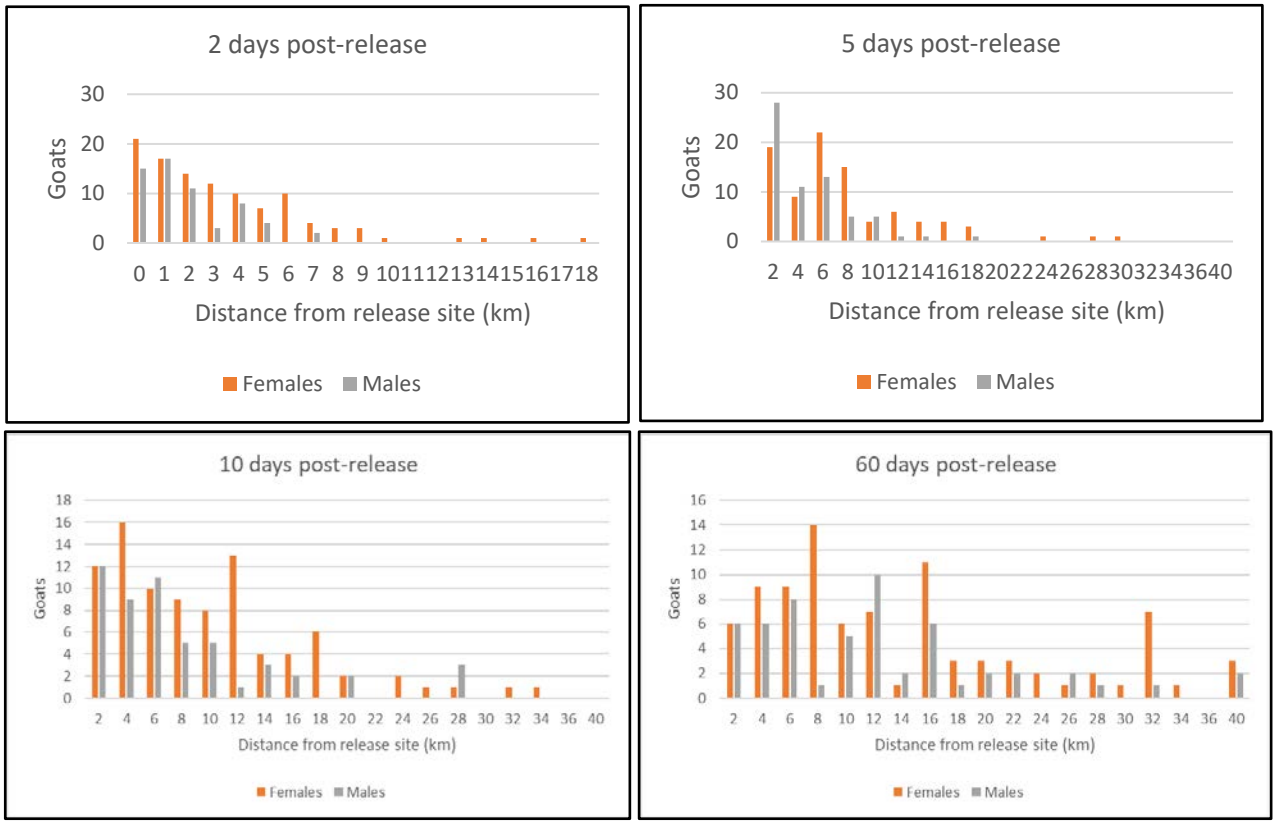

Figure 11. Histograms showing number of goats at selected distances from their release site (orange bars = females, gray bars = males). Upper left: 2 days post-release; upper right: 5 days post-release; lower left: 10 days post release; lower right: 60 days post-release.

Figure 11 averages movement patterns among individuals and thus obscures considerable inter-individual variation. Figure 12 provides an example of short-term distances from the release site for 9 female (blue color) and 3 male (tan color) goats released at the Tower Mountain (Methow) site in September 2018. Movement patterns varied; although almost all goats moved away from their release site quickly, some settled down relatively close by, while others continued moving away for some time, and yet others appeared to backtrack and settle down closer to their release site than they had travelled, suggesting exploratory behavior.

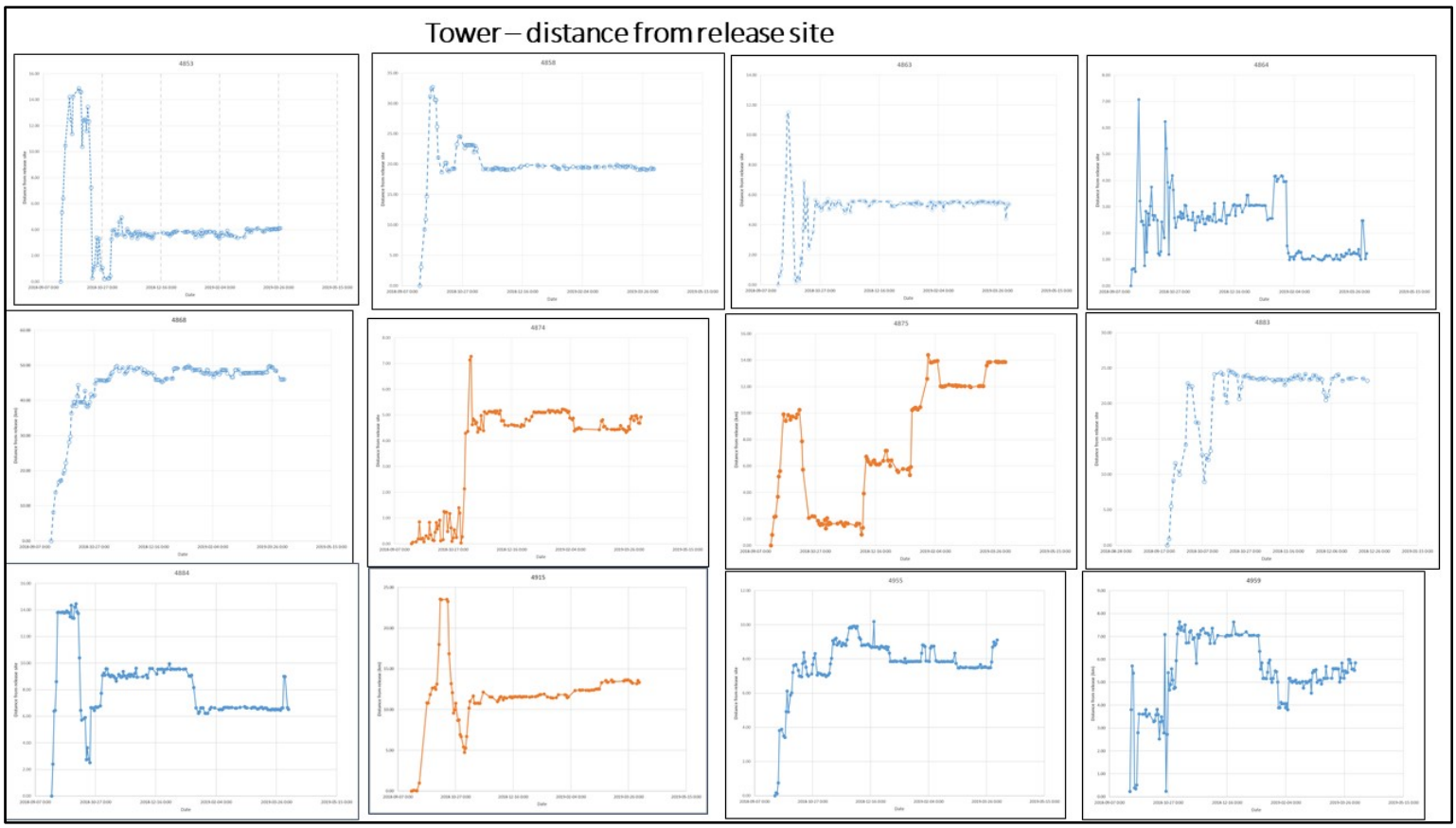

Figure 12. Distance from release site (y-axis) on days post-release (x axis) for 9 female (blue) and 3 male (tan) mountain goats released at the Tower Mountain site in September 2018. Panels with open blue circles represent distances from release sites of females released with their kids. Note that y-axis scales vary.

As expected, goats moved very little during the winter, increasing their movement rates during summer. As discussed by Festa-Bianchet and Côté (2008), females tended to move slightly more than males (Fig. 13). An exception to this pattern occurred in November 2018, when mean daily movement rate of males exceeded that of females. This most likely reflected reproductive behavior (which generally peaks in November), in which males typically search out receptive females, and thus travel more widely.

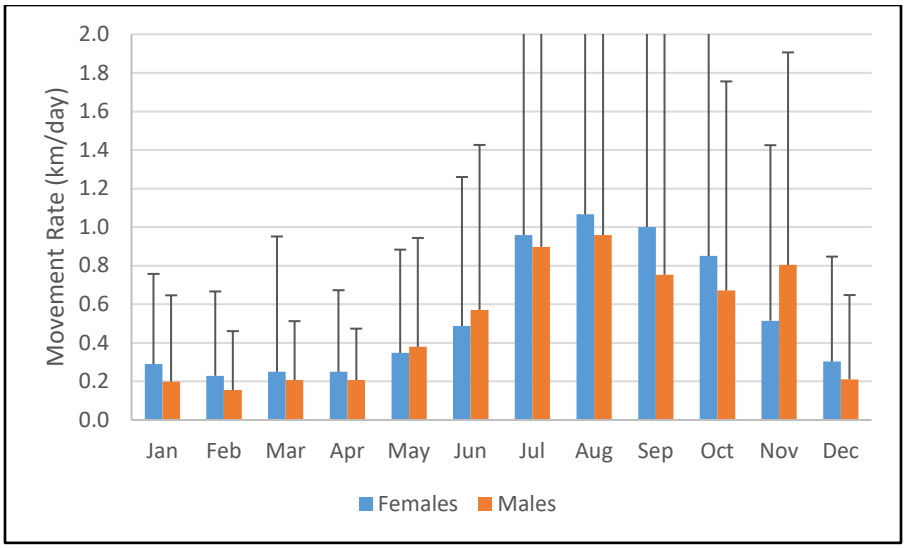

Figure 13. Mean (vertical histogram) and standard deviation (error bar) of daily movement rates of female (blue) and male (orange) mountain goats fitted with GPS collars, by month.

As we expected (Rice 2018), goats descended to lower elevations beginning in October, averaging about 1,000 feet lower during mid-winter than mid-summer (Fig 14.). Similarly to findings of Rice (2018), translocated mountain goat females began their upward elevational movement in summer earlier than males, and time spent at relatively low elevation exceeded time spent in the alpine.

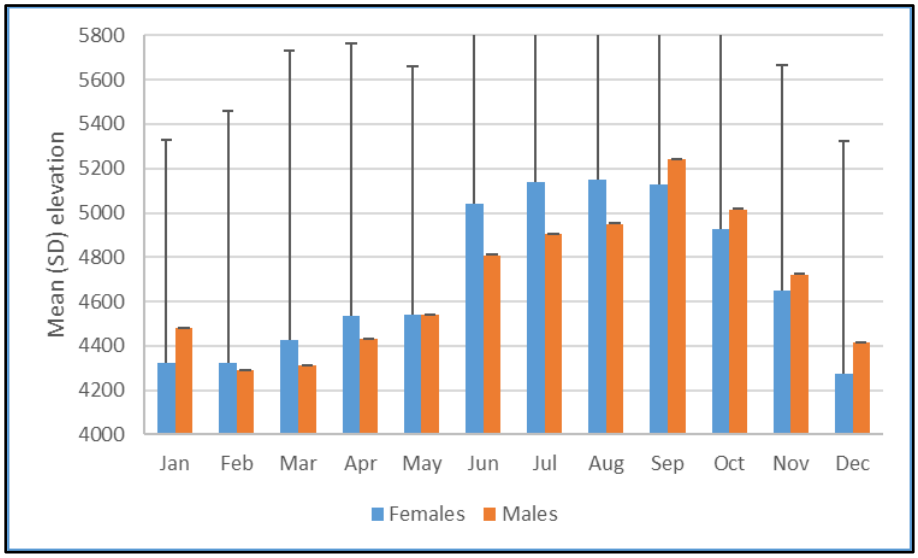

Figure 14. Mean (vertical histogram) and standard deviation (error bar) of elevations (in feet) of locations of female (blue) and male (orange) mountain goats fitted with GPS collars, by month.

3. b. 4. Movements of translocated kid/nanny pairs

Kids translocated in September 2018 were equipped with VHF-only transmitting collars, constraining our ability to monitor their movements to opportunities we had to find them on the ground or via dedicated telemetry flights. We documented no evidence that kids were travelling with their mothers in all 8 cases in which we were able to document their locations on the same day (Table 11). Straight-line (SL) distances between kids and their mothers varied from approximately 2.7 to 55.6 km.

Table 11. Dates when radio-telemetry relocations of VHF-collars mountain goat kids translocated in September 2018 were tracked (left set of columns) and their mortality status; along with approximate straight-line (SL) distances (km) from their putative mothers obtained from GPS locations on the same date.

Kid				Nanny		SL distance
						km
Date	**ID**	**Gender**	**Status**	**ID**	**Status**	
3/4/2019	4854	M	Alive	4851	dead	36.5
10/18/2018	4859	F	Alive	4883	alive	22.3
3/4/2019	4859	F	Alive	4883	alive	18.1
3/4/2019	4865	F	Alive	4868	alive	9.5
10/18/2018	4880	F	Alive	4870	alive	27.7
1/16/2019	4880	F	Mort	4870	dead	29.0
10/18/2018	4893	M	Alive	4869	alive	2.7
3/4/2019	4893	M	Mort	4869	alive	14.2
10/18/2018	4941	M	Alive	4903	alive	
3/4/2019	4941	M	Mort	4903	alive	22.1
10/18/2018	4942	F	Alive	4932	alive	48.8
3/4/2019	4942	F	Alive	4932	dead	24.0
10/18/2018	4943	M	Alive	4889		55.6

In summer 2019, kids were either not equipped with radio-collars (when judged too small to wear one), equipped with VHF-collars as in 2018, or equipped with light-weight, expandable, drop-off GPS collars (Vectronics Aerospace, Berlin, Germany). We attempted to locate all kids

released without GPS collars, as well as their mothers, during August 25 and 26, 2019. Although we were unable to observe kids visually, we obtained approximate locations of 5 kids alive at the time: as with kids released in September 2018, they were far from their mothers in all 5 cases.

We were also able to document precise locations of 5 other nanny/kid pairs in which both wore GPS collars. Mothers had separated from their kids by > 5 km by the time the first GPS locations were transmitted in 4 of the 5 cases. Although patterns varied, we observed no indications that kids and their mothers were travelling together.

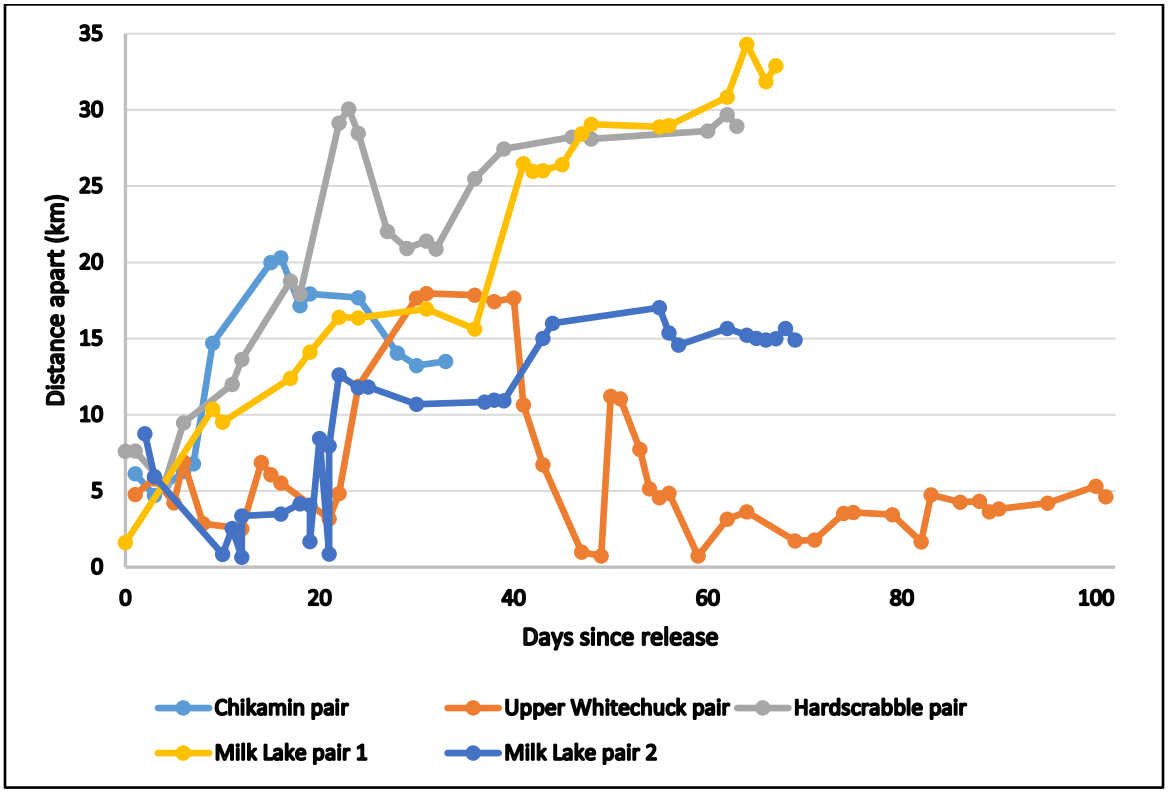

Figure 15. Distances between nannies and their kids obtained on the same day (from their GPS collars), on days post-release. Shown are 5 nanny-kid pairs in which both were fitted with GPS collars.

Although some kids no doubt became solitary, we obtained anecdotal evidence that at least some kids found other mountain goats to associate with, and that these associations were evidently tolerated by the other animal (Fig. 16).

Figure 16. Anecdotal evidence that some translocated mountain goat kids, although not following their mothers, found other mountain goats to follow. Top: Goat kid 5188 following yearling billy 5130 in August 2019. Bottom. Unidentified kid following un-collared (resident) billy, near Hart's Pass in the upper Methow drainage, game camera photo managed by WDFW biologist Scott Fitkin.

3. b. 5. Survival of translocated kids

As documented in the FEIS, we expected survival of translocated kids to be poor. We released 11 kids (6 ♀, 5 ♂) in September 2018; we were able to determine their fate as opportunity permitted at various times post-release. As of late October 2018 we knew that 6 remained alive. By early March 2019, 2 of those had died, leaving 4 known alive (3♀, 1 ♂), 6 dead (4♀, 2 ♂), and 1 (♂) unknown. During the combined July and August 2019 translocations, we released 23 kids (4 ♀, 19 ♂). (A primary reason for the skewed sex ratio of released kids is that the zoo consortium took mostly females). As of this writing, we have documented 5 mortalities among these kids (1 ♀, 4 ♂). As of August 26, we knew that at least 6 kids were alive (including GPS and VHF-only equipped animals). As of this writing, 5 of the 6 kids wearing GPS collars (and thus providing real-time data on survival) remain alive. Given that over-winter survival of resident kids is typically around 50%, that we expected it to be lower than that due to the stress of translocation and adapting to new home ranges, and that – despite our efforts – nannies did not stay with their kids post-release, we are pleasantly surprised to find kid survival this high.

3. b. 6. Reproduction from 2018 releases

Because only 14 of the 98 animals released in September 2018 were adult billies, and because they all had relatively little time to adapt to their new surroundings, we did not expect much reproduction from translocated nannies in spring 2019. Further, our monitoring budget was insufficient to allow visual confirmation of reproductive status of all but a selected handful of nannies that might have produced offspring in 2019.

With a grant from Seattle City Lights, teams of students from Western Washington University made 14 back-packing trips during summer 2019 with the objective of observing selected nannies that could plausibly have produced kids, and that were accessible within the time constraints of a 4-day backpacking trip. The teams were able to observe 8 of the 18 candidate nannies. Of the 8, 3 were confirmed to have produced kids (Fig. 17). All 3 of these nannies had been aged at capture as 5-years old (the 5 nannies without kids were aged as 3, 4, 4, 5, and 5). Muckleshoot biologists additionally confirmed kids with 3 of 6 nannies they were able to visually identify in August 2019. During August radio-tracking, we additionally observed a

kid with the only nanny released in 2018 that we attempted to observe visually. Thus, we can account for 7 kids born to nannies released in 2018 (out of 15 for which we have information).

Figure 17. Evidence of reproduction among translocated nannies.

3. b. 7. Preliminary information regarding genetics of translocated goats

WDFW has contracted with Dr. Aaron Shafer, Trent University, Peterborough, Ontario, to provide genotyping and basic analyses of genetic diversity among mountain goats removed from and translocated to the North Cascades. Results from 112 of 115 samples sent from September 2018 captures are complete; samples from 2019 captures are currently in process.

Table 12 provides a summary of genetic diversity indices as well as the same indices from other populations. These generally suggest that Olympic goats have similar genetic diversity to other populations. This conclusion appears to differ from those of Shirk (2009) who found considerably lower genetic diversity in a sample of 12 Olympic National Park goats than reported here. We are currently working to better understand the difference in these two assessments. We would expect these diversity measures to increase in native Cascade mountain

goats as ONP goats begin reproducing (i.e., producing ONP x Cascade hybrids) and introduce novel alleles.

Table 12. Summary of genetic diversity indices for 112 mountain goats removed from Olympic National Park in September 2018 (red font) as well as the same indices for other mountain goat populations. Shown are mean number of alleles, observed (O) and expected (E) heterozygosity, and inbreeding coefficient (F_{is}) from 16 microsatellites. Analyses courtesy of A. Shafer, Trent University, Peterborough, Ontario.

Population	No. Samples	No. Alleles	Heterozygosity (O)	Heterozygosity (E)	Fixation index (F_{IS})
Washington (ONP)	112	3.31	0.41	0.42	0.03
Washington (Cas.)	23	3.00	0.29	0.33	0.08
BC / AB (Rockies)	221	5.31	0.47	0.51	0.08
BC (Selkirk)	33	4.00	0.40	0.46	0.16
BC (Pacific Range)	19	4.56	0.48	0.50	0.05
BC (Purcell)	27	3.56	0.45	0.51	0.11
Montana	12	2.68	0.33	0.43	0.24
Idaho	20	2.50	0.29	0.32	0.08

In accord with the results of Shirk et al. (2010), the newer, larger sample found that Olympic Park goats were readily differentiable from resident goats in the Cascades (Fig. 18) using these 16 microsatellites, providing the basis for future sampling to determine the goat's origin. There is no evidence currently supporting outbreeding depression in mountain goats that could arise from the introduction of maladaptive alleles from ONP into the North Cascades, and thus adverse genetic effects from hybridization is not expected.

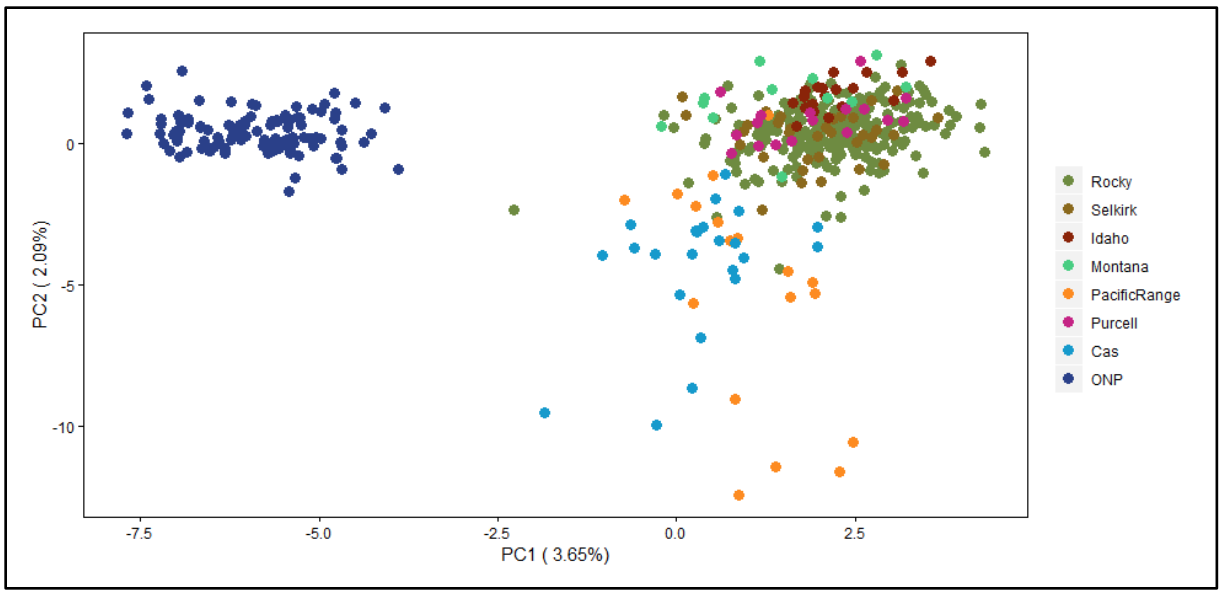

Figure 18. Principle component of Olympic National Park (ONP) mountain goats and neighboring populations based on 16 microsatellite data. Analyses by A. Shafer, Trent University.

3. b. 8. Anecdotes relevant to potential human-goat interactions

a) Nanny 4935, known to be habituated to humans, released in the Cedar River drainage on September 11, 2018 moved on about September 24, 2018 to McDonald Mountain (Fig. 19) where she remained, essentially sedentary within an area of < 1 km^2 for almost an entire year. Although we have no indication that she caused any problems, we were concerned due to the relative proximity of rural dwellings (in Ravensdale, Black Diamond, and other small communities in rural King County) and visits by maintenance personnel to the communications installations nearby (she was occasionally seen and photographed by local hikers). Sometime during the period September 3-8, 2019, she abruptly moved south, toward Howard Hanson

reservoir for approximately a month, and then moved further south to Grass Mountain in early October, 2019, where she remains as of this writing.

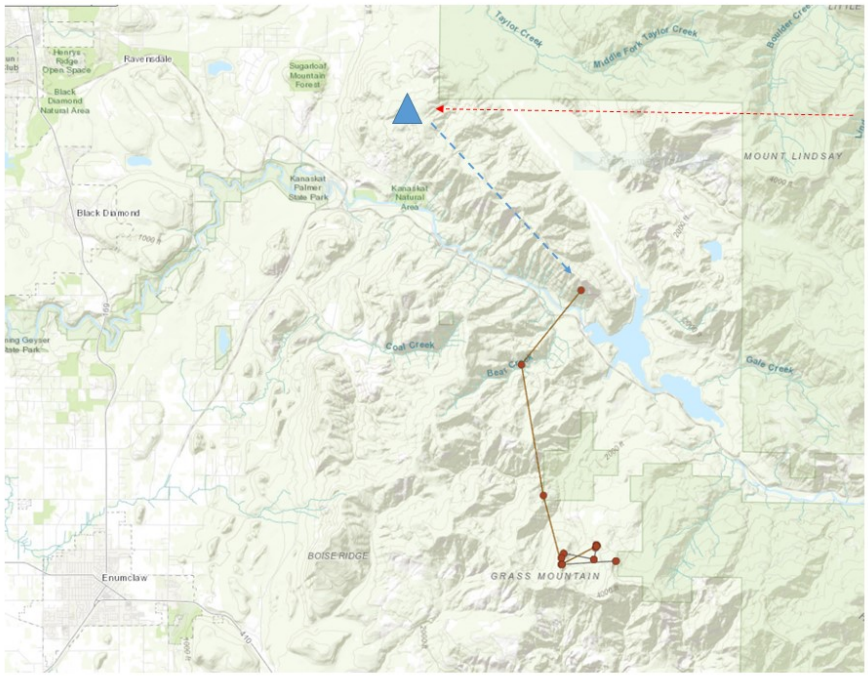

Figure 19. Locations of nanny 4935, showing the direction of her travel from the release site in September 2018 (red dashed arrow), her "home" for the next year on McDonald Mountain (blue triangle), and subsequent movements beginning in October 2019 (brown circles connected by straight-line movement paths).

b) Nanny 5110 was released on July 17, 2019 at the Prairie-Whitechuck (ground) release site, when weather precluded releasing goats via helicopter at more remote locations. We observed a mountain goat, who we suspect was this animal, running down USFS Road 24 less than 1 hour after the release. Nanny 5110 subsequently spent all her time beginning about July 21 in low elevation, forested, and relatively flat terrain only a few hundred meters from the town of Darrington, east across the North Fork of the Sauk River. Although she caused no problems and we are unaware of any sightings, her proximity to the town caused us some anxiety. However, sometime during the period October 4-9 2019, she abruptly moved further up Prairie Mountain into steeper terrain, where she has remained as of this writing (Fig. 20).

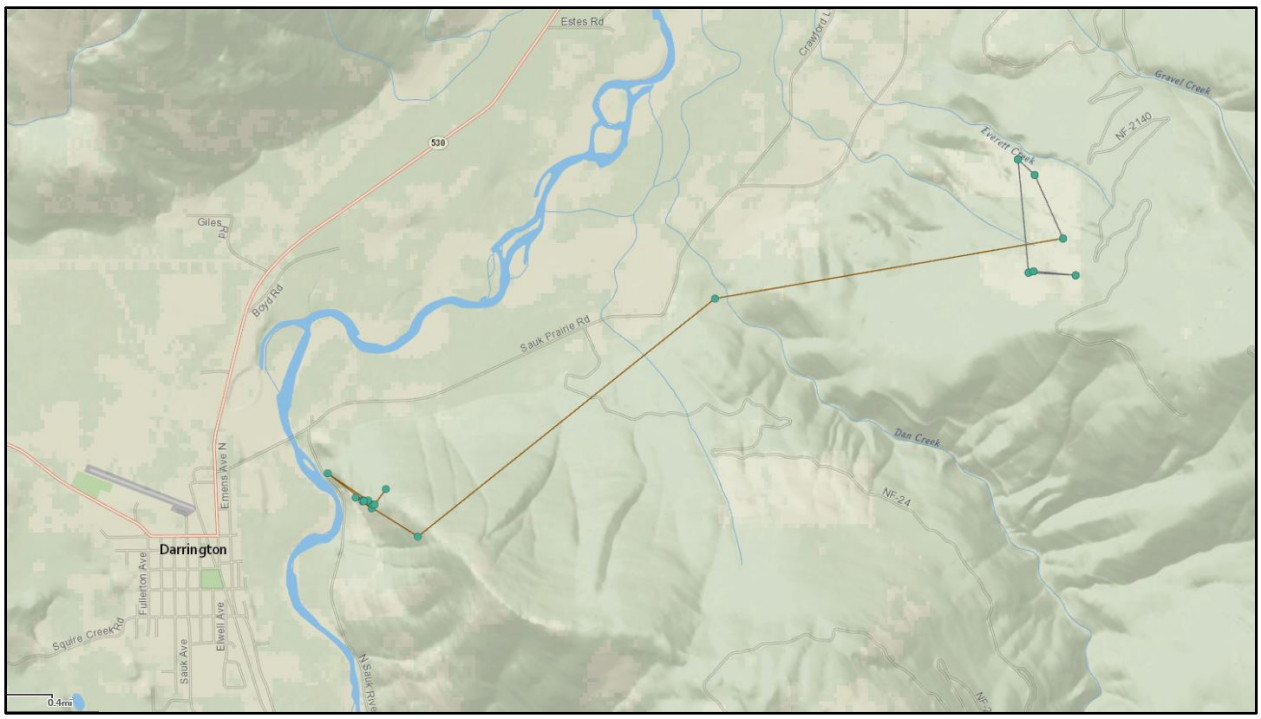

Figure 20. Locations of nanny 5110 during October 2019, showing the cluster of locations just east of Darrington (note the airstrip from which we conducted helicopter-based operations), and her abrupt movements a few km further up Prairie Mountain.

c) Male 5006 is large adult male captured August 19, 2019 Upper Royal Basin in Olympic National Park. Park staff had had goats appear in this area for a number of years, but since 2016 had begun getting reports of a male goat that was getting increasingly more persistent in approaching campers. He would respond to hazing (in this case yelling and rock-throwing by visitors or back-country staff), but during the 2017-18 he was getting more persistent, and due to his large size (136 kg when captured), more intimidating to visitors. ONP staff have no record of him being aggressive to people, but a shirt and (salty) hat were reported as being eaten in 2018.

Given this history, we would ideally have released him in as remote a location as possible. Unfortunately, his arrival coincided with another poor weather day; thus we had little choice but to release him at the Prairie-Whitechuck (ground) release site on August 19, 2019. He spent approximately 1 week relatively close to the release site, but then began travelling in a southeast direction, and by mid-September had skirted north of Glacier Peak and reached the White Mountains on the eastern extent of the Glacier Peak Wilderness Area (Fig. 21), where a group of resident goats were known to occur, and where he remains of this writing.

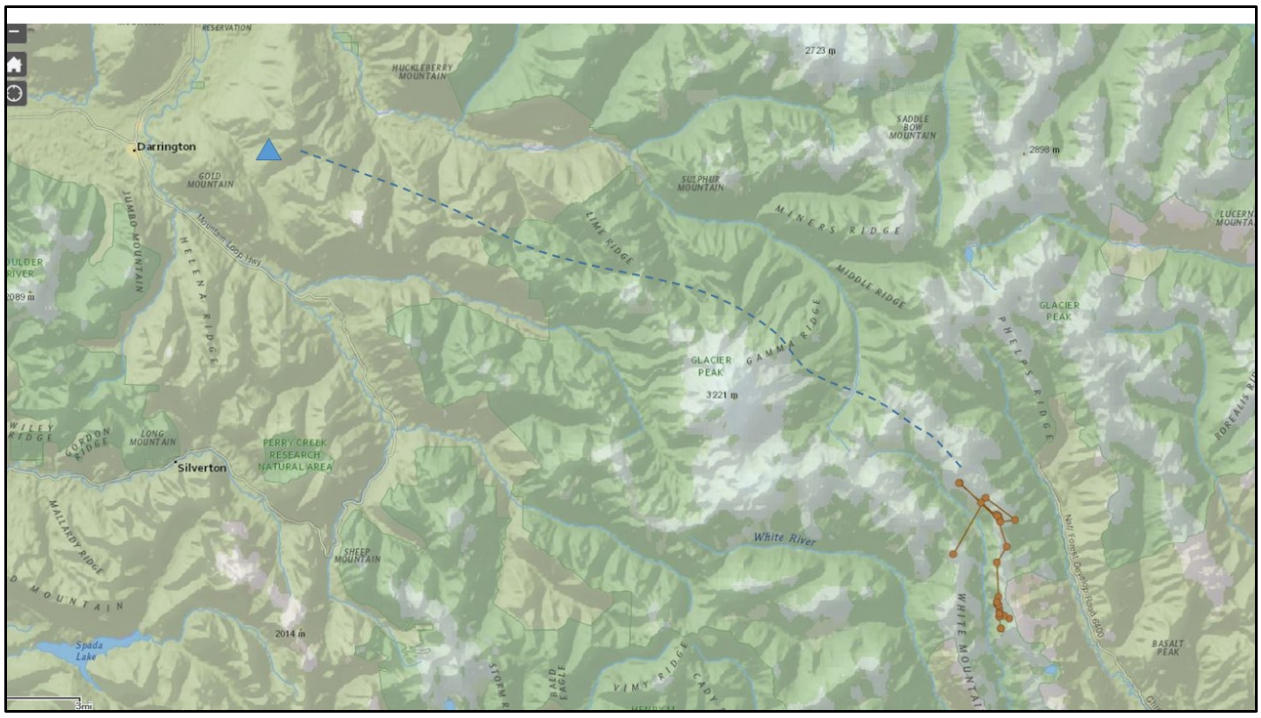

Figure 21. Movements of billy 5006 released at the Prairie-Whitechuck site (blue triangle) on August 19 2019, GPS points in September 2019 shown in brown.

d) Male 5138 (which was not considered habituated according to our definitions) was released at the Box Canyon (ground) site on July 10, 2019. Within a day, he had moved south to the west slope of Amabilis Mountain (which separates the southern portions of Kachess and Keechelus Lakes), within a stone's-throw of heavily travelled Interstate 90 (Fig. 22). Although he has been observed by motorists a number of times, we are unaware of attempts he may have made to cross south across the highway. He has preferred staying in dense cover (twice evading attempts to observe him from helicopter, when considering whether moving him might be feasible), and remains in this general location as of this writing.

Figure 22. Locations of male 5138 during October 2019, just north of Interstate 90 on Amabilis Mountain.

e) We previously provided a brief narrative about goat 4940, which locally became known as the "Rattlesnake Nanny" because of her short sojourn – amply documented via smart phone selfies – at the Rattlesnake Lake Recreation Area operated by Seattle Public Utilities near North Bend, Washington (Happe and Harris 2018). We reported that, as of December 2018, she had returned to near her release site and was associating with other released mountain goats. As of this writing she has remained near her Goat Mountain release site, continued to associate with other goats, and has made no movements back to the Rattlesnake Recreation Area. On August 13, 2019, Muckleshoot biologists reported that she was accompanied by her newly-born kid.

f) In late August 2019 while focused on translocating Olympic goats, WDFW Region 4 staff received a report from a concerned citizen of a mountain goat in a residential area just north across Interstate 90 from the town of North Bend. After confirming the report and failing in attempts to haze the animal from the reporting party's residence (Fig. 23), WDFW staff immobilized the animal chemically, kept it overnight, and added it to the planned mixture of animals coming from the Olympics for translocation on August 23. We lack a convincing hypothesis regarding why this young billy was so insistent on remaining at the residence, nor do we know its origin (save that it was not an animal we had translocated from the Olympics). However, both the goat and the residential community were fortunate in that this occurred just as

we were in a position to move it. The animal was given ear-tag number 1857, released near Pear Lake in the northern portion of the Glacier Peak Wilderness Area on August 24, where it has remained to this writing. It has frequently travelled in association with male 5090, with which it was released.

Figure 23. Un-collared (resident) yearling billy at a residence near North Bend, WA that WDFW staff immobilized, renamed 1857, and added to the goats being relocated in Glacier Peak Wilderness Area of the North Cascades on August 24, 2019.

4. Discussion

Previous translocations of mountain goats have documented considerable dispersal of animals immediately following release (Fielder and Keesee 1988, Jorgenson and Quinlan 1996), Harris and Steele 2014). We were thus not surprised to see similar behavior among many albeit not all, the released goats. However, visual depictions of goat locations (i.e., from maps) may not

reflect how much goats know about each other, or about the terrain separating them. We have already noted instances in which animals seemed to find each other after being separated quite some distance. We are heartened that some of the nannies released in September 2018 produced kids in summer 2019; we expect to find many nannies producing kinds in summer 2020.

Survival among adults has been lower than will ultimately be needed for sustainability, let alone population growth. However, we anticipated that abundance would decline before it would begin increasing; animals exploring new terrain are expected to suffer higher mortality rates than residents. At this early stage, it seems likely that some of the translocated goats will live out their lives without forming new, or joining existing social groupings. However, we remain optimistic that many will find each other, begin producing offspring, and form the nucleus of new, or newly enlarged, breeding groups. As of November 5, 2019, data from GPS-transmitting collars suggested that at least 10 translocated billies had been in close proximity to translocated nannies for at least one day during the period November 1-November 3, 2019.

5. Future plans

A fourth and final capture and translocation effort is planned for the 12-day period beginning July 27, 2019. We are starting later in July in 2020 than in 2019 in order to provide more time for nannies to recover from the stress of pregnancy and lactation, be in better condition, and consequently improve their chances of surviving translocation. We expect operations, processing sites on the Olympic Peninsula, and release areas in the North Cascades to be very similar to those used in summer 2019. An additional 80-120 goats released in these areas will increase the probability of achieving our long-term goal of well-distributed and genetically connected groups of mountain goats wherever appropriate habitat allows for it throughout the North Cascades.

Tentative plans call for lethal removals of remaining mountain goats in Olympic National Park to begin in autumn 2020, with use of citizen volunteers working under NPS direction and authority. WDFW will consider whether, and if so, how to use licensed hunters to remove any mountain goats remaining on Olympic National Forest lands following the summer 2020 translocation effort.

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At Hamma Hamma Staging Area:

Numerous personnel from WDFW, USFS, NPS, the Skokomish, Port Gamble, Point-No-Point, and Quinault Tribes, along with citizen volunteers from WDFW, Student Conservation Association, Eyes-in-the-Woods, and Olympia Mountaineers aided the Hamma Hamma staging area operations. The support of these people was critical for this operation to run safely and smoothly. We thank them all.

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