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GRIZZLY BEAR SPACE-USE & MOVEMENTS RELATIVE TO HABITAT & HUMAN INFLUENCE IN THE SOUTHERN COAST RANGES, BRITISH COLUMBIA

Annual Progress & Summary Report

2012/13

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HABITAT CONSERVATION TRUST FOUNDATION

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PREFACE

This report is a summary of progress and data toward specific objectives within an active research program. Work to date on different aspects of the program are addressed herein. As such, this report supersedes all previous reports pertaining to grizzly bear space-use, movements, and ecology within landscapes of the Sea to Sky Planning Area.

The summaries presented within this report are intended only to demonstrate progress toward study objectives and are not intended for direct decision-support independent of analysis and interpretation by the principal researcher. However, given existing data, annual reports may include preliminary inferences relevant to specific landscapes. Such discussion may be qualified with recommendations to address data gaps or to assess temporal trends where appropriate confidence is lacking. This said, the most important outcome of this research program is in fact the development of empirically-derived predictive models to support resource planning, mitigation, and monitoring.

ACKNOWLEDGEMENTS

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SUMMARY

BC's southern Coast Ranges represent a southwestern lobe of grizzly bear distribution in North America. In this region, there has until recently been little known of grizzly bear population abundance, distribution, connectivity, or factors influencing them and the foraging and movements of individuals. This knowledge gap has been of concern given the wide range of land resource demands, particularly in the southern Coast Ranges. Mounting cumulative impacts are expected to result from the area's growing recreational popularity, associated development trends, existing and proposed industrial activities, and its accessibility from the nearby lower mainland. Currently, four of the five grizzly bear population units (GBPUs) in this region are considered Threatened and are designated for recovery by Cabinet in the Sea to Sky Land and Resource Management Plan (LRMP). Addressing grizzly bear conservation issues such as mortality risk, habitat effectiveness and population connectivity requires first an understanding of core, peripheral and linkage landscapes at the population level. This is being achieved through a regional population study near completion (Apps et al. 2013). Outputs from this work have also helped to highlight landscapes where a more detailed understanding of grizzly bear movements, seasonal foraging habitats, and potential human influences is appropriate and feasible.

In light of the above, grizzly bear conservation has been of particular focus within and around the Sea to Sky LRMP planning area (defined by the Squamish Forest District), an area subject to a burgeoning spectrum of land uses and an expanding human population. The aforementioned regional study is modeling population abundance, distribution and connectivity. However, given current and proposed development within and adjacent to landscapes occupied by grizzly bears, a detailed understanding of the movements and seasonal foraging patterns of resident animals relative to influential factors is required to assess and monitor cumulative impacts of existing and proposed development and to implement effective mitigation strategies.

The overall goal of this study is to build databases in order to develop and test predictive models of fine-scale grizzly bear movements and seasonal foraging habitats. Outputs are intended to inform assessments and mitigation at landscape and operational levels of resource planning, as well as strategic land-use decisions. Products will compliment and integrate with broader-scale planning tools derived at the population level across the southern Coast Ranges.

Monitoring and researching behavioural responses of grizzly bears to habitat and human influence is a high priority within southern Coast Ranges GBPUs and especially those of the the Sea to Sky Planning Area (A. Hamilton, MOE, *pers. comm.*). The grizzly bear recovery effort within constituent GBPUs is legally mandated, Cabinet-endorsed and also supported by Squamish and Lil'wat First Nations through the Sea to Sky LRMP and parallel native land use planning. Moreover, the southern Coast Ranges are subject to a considerable number of proposals for industrial

development that require assessment, monitoring, and mitigation with respect to cumulative human impacts on grizzly bears.

This project is intended and designed to provide empirically-derived tools to best understand, predict, mitigate and monitor potential cumulative impacts on grizzly bears. This report represents year-3 of a 5-year program. Described within are project objectives, methods, and interim data and progress based on space-use and movements of 29 adult grizzly bears on which GPS collars have been deployed 34 times, collecting data for up to 2 years.

INTRODUCTION

The southwestern fringe of grizzly bear range in North America occurs largely within British Columbia and is comprised of populations that are generally restricted to the mountains and high plateaus associated with limited human access and settlement (McLellan 1998). Many of the southern grizzly bear populations that have persisted in British Columbia are considered "Threatened" (current population assumed to be 1-50% of potential; Hamilton et al. 2004). This includes the grizzly bear population units (GBPUs) that comprise the Sea to Sky Planning Area (Squamish Forest District) within British Columbia's Southern Coast Ranges.

Across the southern Coast Ranges, there has until recently been little known of grizzly bear population abundance, distribution, connectivity, or influences related to the foraging and movements of individuals. This knowledge gap has been of concern given the wide range of land resource demands. Cumulative impacts may result from the area's growing recreational popularity, associated development trends, existing and proposed industrial activities, and its accessibility from the nearby lower mainland. Currently, four of the five grizzly bear population units across the region are considered Threatened and are mandated for recovery. Addressing grizzly bear conservation issues such as mortality risk, habitat effectiveness and population connectivity requires first an understanding of core, peripheral and linkage landscapes at the regional-population level (Apps et al. 2009). Outputs at this broad scale can also help to highlight landscapes where a more detailed understanding of grizzly bear movements, foraging habitats, and potential human influences is appropriate and feasible.

Within the Sea to Sky LRMP planning area (defined by the Squamish Forest District), grizzly bear conservation has been of considerable focus. This region is subject to a burgeoning spectrum of land uses and an expanding human population. The aforementioned population study is modeling regional grizzly bear abundance, distribution and connectivity. However, given current and proposed development within and adjacent to occupied landscapes, a detailed understanding of daily and seasonal movements and foraging patterns of resident grizzly bears, relative to influential factors of habitat and human influence, is required in order to assess and monitor cumulative impacts of existing and proposed development and to implement effective mitigation strategies.

OBJECTIVES & STUDY AREA

There are two components to this study: (1) long-term monitoring of grizzly bear abundance and distribution with reference to underlying causal factors, and (2) providing detailed understanding of daily and seasonal movements and foraging patterns of resident grizzly bears relative to habitat and human factors. Both components are required to assess and monitor cumulative impacts of existing and proposed development, and to implement effective mitigation strategies. The current focus of this project is grizzly bear space-use, movements and ecology relative to local conditions of habitat and human influence. Because DNA-based monitoring has not been intensively conducted in the past three years, we refer readers to summary reports of previous years for overview and interim results of this component.

In addition to DNA-based population monitoring, we began deploying GPS collars on a sample of adult grizzly bears within the region during the summer of 2007 and the summer and fall of 2008. The program continued with HCTF partnership during spring through fall of 2010, 2011, and 2012, with varying study animals monitored 2007 through 2012. This research phase of our program involves relatively fine-scale sampling of grizzly bear space-use and movements for evaluation of seasonal habitat preferences, habitual movements, and the natural and human factors that influence them. The study area presently encompasses the Squamish-Lillooet GBPU including much of the larger Sea to Sky Planning Area, but the study area has been expanded to include the southern portion of the South Chilcotin Ranges GBPU (Figure 1).

Through this work, we intend to illuminate local grizzly bear ecology, probable requirements, and response to cumulative human activities, with derived products supporting resource management and mitigation at local planning levels. Resulting predictive outputs will integrate with, and compliment, the strategic planning tools being derived at the scale of population distribution across the southern Coast Ranges (Apps et al. 2013; Figure 2). Integrating these two scales of research will facilitate a regional grizzly bear recovery and conservation strategy that is hierarchical and spatially nested as is appropriate for wide-ranging species. Objectives are summarized as follows:

1. document detailed spatial/temporal patterns pertaining to grizzly bear movement, foraging, and denning habits;
2. evaluate the above data with respect to multi-scale natural and human factors that may influence habitual and potentially critical movement options and seasonal habitats;
3. extend research products to industry and government partners through formal reporting and spatial decision-support tools that facilitate empirical evaluation of cumulative effects;
4. contribute relevant and reliable information in an effective form to support land-use planning and statutory resource management decisions.

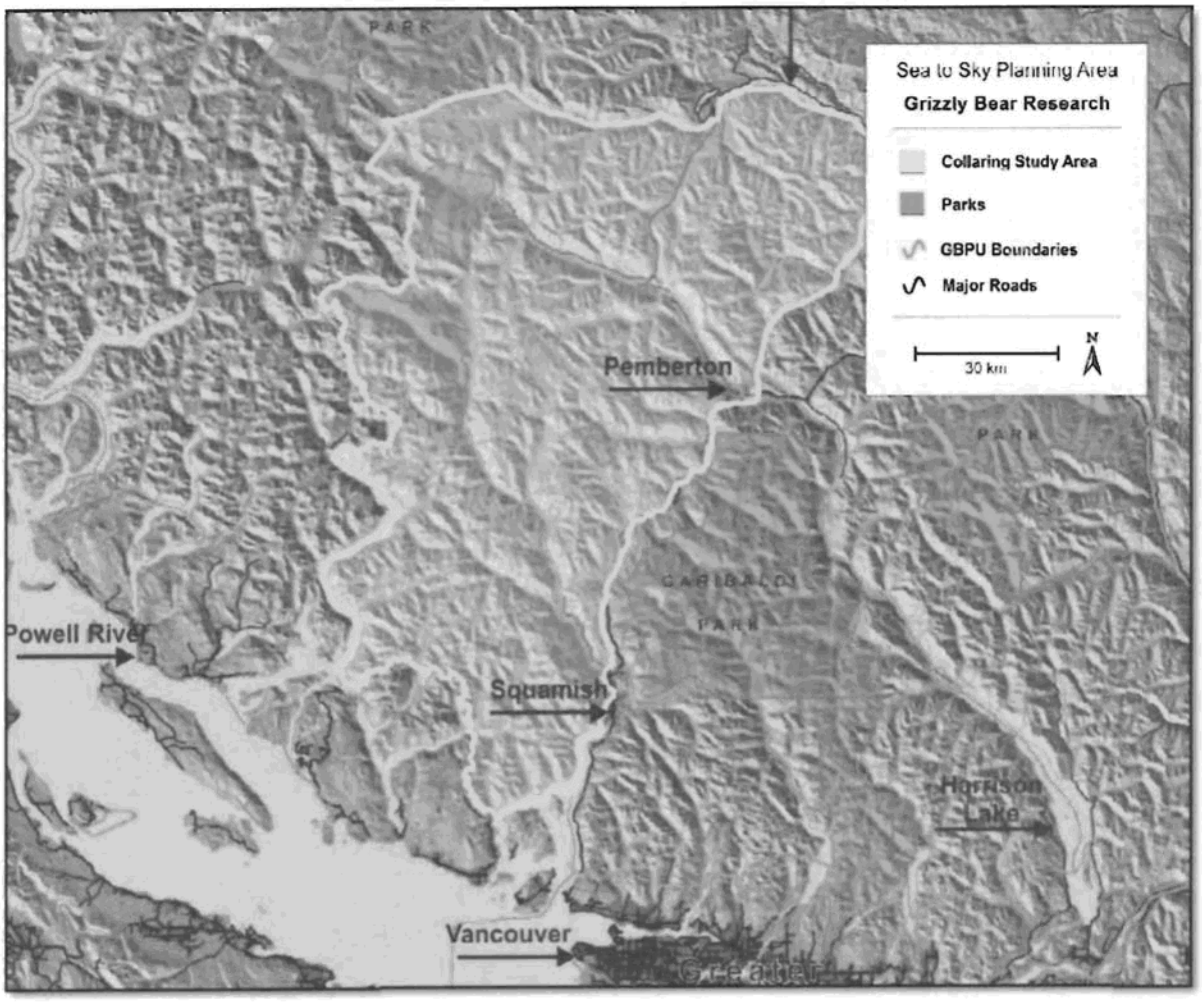

Figure 1. Area defined for detailed study of grizzly bear space-use, movements, and ecology relative to underlying conditions of habitat and human influence. Encompassed is the Squamish-Lillooet GBPU within much of the larger Sea to Sky Planning area, as well as the southern portion of the South Chilcotin Ranges GBPU.

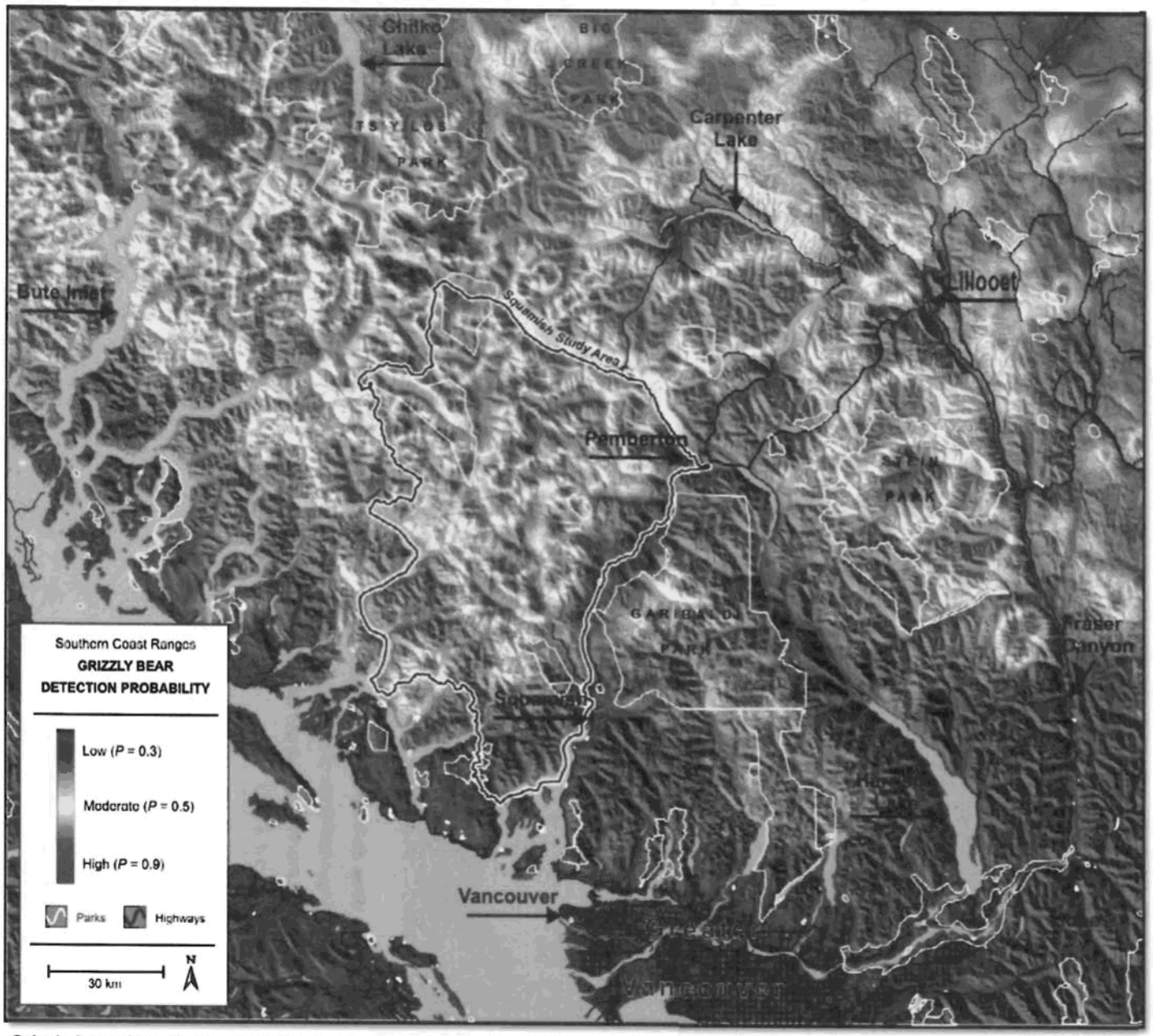

Figure 2. Grizzly bear detection probability across the southern Coast Ranges of BC from which core habitat areas and landscape linkages can be inferred (Apps et al. 2013). Note the Sea to Sky Planning Area (Squamish study area) that is the focus of this report (now expanded further north).

METHODS

A sample of adult grizzly bears are being fitted with GPS collars programmed to attempt location fixes every hour. We conducted a trapping program during spring through fall of 2007 through 2012 using cable snares and a culvert-trap, with sites accessed and monitored daily by helicopter. Potential study animals were also darted from a helicopter during 2010 - 2012 capture efforts. In accordance with provincial standards (CCAC 2003), precautions were applied to maximize animal welfare and human safety, and to ensure that the health of captured animals was not compromised and that they were rapidly returned to a free-ranging state. Our target areas for grizzly bear capture during 2007 were the Callaghan, upper Brandywine, and Ashlu drainages. In 2008, we initially focused our effort in the Ryan and Rutherford drainages, but then also included the 2007 trapping areas. Capture during 2010 included all of these landscapes. In 2011, we focused on the Rutherford and Ryan drainages but also extended north into the upper Lillooet tributaries of North and Boulder/Pebble Creeks as well as the upper Hurley and upper Birkenhead drainage including Tenquille Creek. During 2012, our focus was primarily on the upper Lillooet Valley and tributaries, extending north to Downton and Carpenter Lakes and including the Hurley and Birkenhead drainages.

Captured animals were immobilized and handled using standard and accepted techniques (Woodbury 1996). Adult grizzly bears were fitted with Lotek GPS collars (models 4400M, 7000MU, and IridiumtrackM). We inserted of canvas "rot-off" spacers into collar belting to help ensure that collars dropped from study animals within an appropriate time. Timer-activated drop-off mechanisms (set to 108 weeks) were used during the first two years but we discontinued their use in 2010 because they generally did not work and rot-off spacers were releasing within the appropriate time frame (we are now using an improved version of the Lotek timer drop-off release mechanisms). Incidentally captured black bears were released. Hair or tissue samples from handled bears are being genetically analyzed for individual identity and matched to and/or included within a database of grizzly bear detections across the larger region.

Deployed collars are expected to remain on study animals for up to 2 years of data collection (turned off during denning period), and data are being remotely downloaded through periodic overflights. We will attempt to retrieve any collars deployed longer than 2 years through helicopter darting. Collars can then be refurbished and redeployed.

Raw GPS location data that we collect from each animal are being processed, summarized, and movement vectors are being mapped with temporal referencing. Summaries are to include movement rates and space-use intensity (i.e., time/activity budgeting) relative to habitat productivity and human activity levels. Based on an adequate sample, data are to be graphically represented to depict the intensity of landscape use within home ranges, and movement routes among seasonally important core habitat areas. Movement vectors will also be summarized to identify habitually-used travel routes. We plan to update data summaries on an annual basis.

Once a sample is obtained that is considered to be spatially and temporally representative of grizzly bear movements and habitat use within the study area, more detailed analyses will be conducted. Data will be screened to minimize the influence of unacceptable spatial error on analyses and to account for potential habitat-related bias in GPS fix-success. Because animal movements are determined by perceptions at different spatial scales (Turchin 1998), our analysis will consider successively broader scales corresponding to movements at defined temporal sampling intervals. We will consider bear response to relevant variables that can be derived with available biophysical and human use inventories. Our evaluation and multi-scale modeling of habitats and movement routes selected by grizzly bears will employ analytical approaches appropriate for such data (e.g., Apps et al. 2001, Apps and McLellan 2006). Methods will involve a suite of quantitative techniques intended to improve our understanding of factors that influence grizzly bear movement behavior and how these vary among animals and with local conditions (e.g., Burnham and Anderson 1998, Boyce et al. 2002). This will result in predictive models appropriate for spatial extrapolation and decision-support.

For grizzly bear conservation planning in the region, our results will be integrated with the broader-scale DNA-based companion study of population distribution and connectivity (Apps et al. 2013). Results at both levels may be integrated within a "graph theory" modeling framework (Bunn et al. 2000). In this way, the value of any given site can reflect the consequence, to greater landscape connectivity, of degrading or blocking permeability to grizzly bear movement. Consequences are gauged in terms of the total number and size of connected suitable habitat patches at various spatial scales. This approach is ideal for conservation planning because model parameters can reflect both empirical and theoretical knowledge and can be readily tested and refined.

Along the course of this study, we will pursue any opportunity to conduct comparative analyses of human activity and/or infrastructure development on grizzly bear movements and/or habitat use. Results of these analyses will serve to refine assumptions regarding cumulative human impacts on grizzly bears in the region.

INTERIM DATA PROGRESS

2007 – Capture Efforts & Bears Collared or Detected

We set and monitored grizzly bear traps from 2 – 12 August in the Callaghan, upper Brandywine, and Ashlu drainages. During this period, we captured 3 adult grizzly bears (1M, 2F) on which we deployed GPS collars (Appendix 1). Based on DNA profiles, all 3 collared grizzly bears had been previously identified through hair-snag sampling within the region. In the database of known individuals, female CF01 ("Ashley") corresponds to F53, female CF02 ("Callie") corresponds to F93, and CM03 ("Kahn") corresponds to M58. In addition, hair samples obtained from a bear that investigated trap sites in the Tatlow Valley (Ashlu drainage) on 4/5 August were from F25, and another

trap investigation at Deserted Pass on 8 August was from CF01/F53 after her initial capture. A male trapped in Pemberton Meadows and moved to the vicinity of Meager Creek (not collared) corresponds to M29.

Collars from all 3 study animals prematurely dropped in September and October 2007 and we recovered all of them. Inspection revealed that the rot-off spacer we inserted had failed to hold (we are correcting our method of inserting the canvas spacers to prevent premature release in future collar-deployments). We have downloaded, screened and processed the data from these collars.

2007 – Summary of Data and Movements

We evaluated the performance of GPS collars during their periods of deployment on all 3 bears. CF01 carried her collar from 03 Aug – 18 Sept. during which time the collar obtained successful fixes on 68% of 1,105 hourly fix attempts. Of successful fixes, 80% were 3D (≥4 satellites used). CF02 carried her collar from 11 Aug – 06 Oct, during which time the collar obtained successful fixes on 87% of 1,339 hourly fix attempts. Of successful fixes, 90% were 3D. CM03 carried his collar from 11 Aug – 05 Sept, during which time the collar obtained successful fixes on 65% of 607 hourly fix-attempts. Of successful fixes, 79% were 3D.

Despite the mediocre performance of CM03's collar, the data revealed an interesting and important movement (Figures 14 & 15). This bear was captured and collared in Deserted Pass at the head of Ashlu Creek on 11 August. Roughly 5 days later, he began a direct movement down the Ashlu Valley. On 19 August, he began moving up Tatlow Creek, a major tributary of the Ashlu, and late the next day he moved into the pass leading to Phantom Lake at the head of the Clowhom drainage. His movements over the next 8 days indicate several nodes of what is likely foraging activity, but he moved over Mt Jimmy (at a point of 1910 m) on 24 August, having ascended ~1000 m in elevation over 4 days since leaving Tatlow Creek (gaining 450 m and 280 m in 1-hr periods). He then moved into a pass linking the Clowhom drainage with Pokosha Ck (Ashlu tributary) and remained there for several days before continuing east into Sigurd Pass and down Sigurd Creek. He took roughly 9 hrs to descend Sigurd Creek before arriving at the Ashlu floodplain near the Squamish River on 29 August. He remained in a tight area (~13 ha) near the Sigurd/Ashlu confluence for the next 7.5 days until his collar dropped and the data sequence ends.

During August – October 2007, adult-female grizzly bear CF03 (without cubs) moved extensively across an area of roughly 189 km^2. This area included the upper reaches of the Callaghan, Brandywine, Roe, and Shovelnose drainages and involved localized nodes of activity (Figure 16). During August – September 2007, adult-female grizzly bear CF01 (without cubs) moved across a 144 km^2 area focused primarily within the upper Ashlu drainage, but made 3 separate movements into the valley of the Deserted River that drains into Jervis Inlet (Figure 17). Her activities in the Deserted drainage were concentrated along the lower Deserted River near the mouth of Tsuahdi Creek, presumably associated with foraging on spawning salmon.

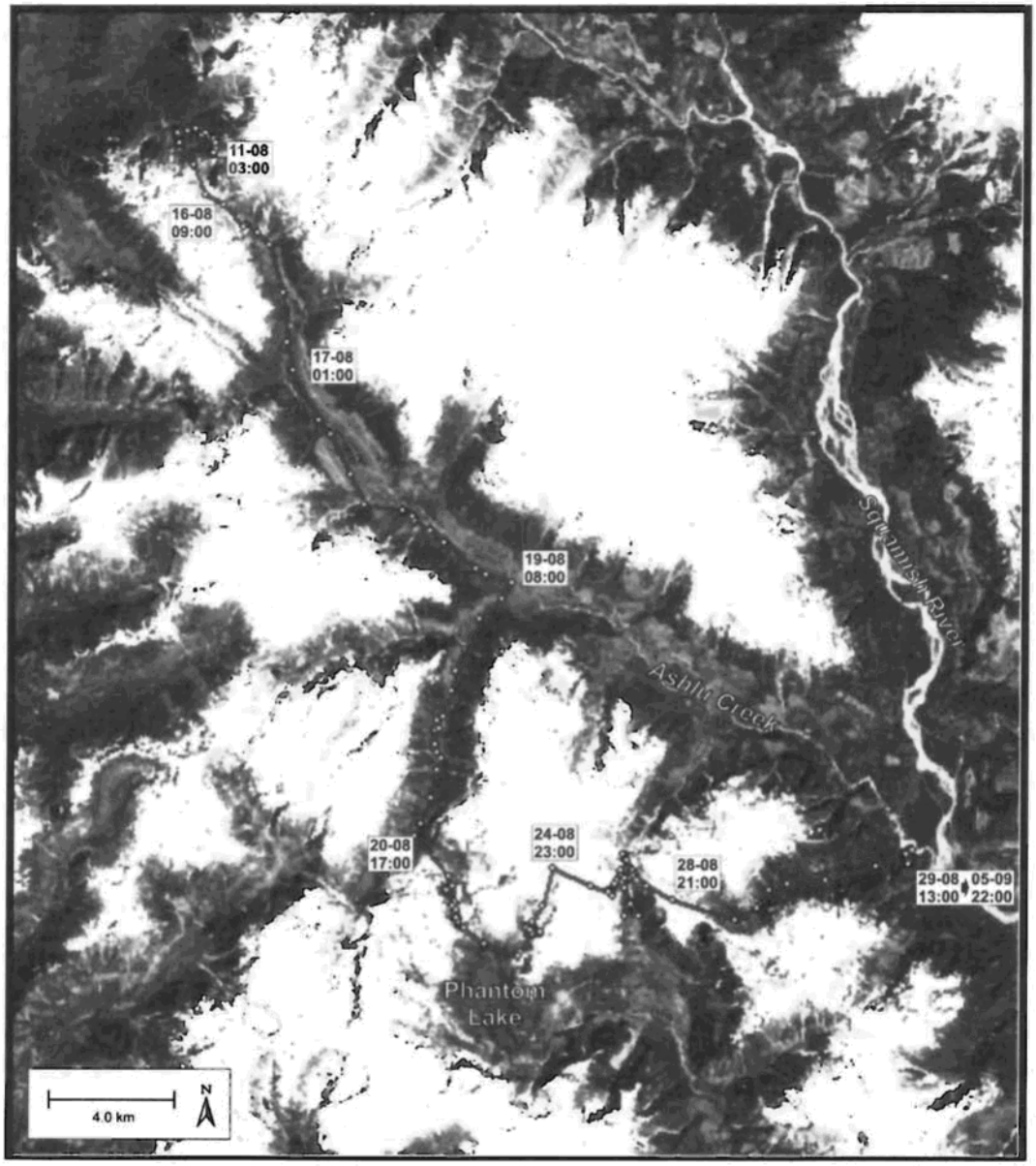

Figure 14. Known movement by grizzly bear CM03 within the Ashlu drainage during August/September 2007. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

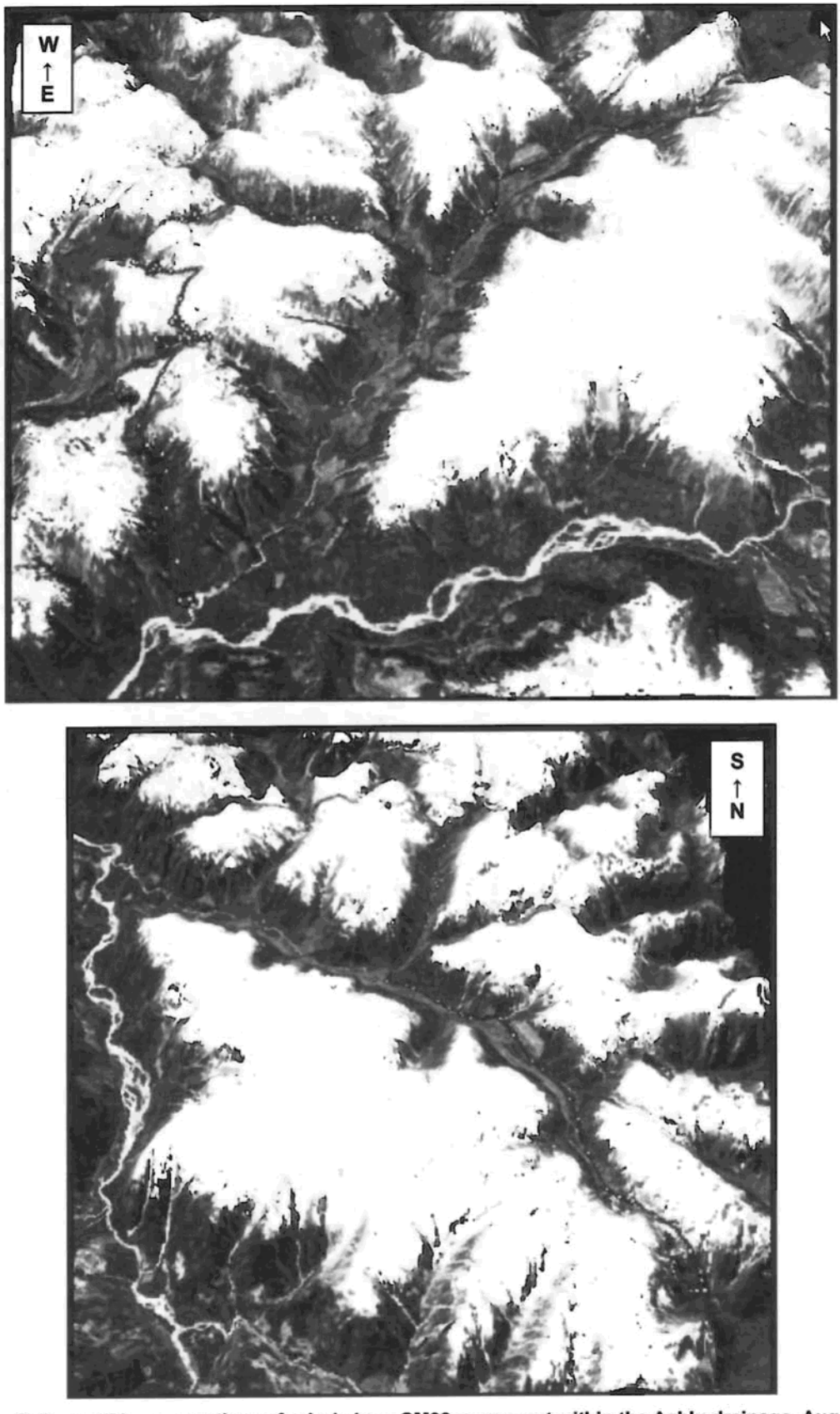

Figure 15. Orthographic perspectives of grizzly bear CM03 movement within the Ashlu drainage, Aug/Sept, 2007.

Figure 15. Continued.

Figure 16. Known movement by grizzly bear CF02 within the Callaghan drainage and environs during August - October 2007. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

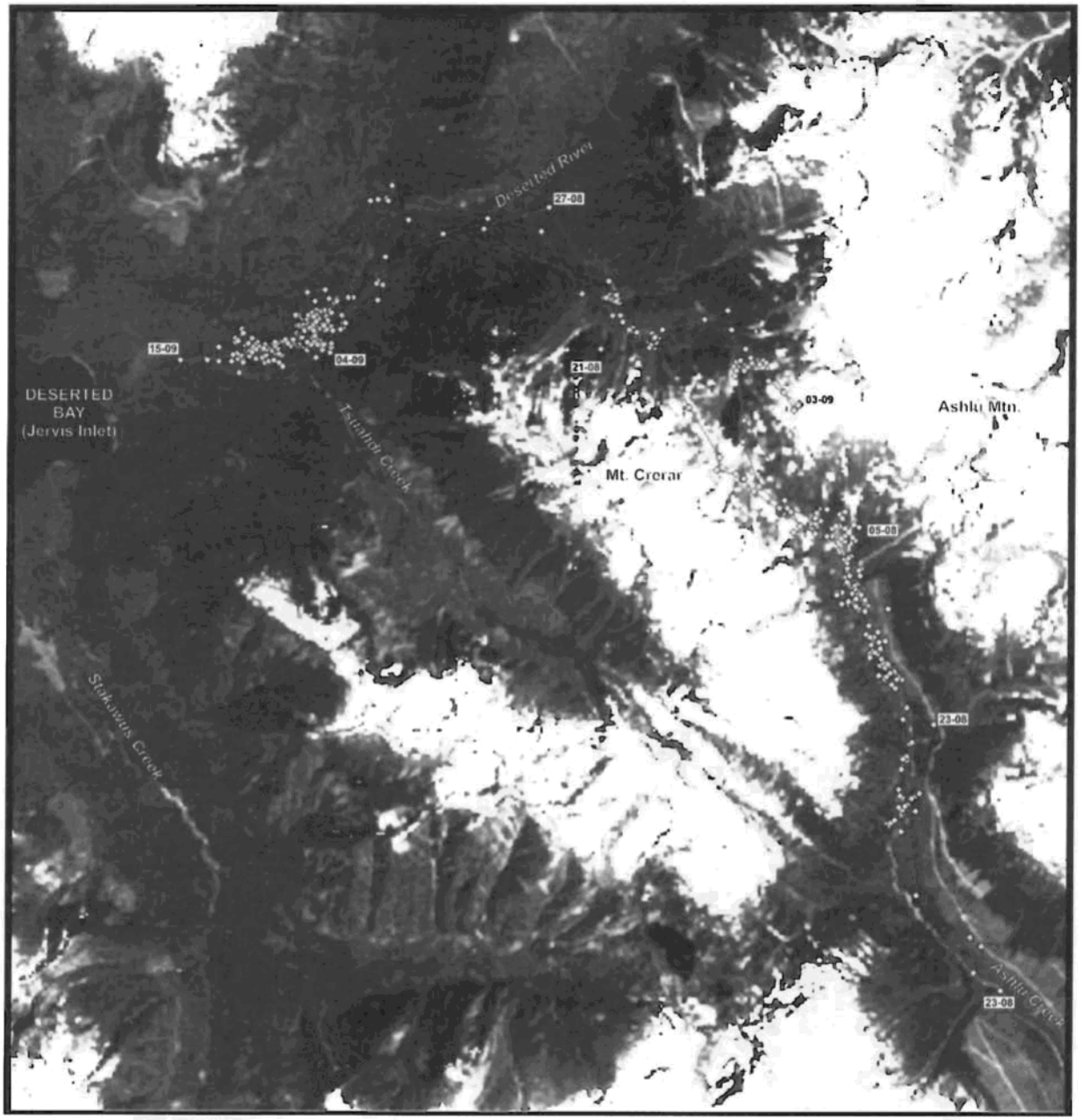

Figure 17. Known movement by grizzly bear CF01 within the upper Ashlu and Deserted drainages during August - September 2007. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

2008 – Capture Efforts & Bears Collared or Detected

Our 2008 capture work was carried out in two separate trapping sessions and one helicopter darting session.

Ryan/Rutherford Capture Effort: From 21 – 25 June, we set and monitored grizzly bear traps in the Ryan and Rutherford drainages. During this period, we captured 3 adult grizzly bears (1M, 2F) on which we deployed GPS collars (Appendix 1). Based on DNA profiles, all three collared grizzly bears had been previously identified through hair-snag sampling within the region. In the regional database of known individuals, female CF04 ("Daphne") corresponds to F88 who we had previously detected through hair-snag sampling in the Petersen and upper Rutherford during previous years. Female CF05 ("Chloe") corresponds to F22, a bear we detected 3 times by hair snagging in the upper Callaghan drainage during 2004 but not since. This is a young bear (estimated 6 years of age) and we suspect that she was a cub within her natal range in 2004 and has dispersed, but we will confirm this once we obtain her movement data and her precise age. Male CM06 ("Mercury") corresponds to M176 who we detected by hair-snagging during 2007 just north of Carpenter Lake – a linear distance of ~70 km. This is also a young bear (estimated 6 years of age) that appears to be a recent immigrant to the local area, though his home range appears to straddle the upper Lillooet Valley at present (see data summary described below).

During this June trapping session in the Ryan and Rutherford, we had several near-captures of bears from which we obtained hair samples. Some of these were bears that either had already been or were subsequently captured (e.g., F88, F22, M176). But we also nearly captured a male and a female who corresponded to M32 and F12 in our regional database. We detected both of these bears by hair-snagging on numerous occasions in 2004 and 2005. Both bears appear to be resident primarily within the Ryan Valley. However, M32 clearly moves over a more extensive area that includes the lower valley, while F12 appears to be more restricted to the upper valley. We also collected a rub tree sample that matched to M33 who we also detected in 2004.

Callaghan/Brandywine/Ashlu Capture Effort: From 2 – 10 July, our trapping effort was focused in the upper Callaghan, Brandywine and Ashlu drainages. Here, we captured and collared one bear in the upper Ashlu. This female CF07 ("Rhea") corresponds to F55 who we identified by hair-snagging during 2004 sampling and again in 2005 in the upper Ashlu drainage (as previously described in this report). From 1 - 2 October, we employed helicopter darting to capture one bear at the back end of the Ashlu Valley. This male CM08 ("Keith") corresponds to M56 in our regional database who we detected at a DNA hair-snag site along the Clowhom River in 2004 (but not since) – a minimum linear distance of ~40 km. Since this is a relatively old bear (estimated 20 years of age), his home range must be extensive and his movements should be highly relevant to our study.

We also opportunistically collected a number of hair samples this year during our work in and around the Callaghan, Brandywine and Ashlu drainages. At a culvert trap we had set in mid-July, we

nearly captured a bear that corresponded to M14. We have a good detection history of this bear dating to 2004 in the upper Ryan and 2005 in the Callaghan. In the upper Ashlu, we nearly captured a bear on at least two occasions who matched to F53 in our regional database. Again, we know of this individual through 2004 and 2005 hair-snag sampling, but this is also study animal CF01 ("Ashley") who was collared in August and September 2007 before her collar prematurely dropped.

Tzoonie Samples: During a field trip into the Tzoonie drainage in December 2008, Apps and Rochetta collected 20 hair samples from beds and rub trees in two relatively close areas along the lower Tzoonie River. Three of these samples collected from both areas yielded a viable DNA and corresponded to bear M46 who we previously identified in 2004 at two separate sites just north of Clowhom Lake roughly 15 km to the east. Interestingly, this individual was also detected near the end of July 2007 in the upper Brandywine drainage, a linear distance of ~55 km from the lower Tzoonie.

Miscellaneous: A sample from a male grizzly bear known to have been poached in Pemberton Meadows matched to M129 in our regional database. This male was detected on several occasions in during 2006 sampling of the South Chilcotin Ranges south of Carpenter Lake.

2008/09 – Summary of Data and Movements

Telemetry-search and data-download flights were conducted during October of 2008 and 2009. From this effort, 4 of the 5 collared bears were found and GPS data were successfully downloaded. Only bear CF05 ("Chloe") was not found. The signal from the collar of female CF04 ("Daphne") was in mortality mode indicating that she had either recently denned or that the collar was dropped; we had to wait the winter to confirm in 2009 that the collar is likely dropped.

Data downloaded from the 4 bears were screened and processed. We evaluated the performance of GPS collars during their periods of deployment (Table 1). Fix success was high, ranging from 79% to 89% of fix attempts. The proportion of successful fixes that were 3D (≥4 satellites used) was also high, ranging from 87% to 95%.

Table 1. Performance of GPS collars deployed on grizzly bears during 2008 in the Squamish Forest District of southwestern British Columbia. Period of data collection is from indicated capture date to 23 October, 2008.

ID	Capture Date	Fix Attempts	Successful Fixes	% Successful of Attempts	% 3D of Successful
CF04	22/06/2008	2,713	2,423	0.89	0.95
CF05	23/06/2008	--	--	--	--
CM06	25/06/2008	2,882	2,472	0.86	0.91
CF07	07/07/2008	2,593	2,052	0.79	0.87
CM08	02/10/2008	506	405	0.80	0.84

CF04 "Daphne" (Figure 18) – During June – October, 2008, the movements of female CF04 were largely constrained to upper Petersen Creek with some short forays into the Ryan Valley and headwaters of Rutherford Creek. Her collar apparently dropped on 12 October.

CF05 "Chloe" – Despite several extensive aircraft searches, this bear was not found since being collared on 23 June,2008.

CM06 "Mercury" (Figure 19) – After being collared on 25 June, 2008, bear CM06 remained largely within the upper Rutherford and Petersen valleys for the rest of June and July before embarking on a movement across the Ryan and Lillooet valleys as of mid-August. He continued movements north and remained in the upper Hurley and associated tributary valleys until mid-October at which time he returned to the Ryan using close to the exact route and pass. He then continued back south across the Ryan River and up the Petersen drainage and to the back end of the west fork, where he apparently denned on 29 October. He emerged from this den on 8 May and gradually moved down the Rutherford drainage where his collar dropped on 14 June.

CF07 "Rhea" (Figure 20) – After being collared on 17 July, 2008 female CF07 moved extensively in the Deserted River drainage as well as the upper Ashlu, upstream of the Ashlu/Tatlow confluence. She spent much of the fall obviously foraging for salmon along the Deserted River, and made several forays, including a brief movement Squamish Valley though not as far down as the river. Unfortunately, this bear could not be located during our telemetry search and data download flight of October 2009.

CM08 "Keith" (Figure 21) – Shortly after male CM08 was collared in the upper Ashlu drainage in early October, he moved into the Deserted Valley and spent most of his time moving along the Deserted River, quite obviously with a focus on salmon. He was observed and photographed by a Conservation Officer along the shore just south of Deserted Bay on around 16 October. He appears to have remained active in this valley through most of December, and he subsequently denned at the back end of the Deserted drainage on the north slope of Mt. Crerar (specific date unclear). CM08 emerged from denning on 15 April. Then, by early May, he made a rather direct movement down the Ashlu Valley, up the Tatlow, and into the Clowhom drainage via Phantom Lake. He then moved extensively among several drainages north of Clowhom Lake, where his collar apparently dropped on 18 June, 2009.

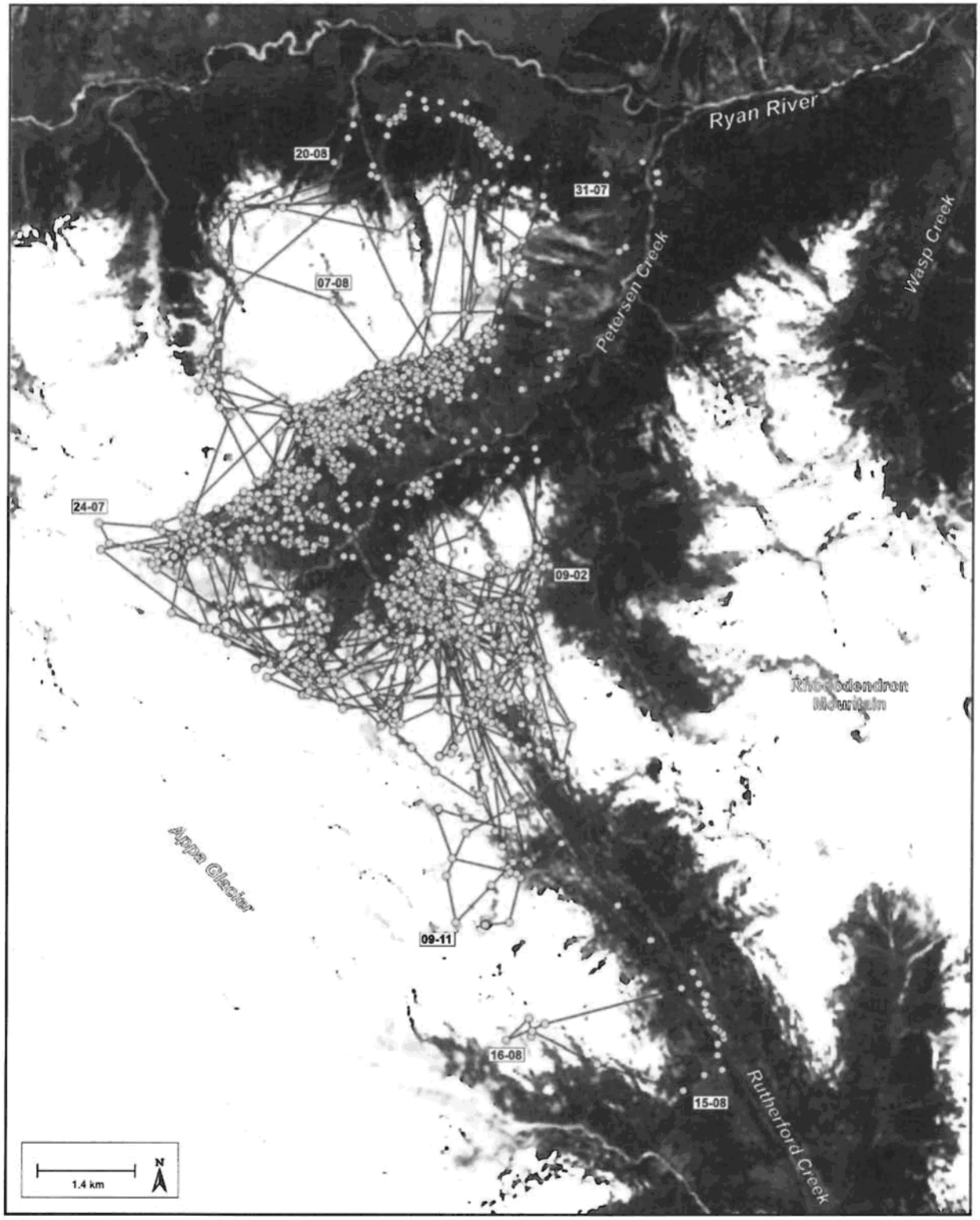

Figure 18. Known movement by grizzly bear CF04 ("Daphne") within the Ryan/Petersen and upper Rutherford drainages during June – October, 2008. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

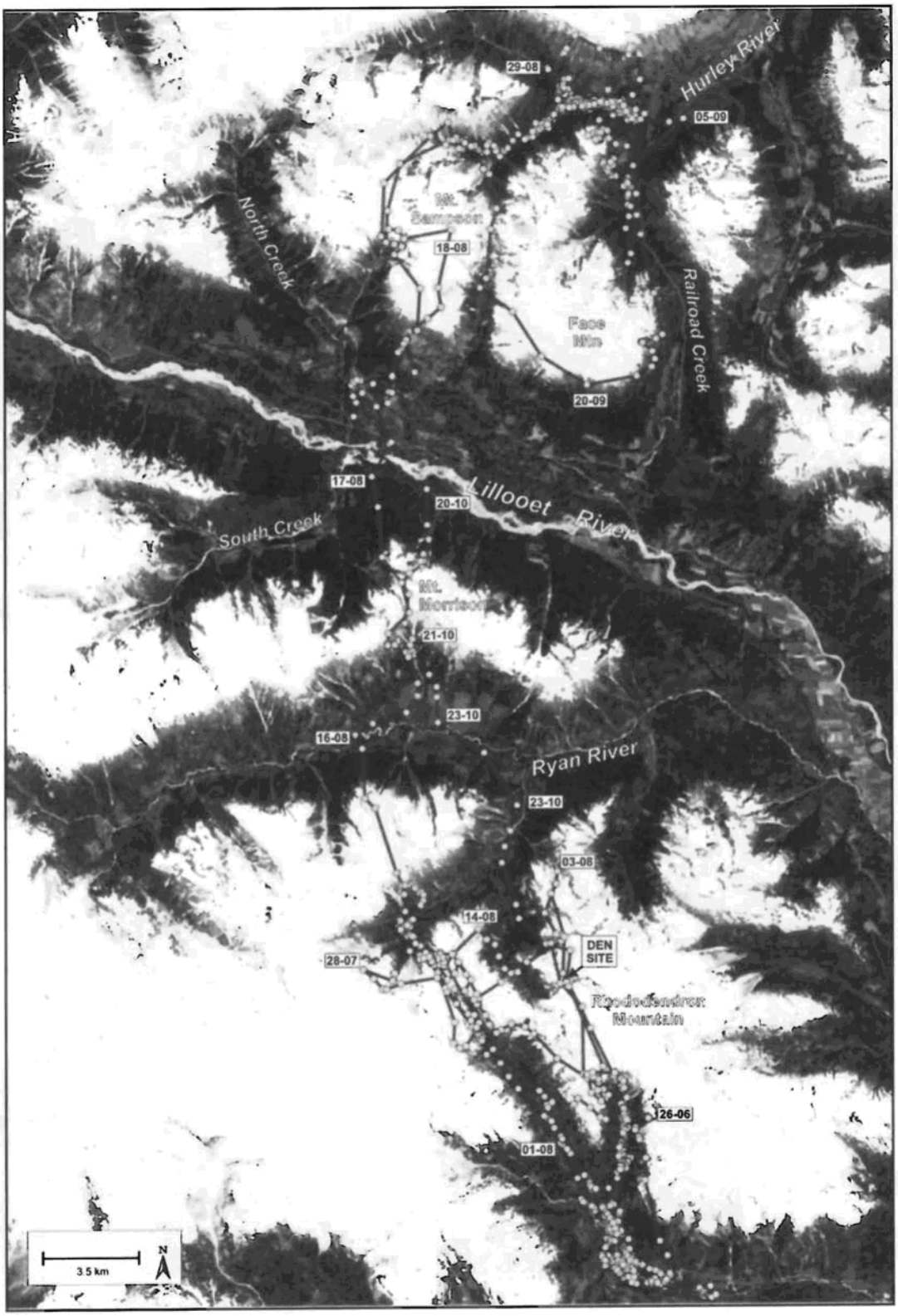

Figure 19. Known movement by grizzly bear CM06 ("Mercury") within the Ryan, Rutherford, Lillooet, and upper Hurley Valleys during June, 2008 – June 2009.

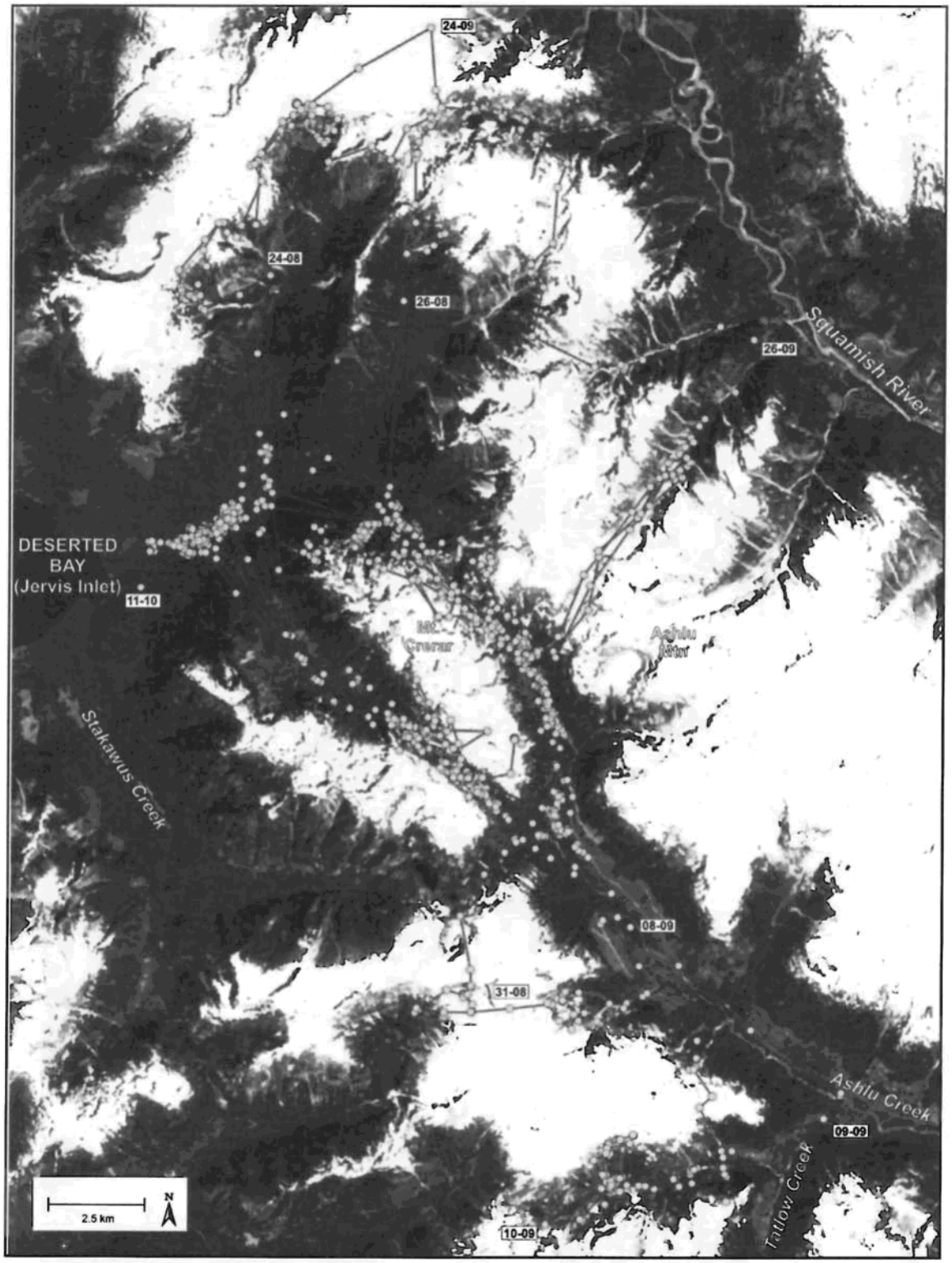

Figure 20. Known movement by grizzly bear CF07 ("Rhea") within the upper Ashlu and Deserted drainages during June – October, 2008. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000

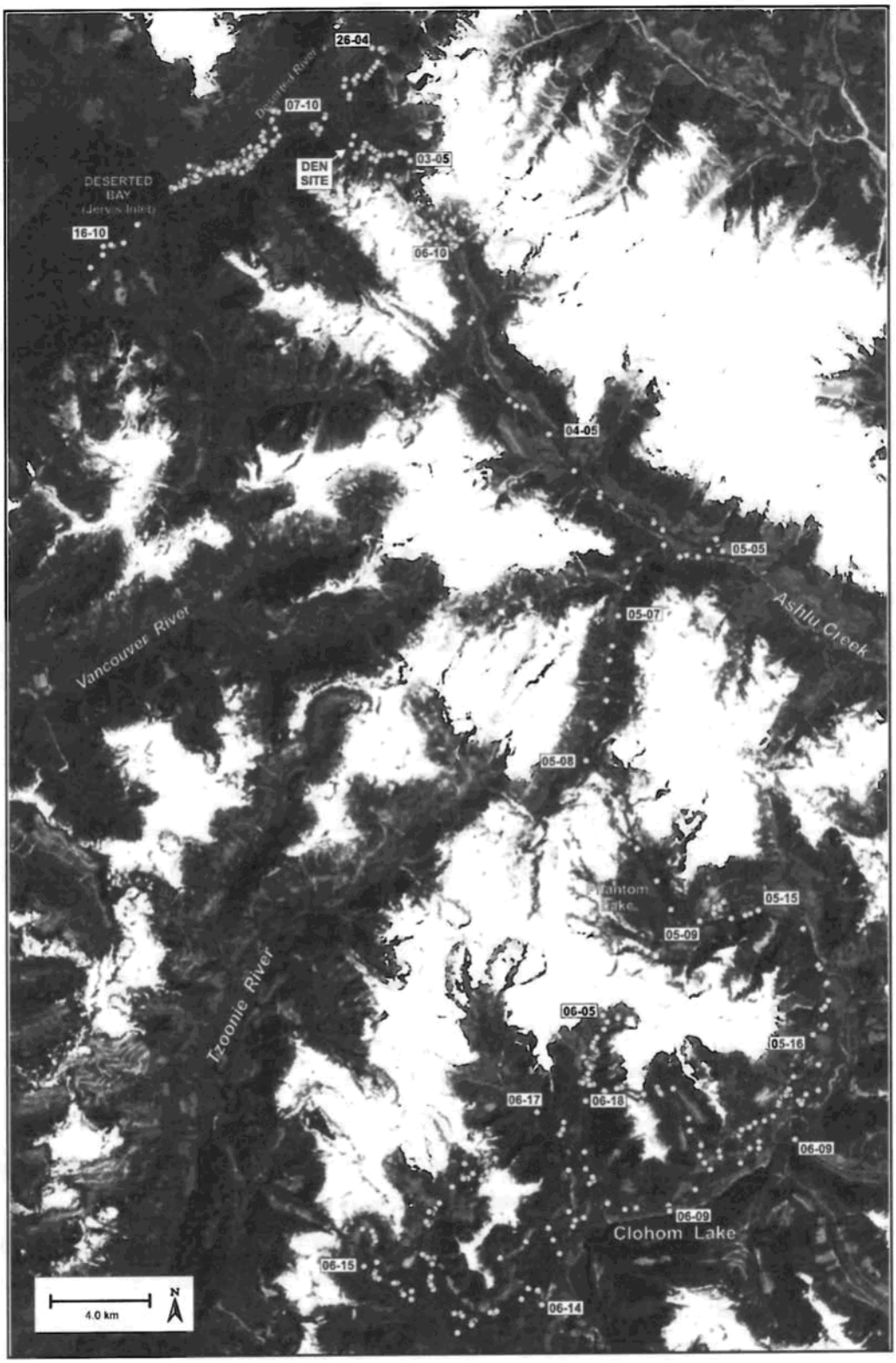

Figure 21. Known movement by grizzly bear CM08 ("Keith") within the upper Ashlu and Deserted drainages during October 2008 – June 2009.

2010 – Capture Efforts & Bears Collared or Detected

Our 2010 capture work was carried out through one helicopter darting session in June and a combined trapping and heli-darting session in July. Combined capture efforts resulted in a total of 8 new study animals (2M, 6F) on which we deployed Lotek GPS 4400M collars programmed for 1-hr fix attempts (Appendix 1). Helicopter search and darting (with Clay Wilson of Bighorn Helicopters) was carried out from 11 - 13 June and resulted in the capture of 3 new study animals (1M, 2F). Helicopter-assisted ground trapping and some opportunistic heli-darting was carried out from 22 to 28 July. This effort yielded 5 new study animals (1M, 4F). Two 2-year cubs of one of the study animals were also incidentally captured and released without collars. DNA profiles confirmed that 2 adult females were study animals previously collared (CF01 "Ashley", CF02 "Callie"). These bears and 5 others had also been previously detected through regional hair-snag/DNA sampling efforts. One bear (CF14 "Phoebe") was not previously known.

2011 – Capture Efforts & Bears Collared or Detected

Capture efforts during 2011 were carried out in late July and early Aug as well as September. Heli-trapping as previously described (snares only) was carried out from 31 July through 5 Aug. On 1 Aug, a 2-year old male was captured and released without a collar in Petersen Creek. On 2 Aug, we captured an adult female CF15 "Hope" at Headquarters Pass (b/w Hope Ck & Birkenhead R.). Two yearling cubs were with her at the time. On 4 Aug, an adult male and female breeding pair were captured and collared in Petersen Creek. An ear-tag indicated that the female was CF12 "Phoebe" who had just dropped her previous collar on 26 June. The male was a new study animal CM16 "Titus". Ground trapping was also carried out in the upper Birkenhead and Tenquille Creeks during September. During that time adult male CM17 "Huck" was captured and collared. We attempted to heli-dart one bear known to be CF05 but she did not induce due likely to a drug-delivery problem. Combined capture efforts resulted in the collaring of 4 bears (2M, 2F), 3 of which were new study animals, on which we deployed Lotek GPS 4400M and 7000MU collars programmed for 1-hr fix attempts (Appendix 1).

2010/11 – Summary of Data and Movements

Functioning collars collected data from 9 (2M, 7F) study animals during 2010 and 9 (3M, 6F) study animals during 2011. Data download flights were carried out in June and late October, between which data were also opportunistically downloaded with helicopter assistance and from the ground. Data downloaded from study animals were screened and processed. We evaluated the performance of GPS collars during their periods of deployment (Table 2). Fix success was relatively high, ranging from 79% to 97% of fix attempts with one exception (CM14, collar 919) at 55%. The proportion of successful fixes that were 3D (≥4 satellites used) was also high, ranging from 86% to 95% with the

exception of CM14 (collar 919) at 71%. Cursory inspection of data plots suggest that many if not most miss fixed were associated with heavily forested habitats.

Table 2. Performance of GPS collars deployed on grizzly bears during 2010 and 2011 in the Squamish Forest District and environs of southwestern British Columbia. Period of data collection is from indicated capture date to mid October, 2011. Attempted fixes during denning are excluded.

ID	Name	Collar	Capture Date	Fix Attempts	Successful Fixes	% Successful of Attempts	% 3D of Successful
CF04	Daphne	1349	22/06/2008	2,691	2,401	0.89	0.95
CF05	Chloe	1348	23/06/2008	6,944	6,053	0.87	0.92
CM06	Mercury	1452	25/06/2008	3,823	3,259	0.85	0.92
CF07	Rhea	1345	07/07/2008	2,593	2,051	0.79	0.87
CM08	Keith	1342	02/10/2008	2,952	2,405	0.81	0.86
CF02	Callie	1347	11/06/2010	6,465	5,863	0.91	0.93
CM09	Bruno	1960	12/06/2010	4,011	3,711	0.93	0.91
CF10	Power	1346	11/06/2010	5,001	4,510	0.90	0.93
CF11	Phantom	1451	24/07/2010	4,132	3,346	0.81	0.87
CF01	Ashley	1344	24/07/2010	2,039	1,711	0.84	0.88
CF12	Phoebe	1452	27/07/2010	4,137	3,611	0.87	0.92
CF13	Juno	1343	27/07/2010	2,722	2,403	0.88	0.94
CM14	Atlas	919	27/07/2010	6,490	3,582	0.55	0.71
CF15	Hope	31751	02/08/2011	2,019	1,942	0.96	0.94
CF12	Phoebe	31752	04/08/2011	1,800	1,737	0.97	0.91
CM16	Titus	1342	04/08/2011	2,036	1,862	0.91	0.94
CM17	Huck	31747	22/09/2011	626	579	0.92	0.90

CF02 "Callie" (Figure 21) – This previously collared bear (August - October, 2007) was recaptured and collared on 11 June, 2010. She had 2 cubs of the year at capture and they were observed with her a year later in June 2011. Over the >2 seasons she has been monitored, CF02 has ranged across 358 km^2, from the headwaters of the Soo River in the north to the lower part of Roe Creek in the south, an extent of 390 km. Her east-west extent is much less as she remains in the upper drainages including Roe, Brandywine, Callaghan and Soo, and she occasionally ventures into the extreme eastern portion of the upper Squamish drainage including the back end of Shovelnose Creek. In 2010, CF02 appears to have denned on 22 October. She remained denned until 10 May at which time she emerged for at least 3 h before denning again until 3 June. Her den site was in the very upper end of the south fork of the Brandywine drainage. Her collar remains active and functioning.

CM09 "Bruno" (Figure 22) – This male was collared in the Ryan drainage in June, 2010. He was then tracked until 28 November at which time he dropped his collar in the upper Lillooet valley. During his short monitoring period, CM09 moved extensively through the Ryan and upper Lillooet valleys over 535 km^2. A few separate movements were made between the two valleys, one being via a foray across the Pemberton Icefield to the headwaters of Meager Creek and then down the Meager Valley. His collar has been retrieved.

CF10 "Power" (Figure 23) – This female was collared in the Rutherford drainage in June, 2010. Dependent cubs were not apparent but a male was observed near her so she likely was breeding. She was not observed when located in June 2011 so we could not confirm whether she was with cubs (her movements suggest she was without cubs). During the year, CF10 ranged over 983 km^2, from the upper Ryan (brief foray into the upper Lillooet), through the upper Rutherford, across the Soo and upper elevations of the Callaghan and Brandywine drainages including Rainbow Mtn and Mt. Sproatt. She appears to have denned on 25 October on Rainbow Mountain and emerged on 25 May. Her collar remains active and functioning.

CF11 "Phantom" (Figure 24) – This female was collared in the Ashlu drainage (upper reaches of the Tatlow Valley) in July, 2010. Three cubs of the year were with her at the time, and they were also present when we located her by aircraft in June and October, 2011. Due to a technical issue, her collar could not be downloaded during the October flight. To June 2011, CF11 ranged across 281 km^2, from the middle Ashlu valley, through Tatlow and Falk Creek drainages, into the upper northern reaches of the Clowhom drainage (including around Phantom Lake), and through the Tzoonie drainage with particular focus on the lower reach and estuary. She appears to have denned in a side valley of the upper Tzoonie River likely in December and emerged in on 30 April. Her collar remains active and functioning.

CF01 "Ashley" (Figure 25) – This female was collared in the upper Ashlu drainage in July, 2010. Her two 2-year old cubs were also incidentally captured at the same time (genetic samples taken). Over the next 4 months from the upper Ashlu to Deserted River and Bay, and over the height of land to side drainages of the Elaho River and Sims Creek. She apparently dropped her collar on 17 October near the Deserted River (collar pick-up pending). Combined with her previous data that extends a bit further down into the Ashlu Valley, CF01 has ranged across 234 km^2

CF12 "Phoebe" (Figures 26 & 27) – This female was collared in the Petersen branch of the Ryan River drainage in July, 2010. At this time, two yearling cubs were with her. These cubs appeared to be still with her when we located her in June, 2011, but a breeding male may also have been present. During the past year, CF12 and her cubs ranged extensively throughout the Ryan drainage, including the Petersen Valley and a foray through Wasp Creek. Several movements into the Lillooet Valley and across the Lillooet River were also apparent. She appears to have denned in Petersen Valley in December and emerged on 10 May. CF12 dropped her collar on 26 June and we

recovered it. We then recaptured her on 4 August in a snare in upper Petersen Creek together with male CM16 "Titus" (concurrent location data indicate they did not stay together after capture). She continued to range through Ryan and Petersen valleys from then until late October covering an annual MCP home range of 249 km^2. Her current collar remains active and functioning.

CF13 "Juno" (Figure 28) – This female was collared in back end of the Ryan River drainage in July, 2010. Although she appeared to be lactating, a cub was not observed. She ranged over ~160 km^2 throughout the upper Ryan Valley, with relatively tight movements suggesting that she was in fact with at least one dependent cub. She denned in the back of the Ryan on 30 October and emerged on 2 May. She died apparently from snow avalanche on 21 May and her collar was recovered.

CM14 "Atlas" (Figure 29) – This male was collared in a side valley of Rutherford Creek in July, 2010. Over the next year he ranged extensively over 1,051 km^2, from the upper Ryan Valley to Millar Creek (Pemberton Valley), and across the Rutherford, Soo, and Callaghan drainages. He appears to have denned in December at the back end of Wasp Creek and emerged on 10 May. His collar remains active and functioning.

CF05 "Chloe" (Figure 30) – This female had been collared in June, 2008 but was not found during aircraft searches in 2008 and 2009. We did find her in 2010 although we could not acquire her data because her collar was in "recovery" (low battery) mode. Multiple attempts to recapture her failed. Fortunately, her collar was still transmitting during June, 2011. We determined it was dropped and we recovered it and its data. The collar collected almost two years of data before apparent battery failure after denning in the fall of 2009. During this time (June 2008 - October 2009), CF05 ranged from the upper Brandywine, through the Callaghan, Soo, Rutherford, and upper Squamish drainages, covering 667 km^2. In the fall of 2008, she denned in the upper basin of Madeley Creek, east of Callaghan Lake, on 29 October and emerged on 17 May. In 2009, she denned on 26 October high on the SW slope of Rainbow Mountain though her collar did not obtain fixes upon emergence. It is notable that CF05 used an area closely associated with the Callaghan 2010 Olympic Nordic facility during late June and early July of 2009. The specific attractant to this site and whether it was natural or human-caused is unclear. We attempted to recapture CF05 by heli-darting in Aug, 2011 but were unsuccessful due to a drug-delivery problem.

CF15 "Hope" (Figure 31) – This female was collared on 2 Aug, 2011. From that time to her latest 25 Oct download, CF15 moved across 218 km^2, from upper Hope Creek (upper Hurley drainage), upper Birkenhead drainage, with extensive use of Tenquille Valley. She also made several forays into the Lillooet Valley and ranged into the upper reaches of Sockeye Creek and the headwaters of Noel Creek. Bear CF15 ("Hope") corresponds to F139 originally detected in the Birkenhead drainage in the 2006 hair-snag/DNA grid.

CM16 "Titus" (Figure 32) – This male was collared on 4 Aug, 2011, captured along with CF12 "Phoebe" in upper Petersen Creek. While he moved in the same local area as CF12 in the few days

following capture, it is not apparent that they were together after capture (they in fact may not have been together before capture despite the fact that they were captured together). From this time until his latest download on 28 October. CM16 used upper Petersen Creek extensively and moved from the lower to upper Ryan Valley and over the ridge into South Creek. He then moved across the Lillooet Valley and into the upper Hurley drainage, up Hope Creek and into the upper Birkenhead drainage where he used Tenquille Valley extensively. These 3 months of movement data covered 749 km^2. Bear CM16 "Titus" corresponds to M249 in the regional DNA database and was originally detected in the Birkenhead drainage in 2007.

CM17 "Huck" (Figure 33) – This male was collared on 22 Sept, 2011 by cable snare in the Tenquille Valley. From this date to his latest download on 18 Oct, CM17 moved from the Tenquille Valley to the lower Birkenhead River, obviously for salmon. Bear CM17 ("Huck") corresponds to M105 also originally detected in the Birkenhead area in 2006.

Other Detections (2010) - Hair-snag/DNA detection sampling along the lower Squamish River for long-term monitoring detected several grizzly bears previously identified through regional sampling efforts carried out since 2004. As with previous years, bears detected along the lower Squamish have all been males. Near Shovelnose Creek, bear M8 was detected 3 times and M111 once. In the Ashlu floodplain, bears M32 and M46 were detected once each. Bear M46 was also detected once near Sigurd Creek. One monitoring site in the main Ashlu drainage detected M8 once, and another site in the upper Ashlu detected M8 and M35 once each, and M56 4 times.

Other Detections (2011) - All bears captured and collared during 2011 had been previously detected and included in the regional DNA/detection database. Bear CM16 ("Titus") corresponds to M249 in the regional DNA database and was originally detected in the Birkenhead drainage in 2007. Bear CF15 ("Hope") corresponds to F139 originally detected in the Birkenhead drainage in the 2006 hair-snag/DNA grid. Bear CM17 ("Huck") corresponds to M105 also originally detected in the Birkenhead area in 2006. As discussed in the regional DNA report, this male assigns clearly to the Stein population and obviously has dispersed from there. Interestingly, "Huck" is also known to have mated with F139 (CF15 "Hope") who was also collared this year, parenting a cub who is a 50/50 Stein/McGillivray hybrid. In addition to bears captured and collared, several individuals were detected through hair-snag sites at specific locales.

At a site near Salal Creek in the upper Lillooet Valley, several previously identified males were detected. This included M256 who was originally known from 2007 sampling in the same area. This bear was detected from samples collected during June, July, August and both early and later October but not from a collection visit in September. Samples collected there in September detected M83 who was originally known from 2005 sampling in the Ryan Valley. Finally, samples collected during late October detected M216. This male was originally detected near Edmond Creek at the south end of Chilko Lake in 2007, then also in the Toba drainage in 2008.

At a site near South Creek at 14.5 km of the Lillooet Valley road, three grizzly bears were detected. Bear M247 was identified from samples collected in July. This male is originally known from 2007 sampling in the Birkenhead drainage. Samples collected in August produced F84, a female originally detected from 2005 sampling in the Ryan drainage. August samples also identified a new male (M330), possibly a dependent cub of the F84.

At a site in the upper Rutherford, three individuals were detected. Samples collected in July identified M30 who has been collared as study animal CM14 "Atlas". In August, samples identified F22 who is known as CF05 "Chloe" also from the collaring program. Both bears have been known since the 2004 Squamish-Lillooet sampling. Also, a sample collected at this site in late August identified a new female (F331).

Near Wingate Creek in the lower Elaho Valley, three males were detected from samples collected in September. This included M111 who was originally detected in the upper Lillooet Valley in 2006. Also, M216 was again detected in addition to his October detections near Salal Creek in the upper Lillooet Valley (see above for his detections in other drainages). As well, a sample corresponded to M256 who was originally known from 2007 sampling in the upper Lillooet.

Samples collected in July at a site in lower Sims Creek of the Elaho drainage detected M35, a bear that was originally detected in 2004 within the Squamish-Lillooet GBPU. Also at this site, a newly identified female (F329) was detected.

In the lower Squamish Valley, only one bear was detected from samples collected for 2011 monitoring. Male M46 was once again detected this year, both at the Ashlu floodplain in September and also near Shovelnose Creek in October. This bear was originally detected in the regional DNA survey in 2004 and in subsequent monitoring sampling in 2007 (Callaghan), 2008, and 2010.

Finally, several samples were collected opportunistically during 2011. A young (2-3 year old) male that was captured in the upper Rutherford drainage but not collared had not been previously detected and is now identified as M328 in the regional DNA database. The adult male that was illegally killed in November at kilometer 7 of the Lillooet Valley road corresponds to M133 who had been detected extensively since the 2006 grid in the regional study. And a sample opportunistically collected in September at a site in the lower Homathko Valley corresponded to a male that had previously been detected in the Southgate drainage during 2010 sampling.

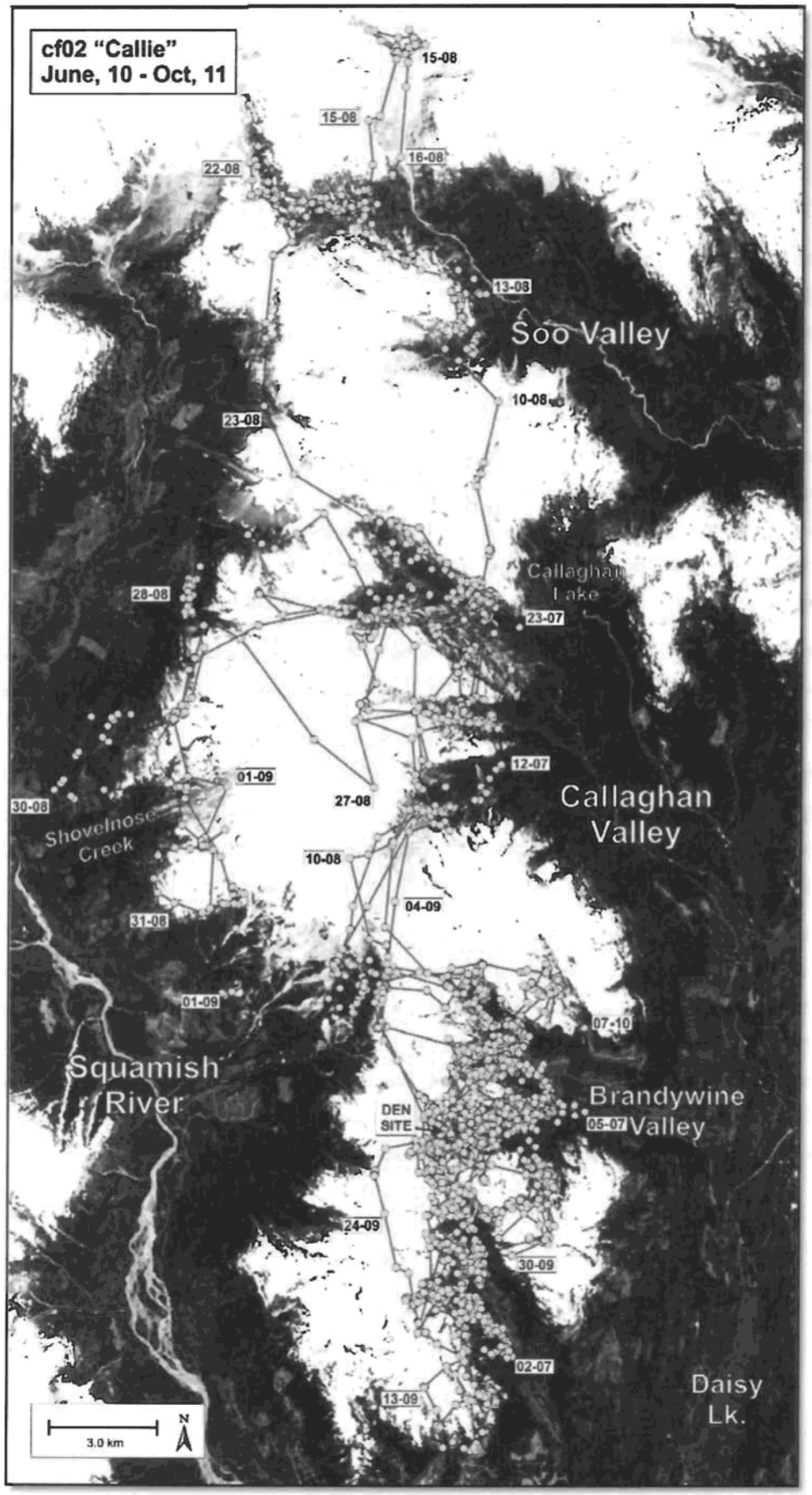

Figure 21. Known movement by grizzly bear CF02 ("Callie") during June 2010 – October 2011.

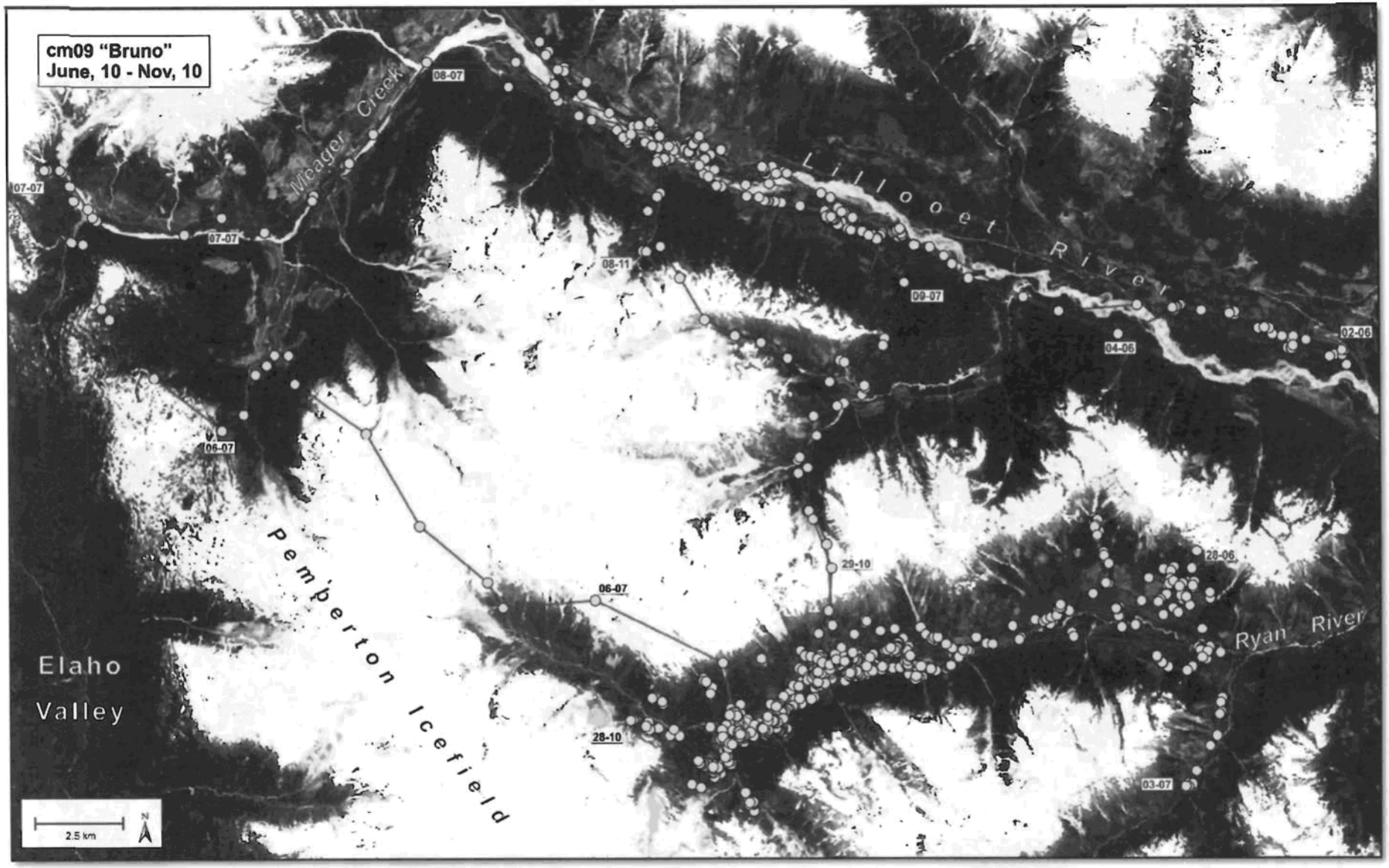

Figure 22. Known movement by grizzly bear CM09 ("Bruno") during June - November, 2010.

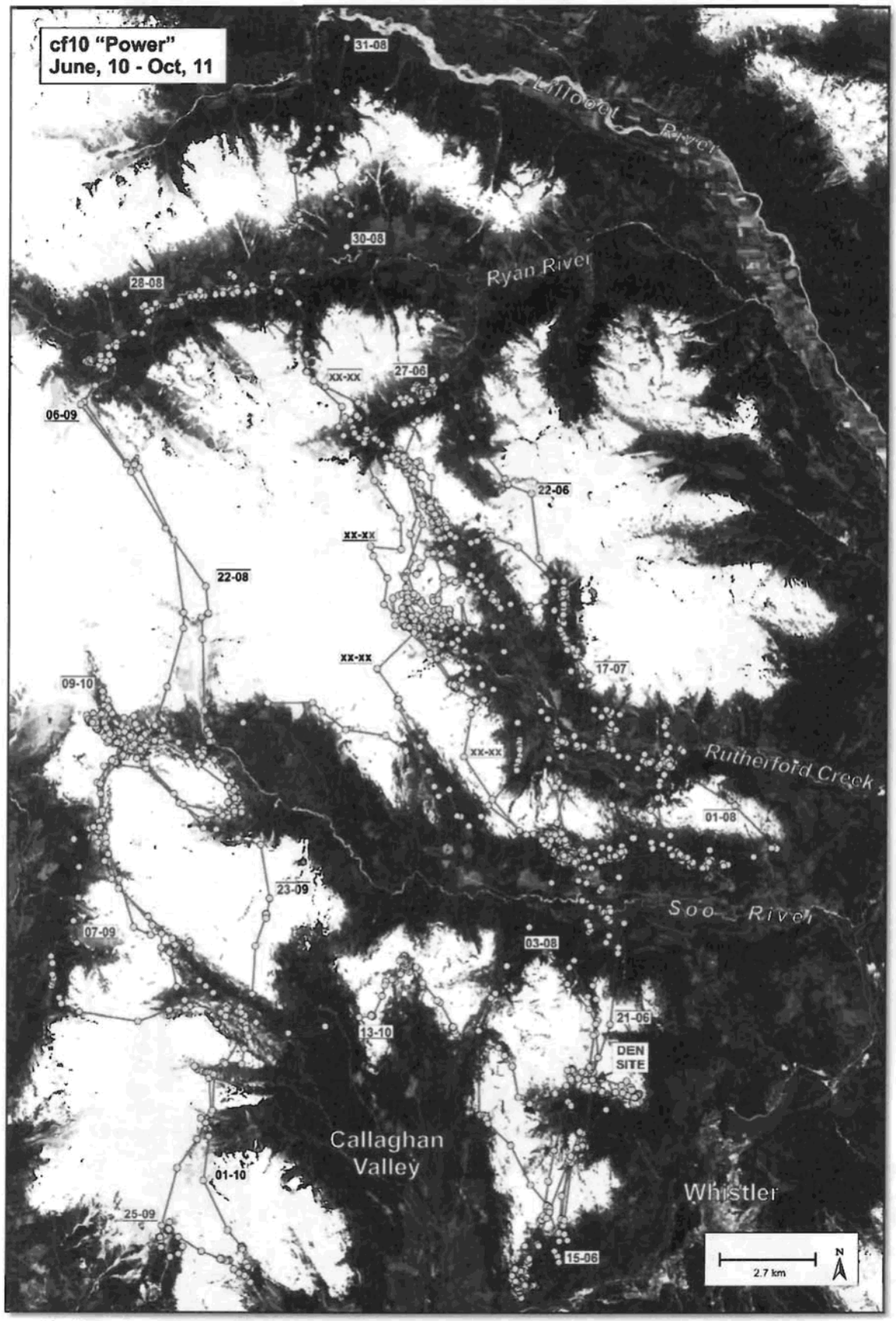

Figure 23. Known movement by grizzly bear CF10 ("Power") during June 2010 – August 2011.

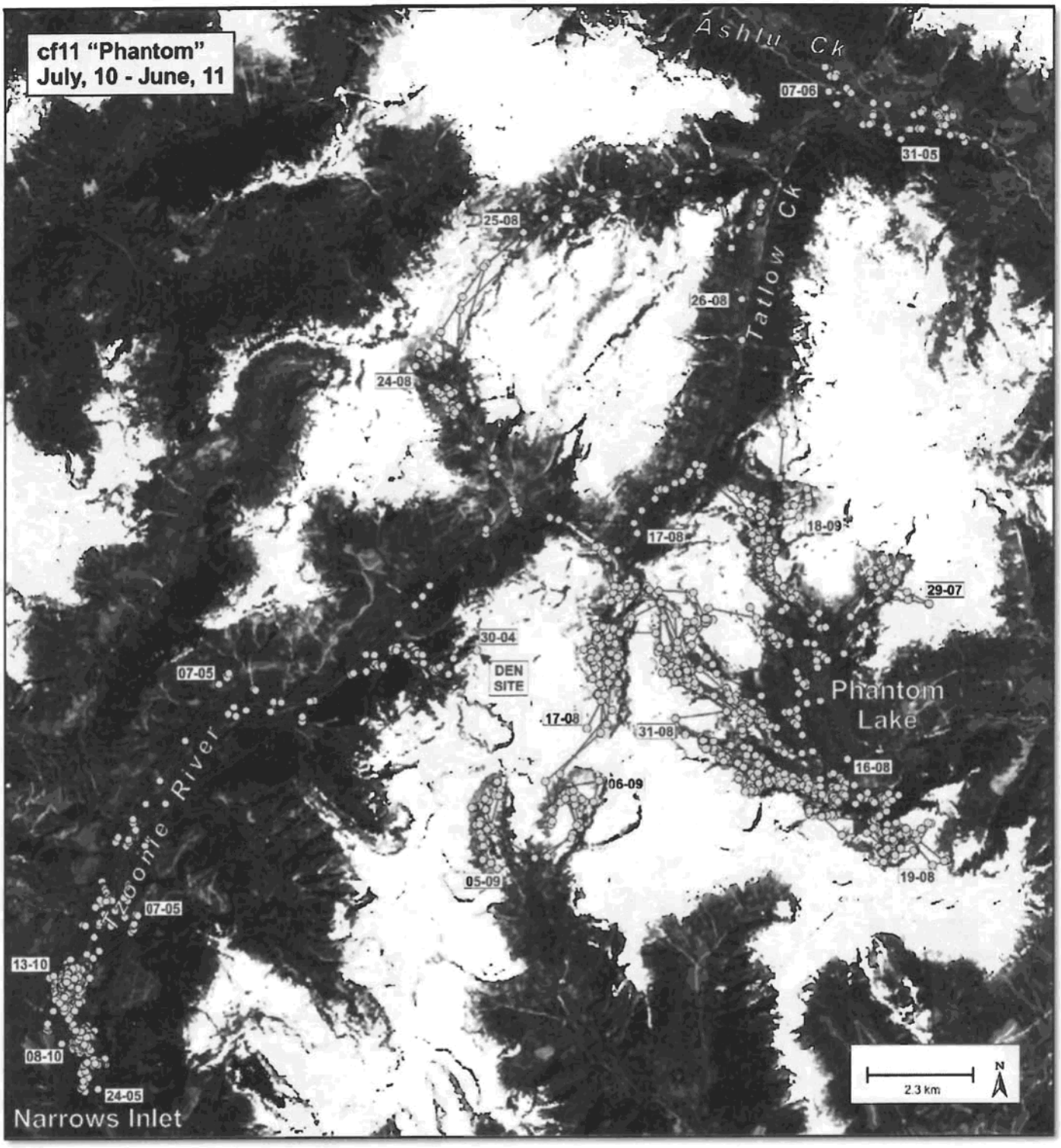

Figure 24. Known movement by grizzly bear CF11 ("Phantom") during July 2010 – June 2011.

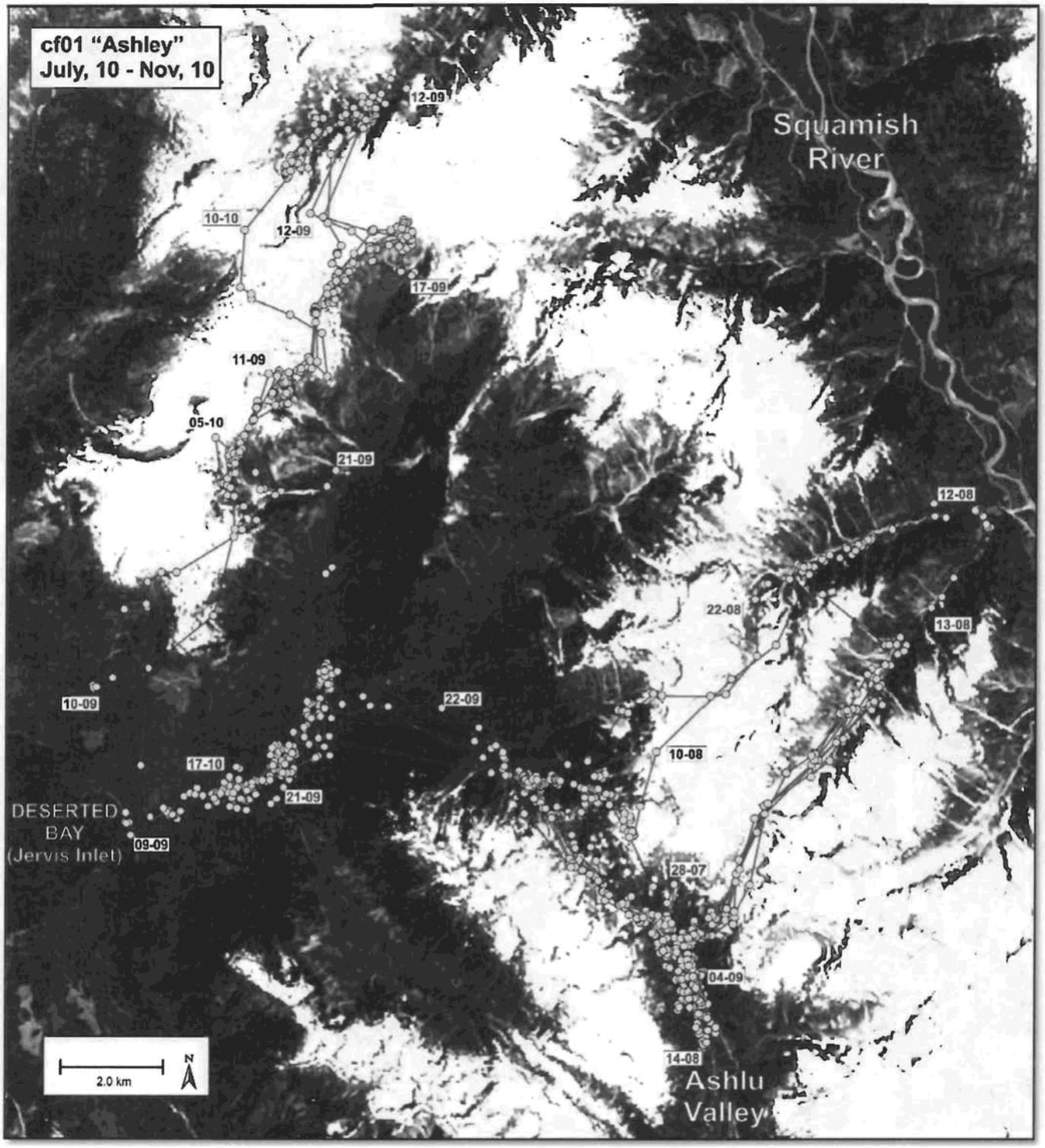

Figure 25. Known movement by grizzly bear CF01 ("Ashley") during July 2010 – November 2010.

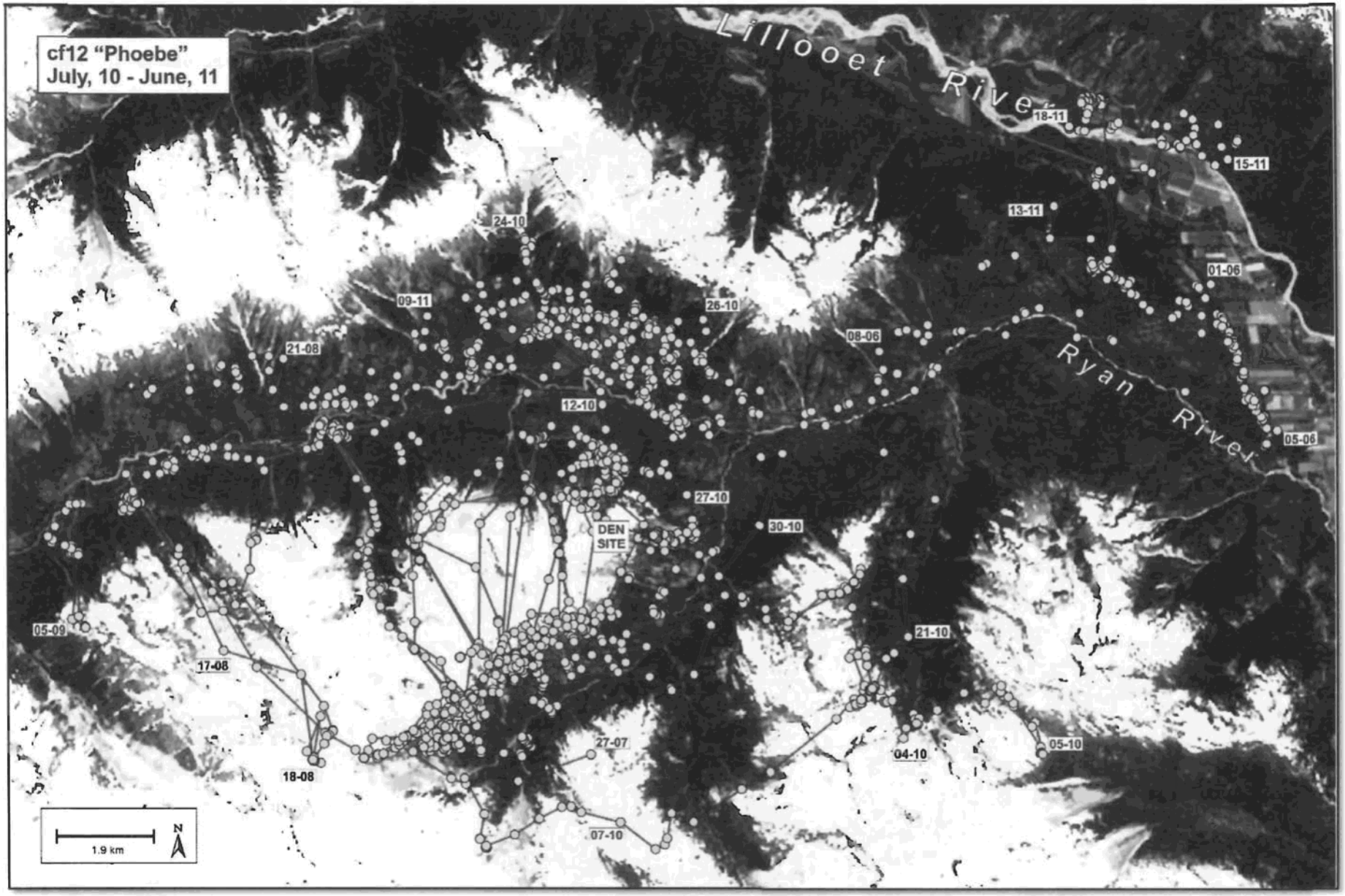

Figure 26. Known movement by grizzly bear CF12 ("Phoebe") during July 2010 – June 2011.

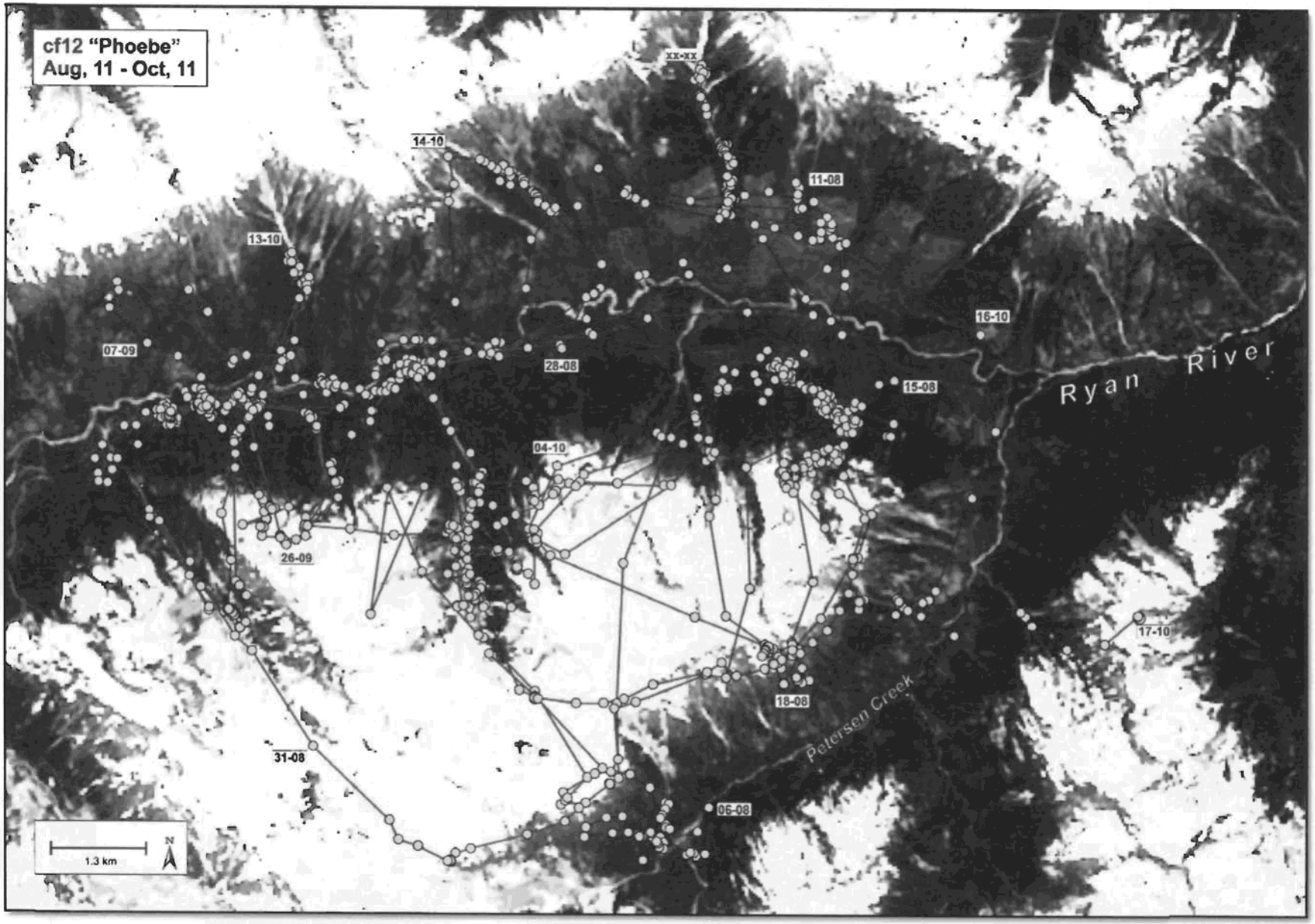

Figure 27. Known movement by grizzly bear CF12 ("Phoebe") during August 2011 – October 2011.

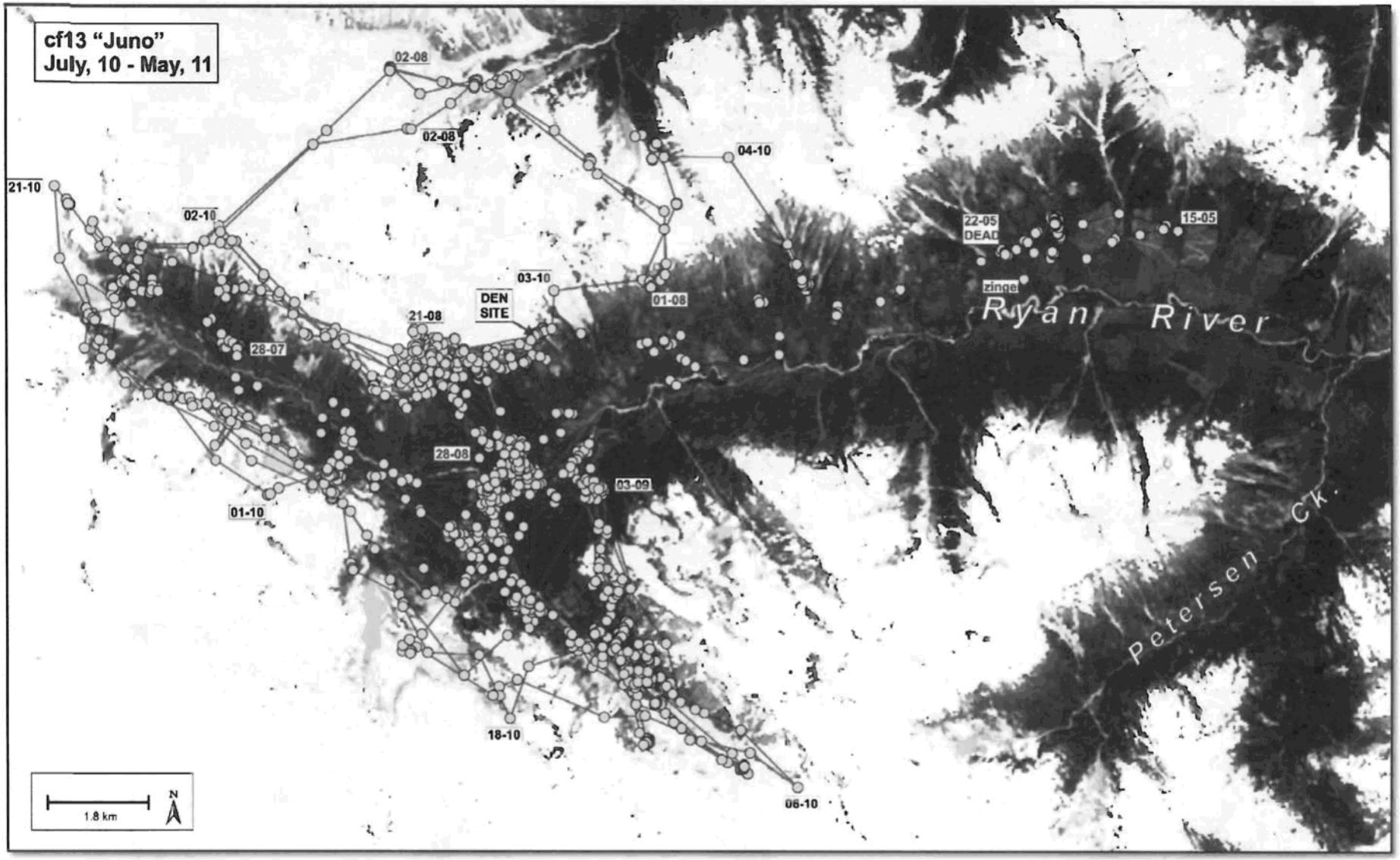

Figure 28. Known movement by grizzly bear CF13 ("Juno") during July 2010 – May 2011.

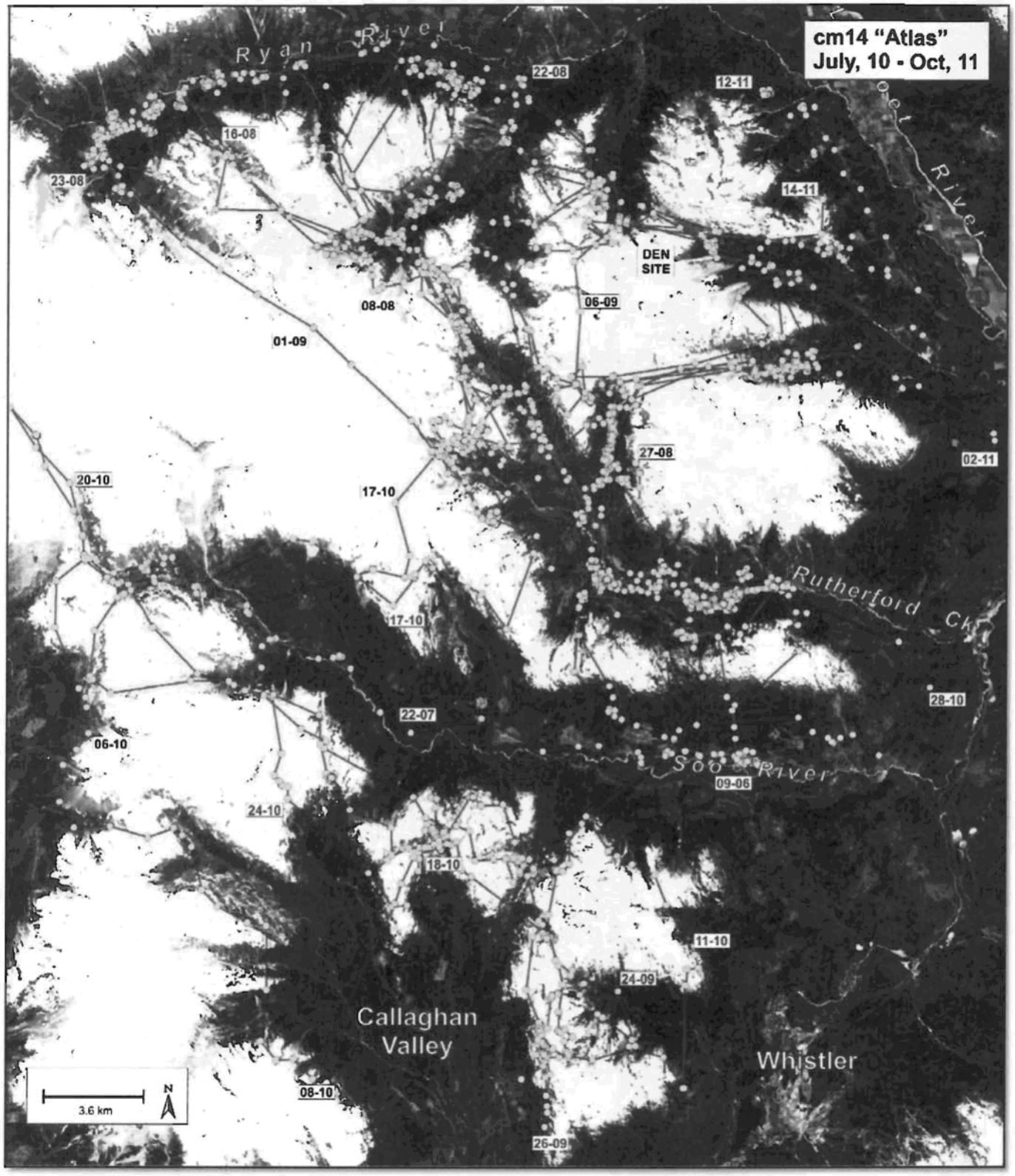

Figure 29. Known movement by grizzly bear CM14 ("Atlas") during July 2010 – October 2011.

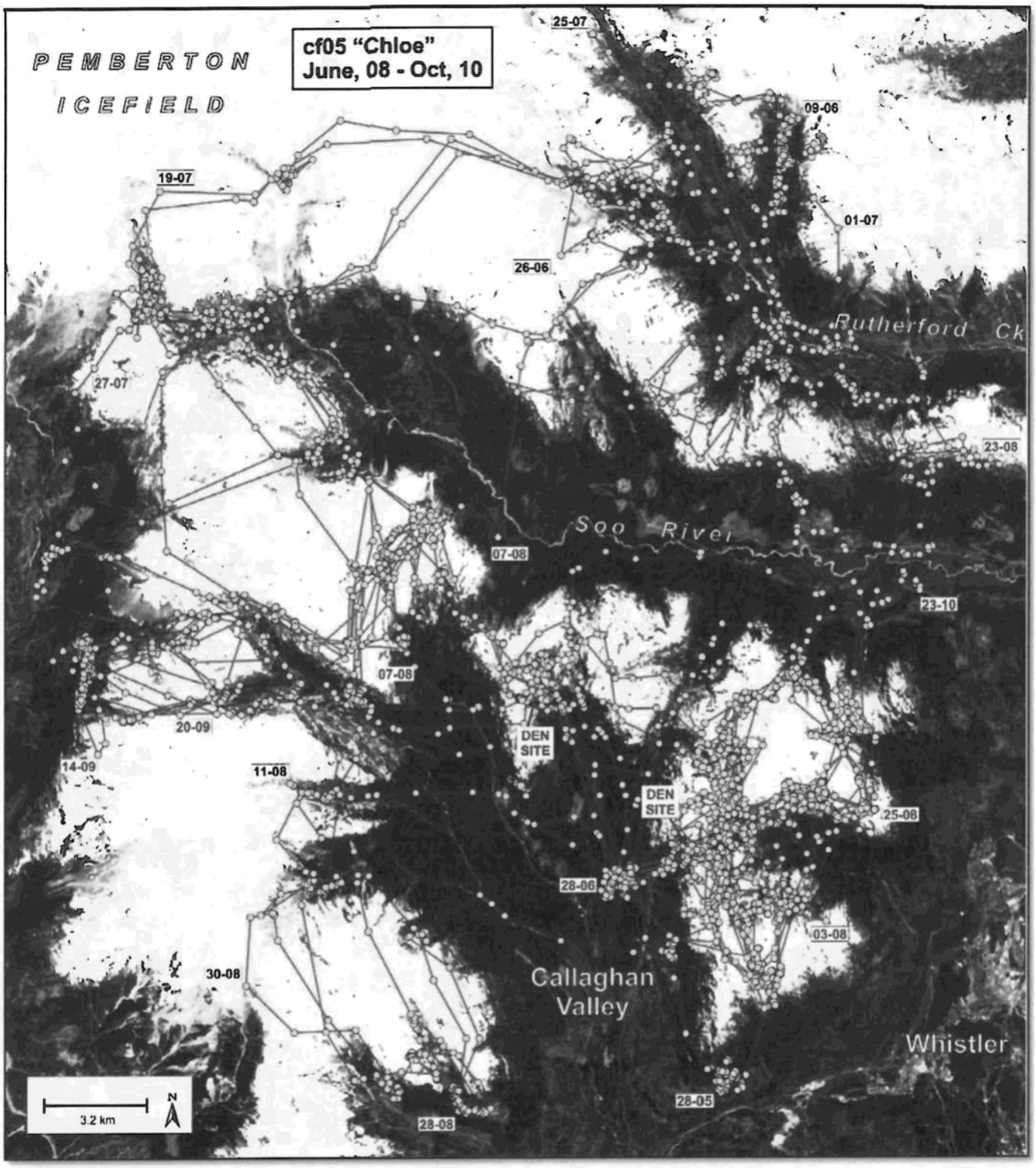

Figure 30. Known movement by grizzly bear CF05 ("Chloe") during June 2008 – October 2010.

Figure 31. Known movement by grizzly bear CF15 ("Hope") during Aug 2011 – October 2011.

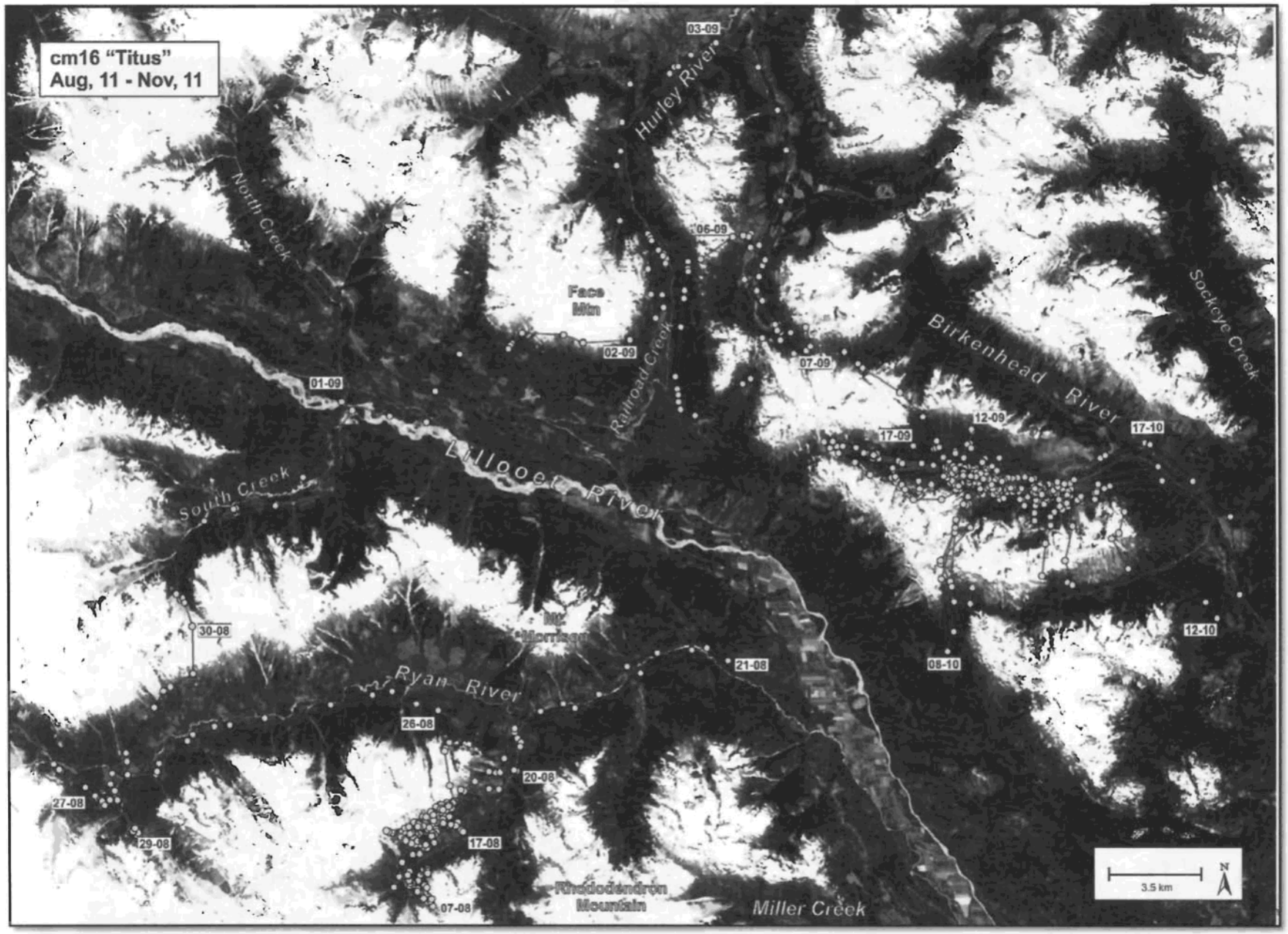

Figure 32. Known movement by grizzly bear CM16 ("Titus") during August 2011 – November 2011.

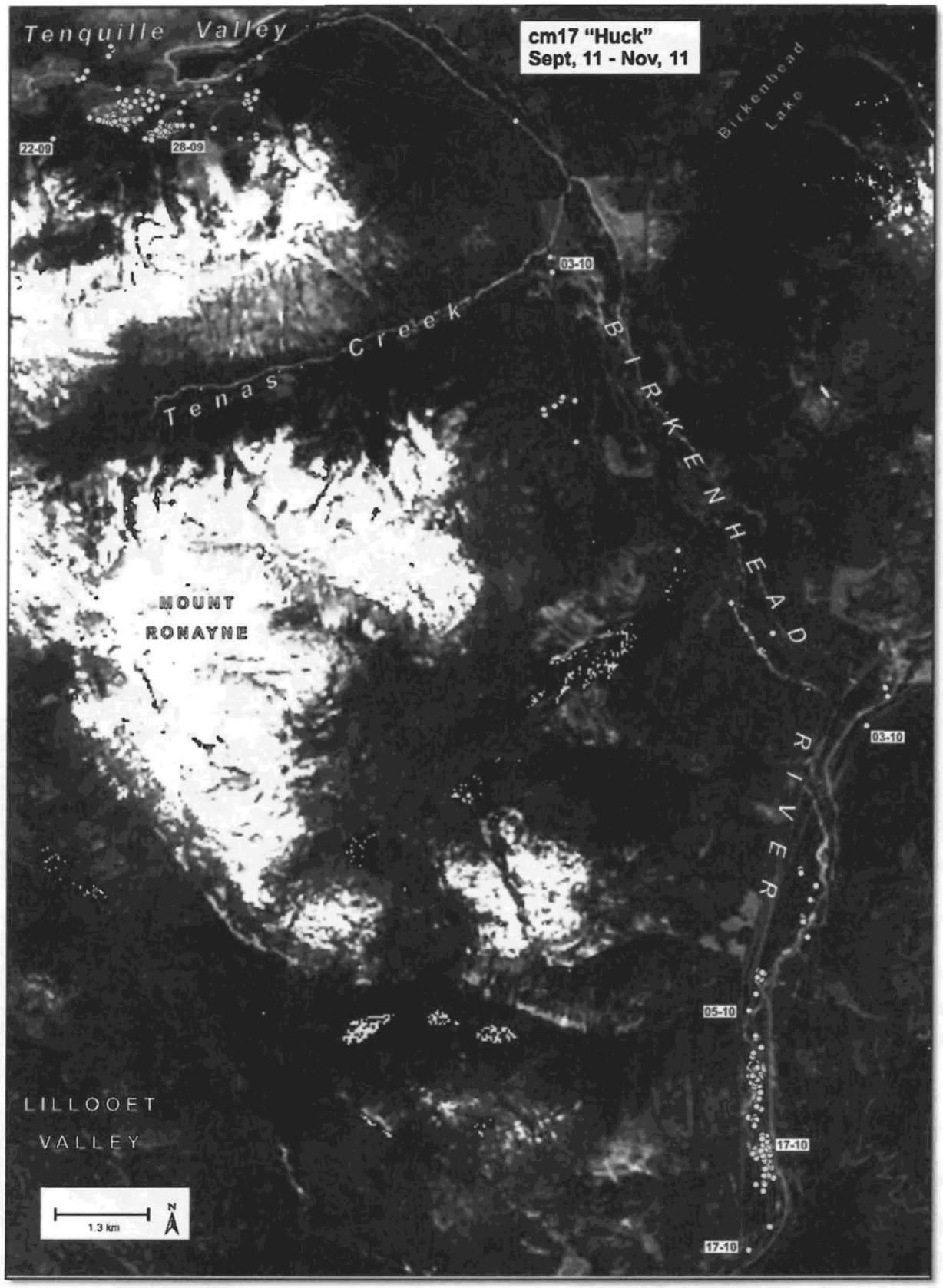

Figure 33. Known movement by grizzly bear CM17 ("Huck") during September 2011 – November 2011.

2012 – Capture Efforts & Bears Collared or Detected

Capture efforts during 2012 were carried out through July, August and September. Grizzly bears were captured using both helicopter-based aerial darting as well as helicopter-accessed ground snaring. On 4 July, an existing study animal CF02 "Callie" was recaptured through heli-darting and her collar was changed. On 19 July, we snare-trapped and collared an adult male CM18 "Boulder" in Pebble Creek. On 20 July, we snare-trapped and collared adult male CM19 "Silt" in the upper Lillooet Valley. On this same day we also snare-trapped and collared CF20 "Harriet" in a branch of the Hurley Valley, 6 km south of Jamie Creek, and we subsequently confirmed that she has two yearling cubs with her. On 24 July, we heli-darted and collared subadult male CM21 "Skid" and we snare-trapped adult male CM22 "Grey" both in the Petersen Valley. On this same day, we snare-trapped adult male CM23 "Shaggy" in the back of the Ryan Valley. On 29 July, we heli-darted and collared adult female CF24 "Melanie" in the back of the Meager drainage, and she is apparently not with cubs. On 15 September, we heli-darted and collared adult female CF25 "Natasha" in North Creek. On 16 September, we heli-darted and collared adult male CM26 "Hector" in the Hurley drainage, and existing study animal adult male CM14 was recaptured through heli-darting in Rutherford Creek and his collar was changed. Also on 16 September, adult female CF27 "Pebbles" was heli-darted and collared in the Pebble/McParlon pass, and she was with two yearling cubs. On 17 September, subadult female CF28 "Peanut" (offspring of CF15 "Hope") was heli-darted and collared (smaller collar used); this bear was travelling with a presumed sibling. On 18 September, adult female CF29 "Fay" was heli-darted and collared in the Ryan Valley. It is possible that this female is in fact previously-collared study animal CF10 "Power", which will be determined conclusively once we have the DNA lab results from this capture. Finally, on 22 September, a subadult male was heli-darted in the Hurley Valley but was not collared. Combined capture efforts during 2012 resulted in the collaring of 14 grizzly bears (7M, 7F), 12 of which were new study animals. On these bears we deployed Lotek GPS 7000MU remotely-downloadable collars as well as Lotek IridiumTrackM 2-way satellite communication collars (Lotek GPS 4400S used for CF28). All collars were programmed for 1-hr GPS fix attempts (Appendix 1).

2012 – Summary of Data and Movements

Functioning collars collected data from 21 (10M, 11F) study animals during 2012. Four study animals either could not be found during data download flights or there was a communication problem with their collars that precluded data acquisition. Six collars were recovered either by pick-up because they were dropped, or by recapture either because they were in "recovery" mode and were no longer obtaining GPS fixes or opportunistically because they were nearing the end their expected battery life. Periodic and opportunistic downloads were conducted on several bears through the summer and fall, and fixed-wing aircraft search and download flights were conducted in June and October. Data download flights were carried out in June and late October, between which data were also opportunistically downloaded with helicopter assistance and from the ground. Data downloaded from

study animals were screened and processed. As of March 2013, the number of existing collared bears is 15, although we expect some collars will be dropped this spring. Also, one of these collars is known to be malfunctioning and will require recovery through recapture this spring. For this study to date, GPS collars have been deployed 34 times on 28 or 29 (depending on results of a pending DNA test) grizzly bears (13M, 15-16F). Plots illustrating data collected during 2012 are provided for individual study animal in Figures 34 - 50, below.

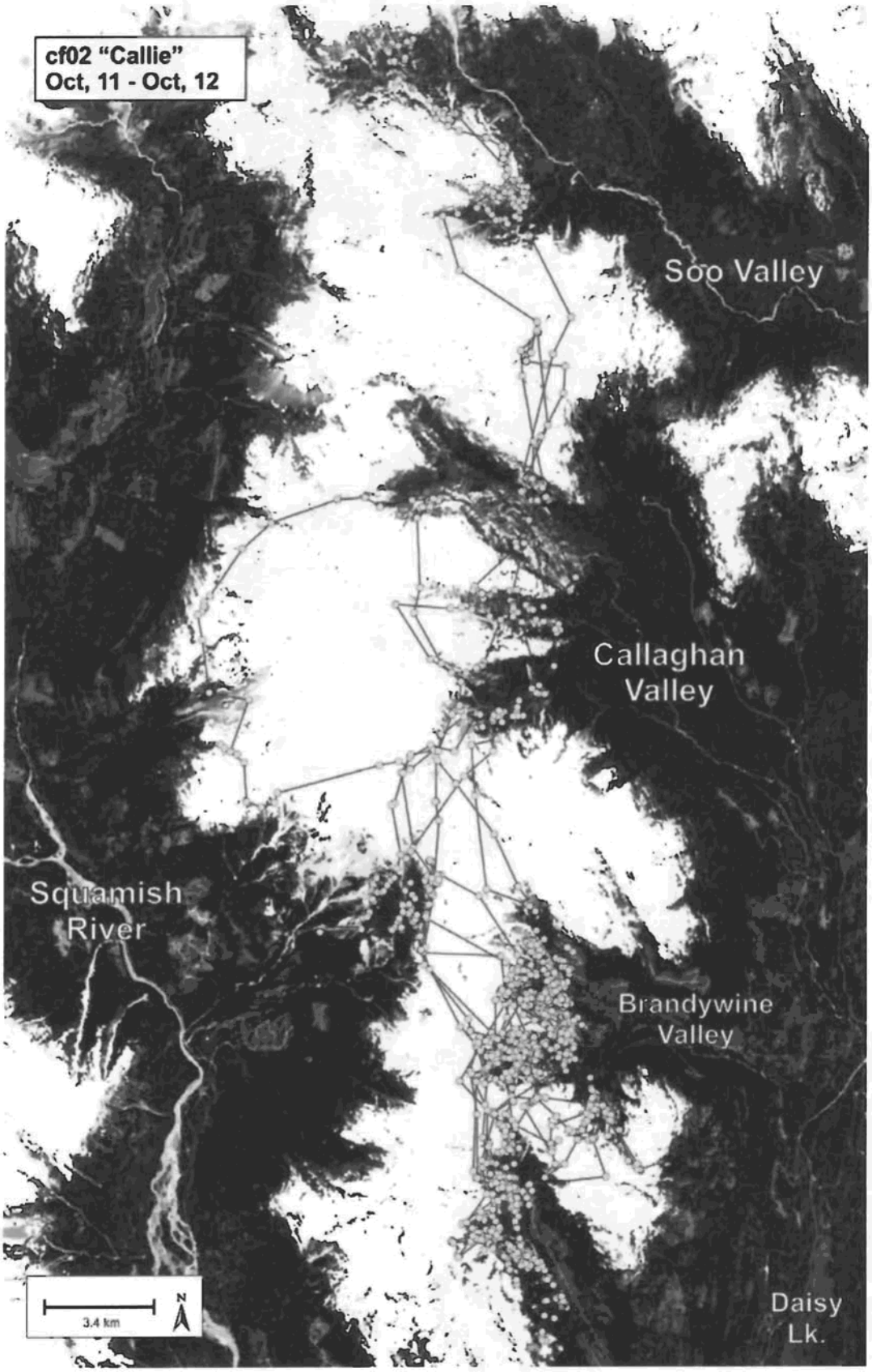

Figure 34. Known movement by grizzly bear CF02 ("Callie") during 2012 and since previous data download.

Figure 35. Known movement by grizzly bear CF10 ("Power") during 2012 and since previous data download.

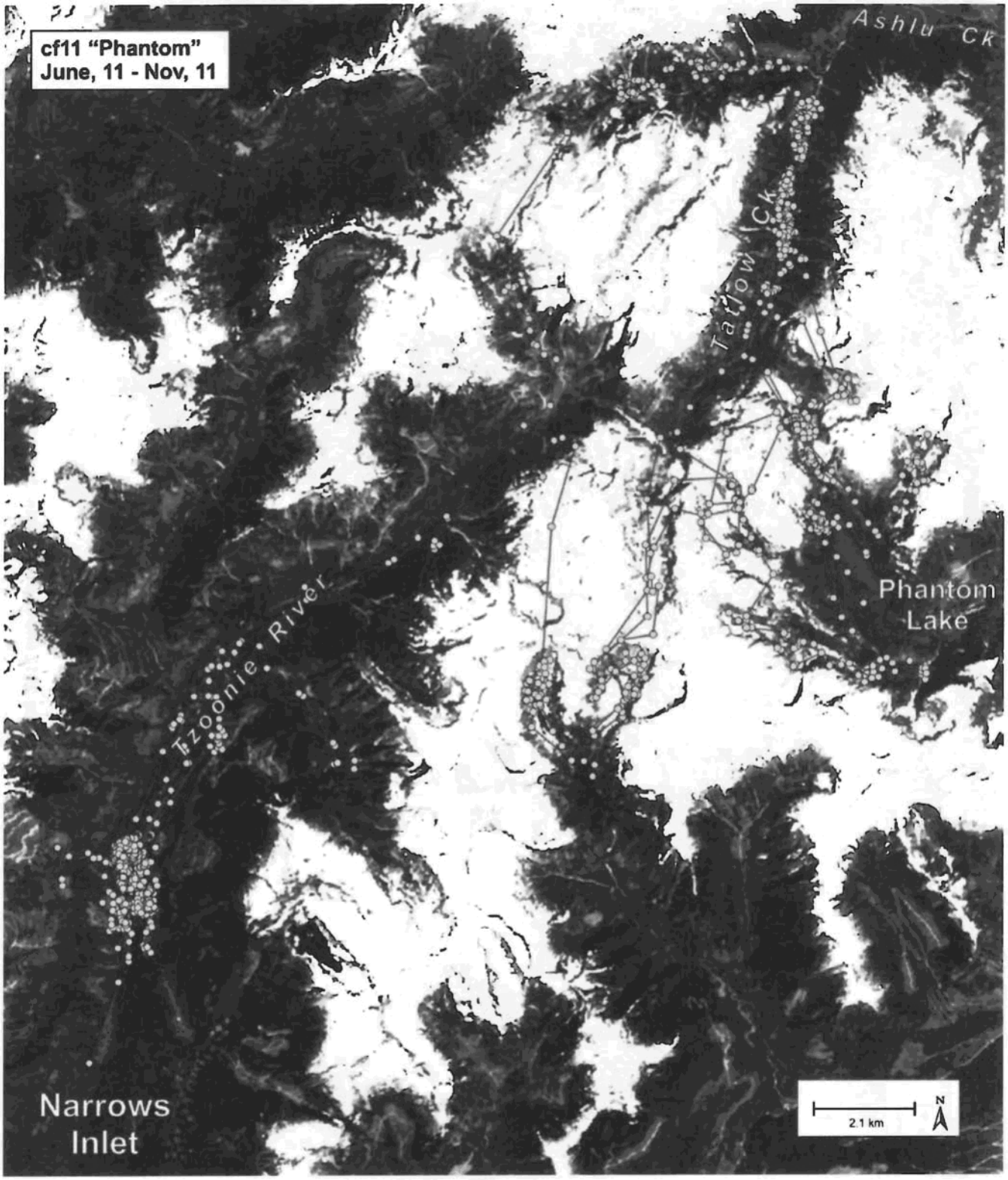

Figure 36. Known movement by grizzly bear CF11 ("Phantom") during 2012 and since previous data download.

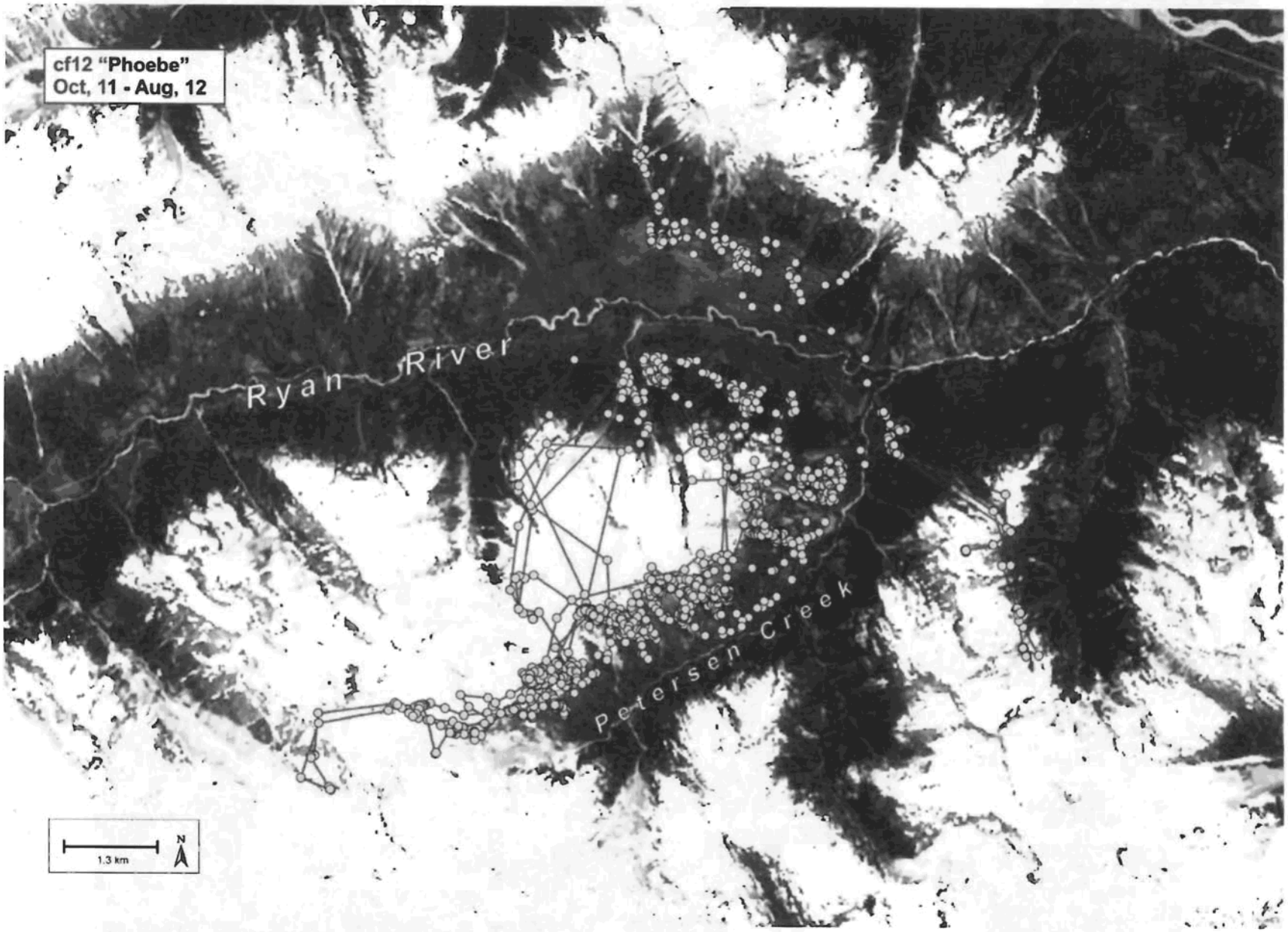

Figure 37. Known movement by grizzly bear CF12 ("Phoebe") during 2012 and since previous data download.

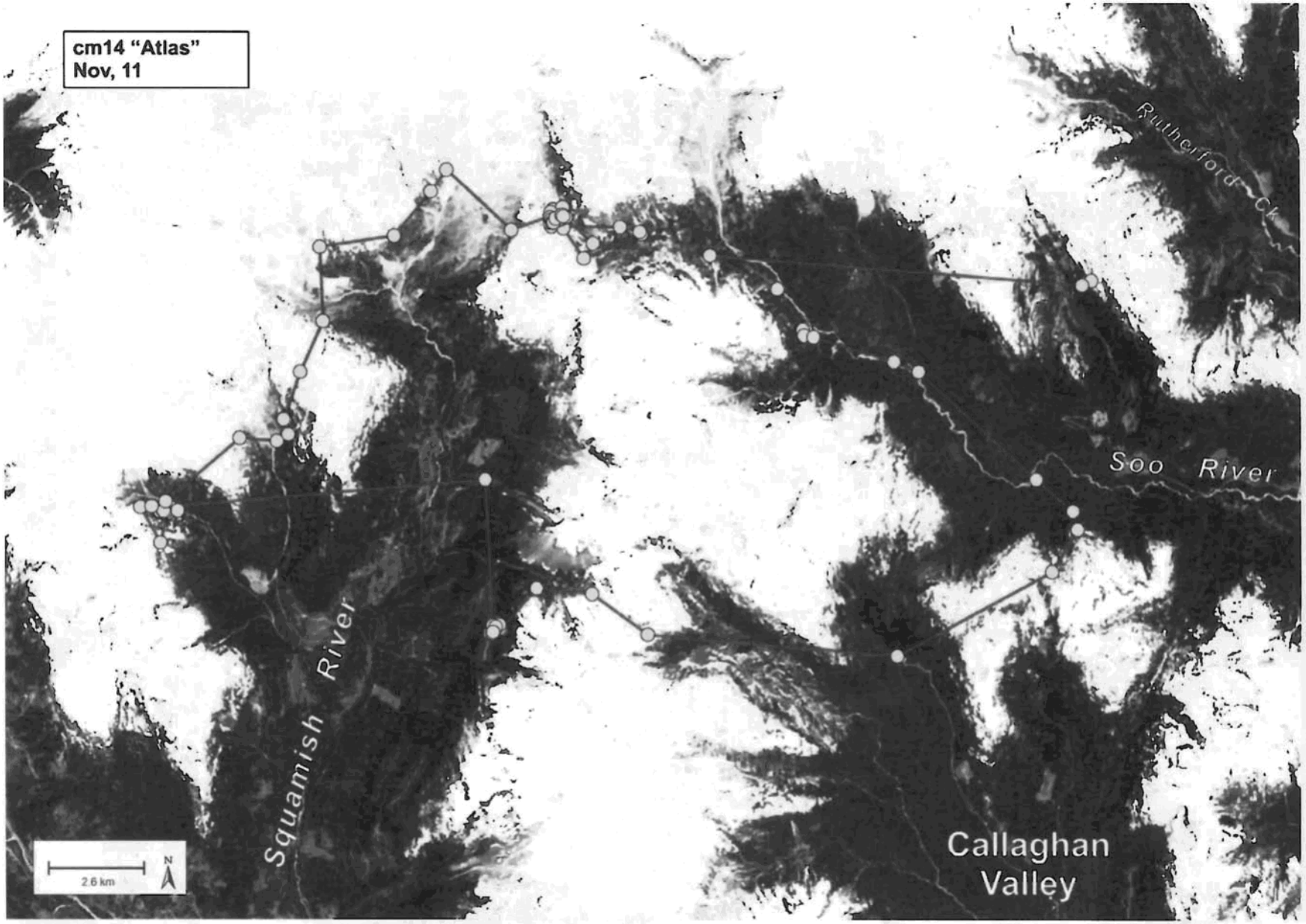

Figure 38. Known movement by grizzly bear CM14 ("Atlas") during 2012 and since previous data download.

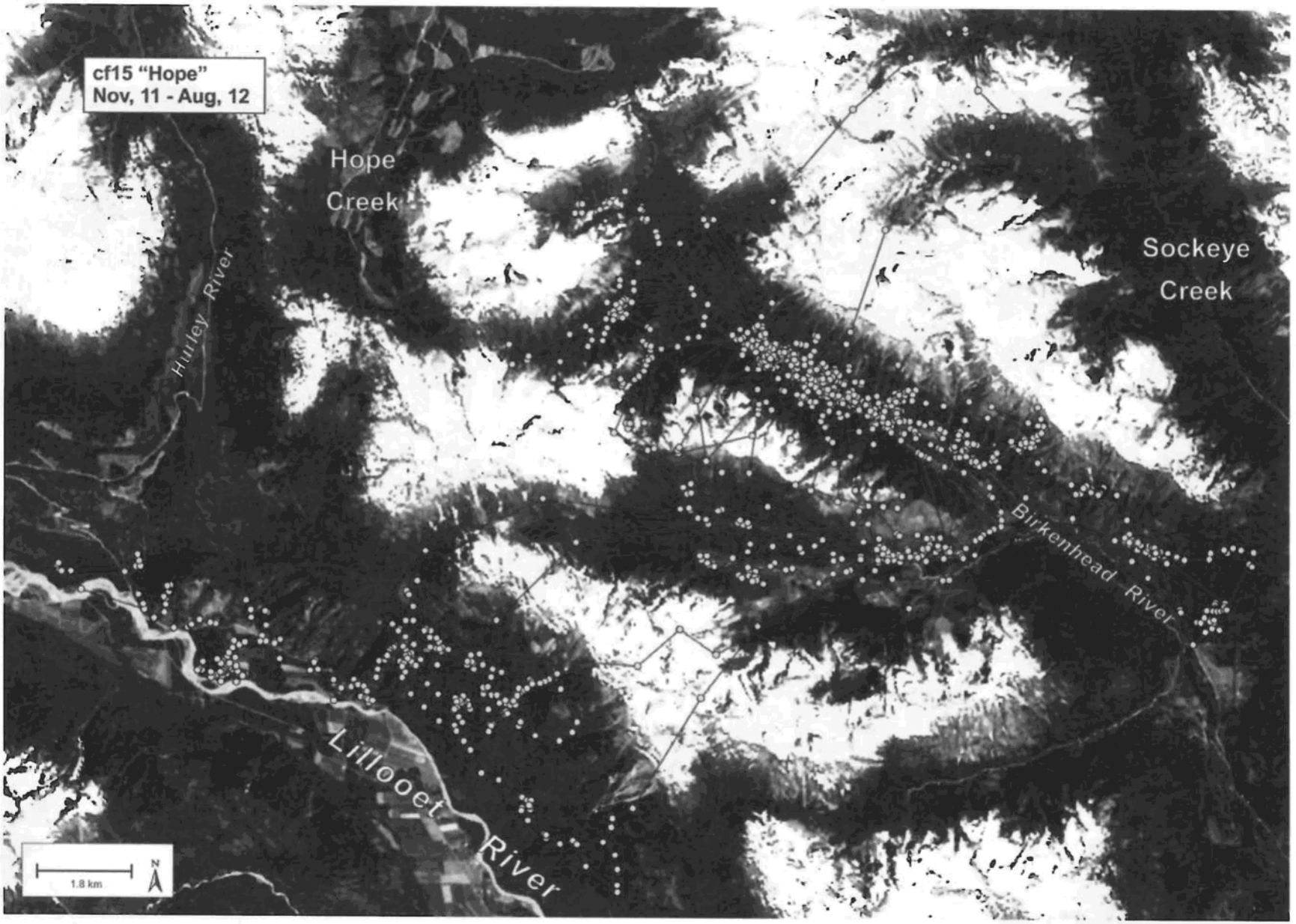

Figure 39. Known movement by grizzly bear CF15 ("Hope") during 2012 and since previous data download.

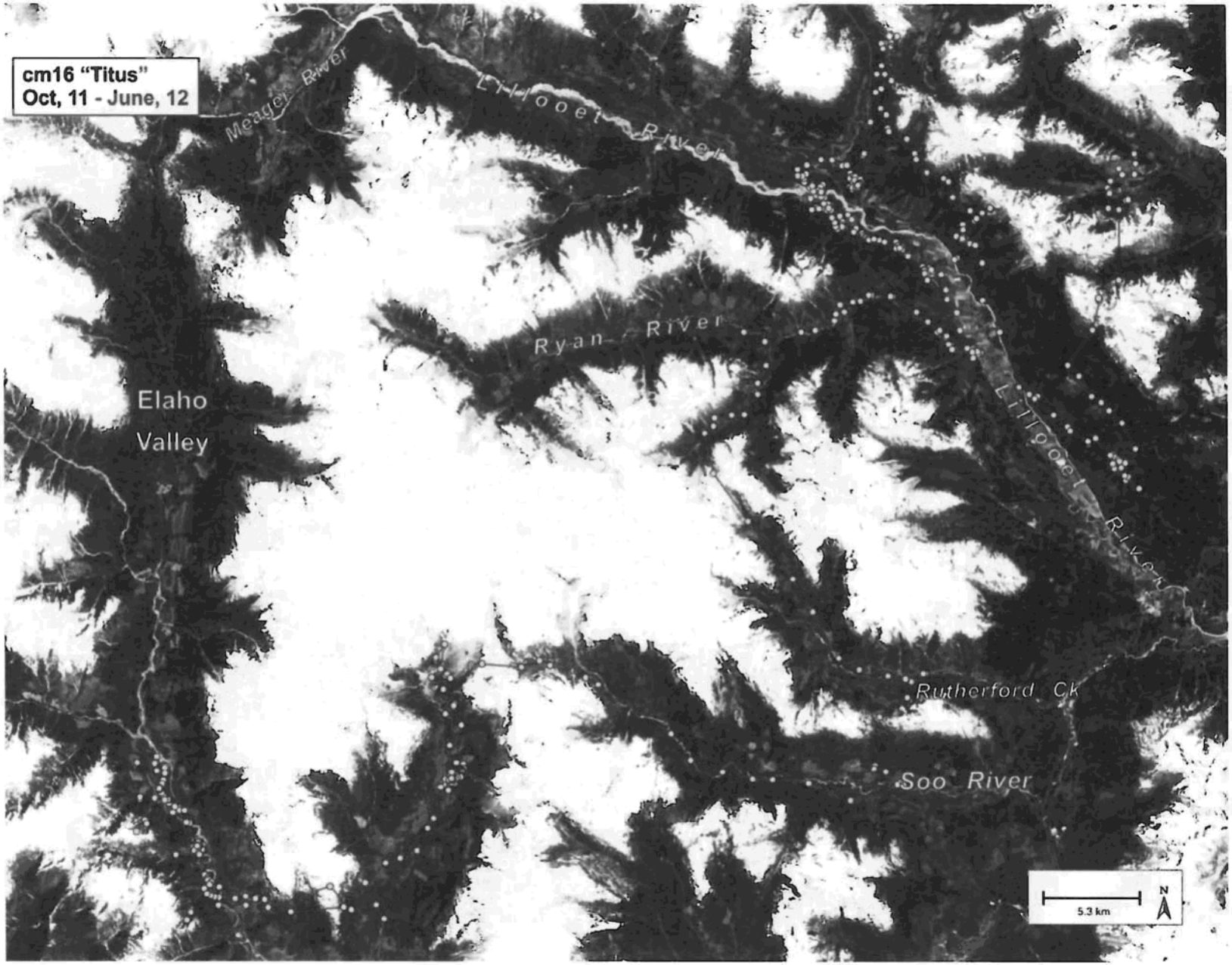

Figure 40. Known movement by grizzly bear CM16 ("Titus") during 2012 and since previous data download.

Figure 41. Known movement by grizzly bear CM17 ("Huck") during 2012 and since previous data download.

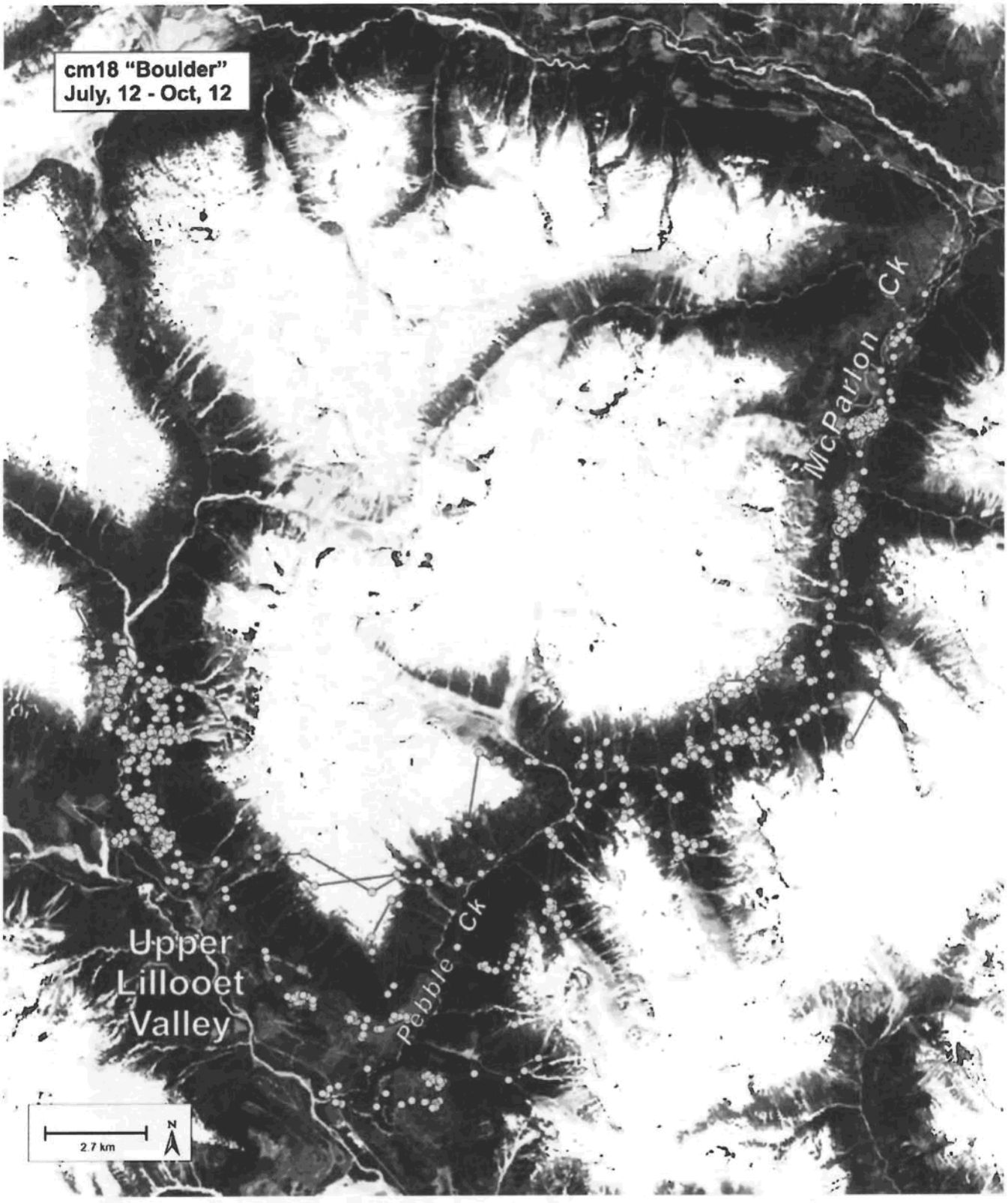

Figure 42. Known movement by grizzly bear CM18 ("Boulder") during 2012 and since previous data download.

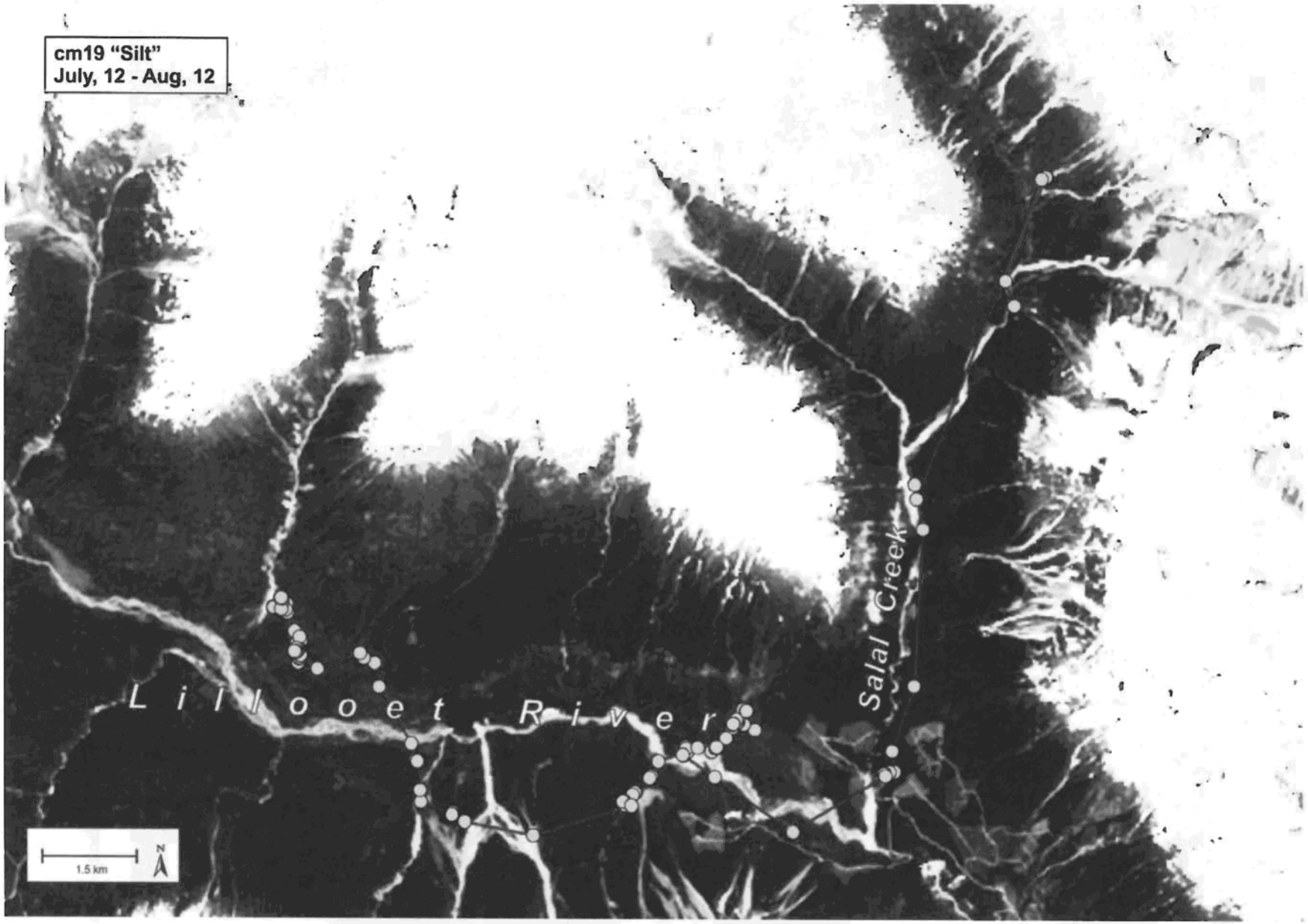

Figure 43. Known movement by grizzly bear CM19 ("Silt") during 2012 and since previous data download.

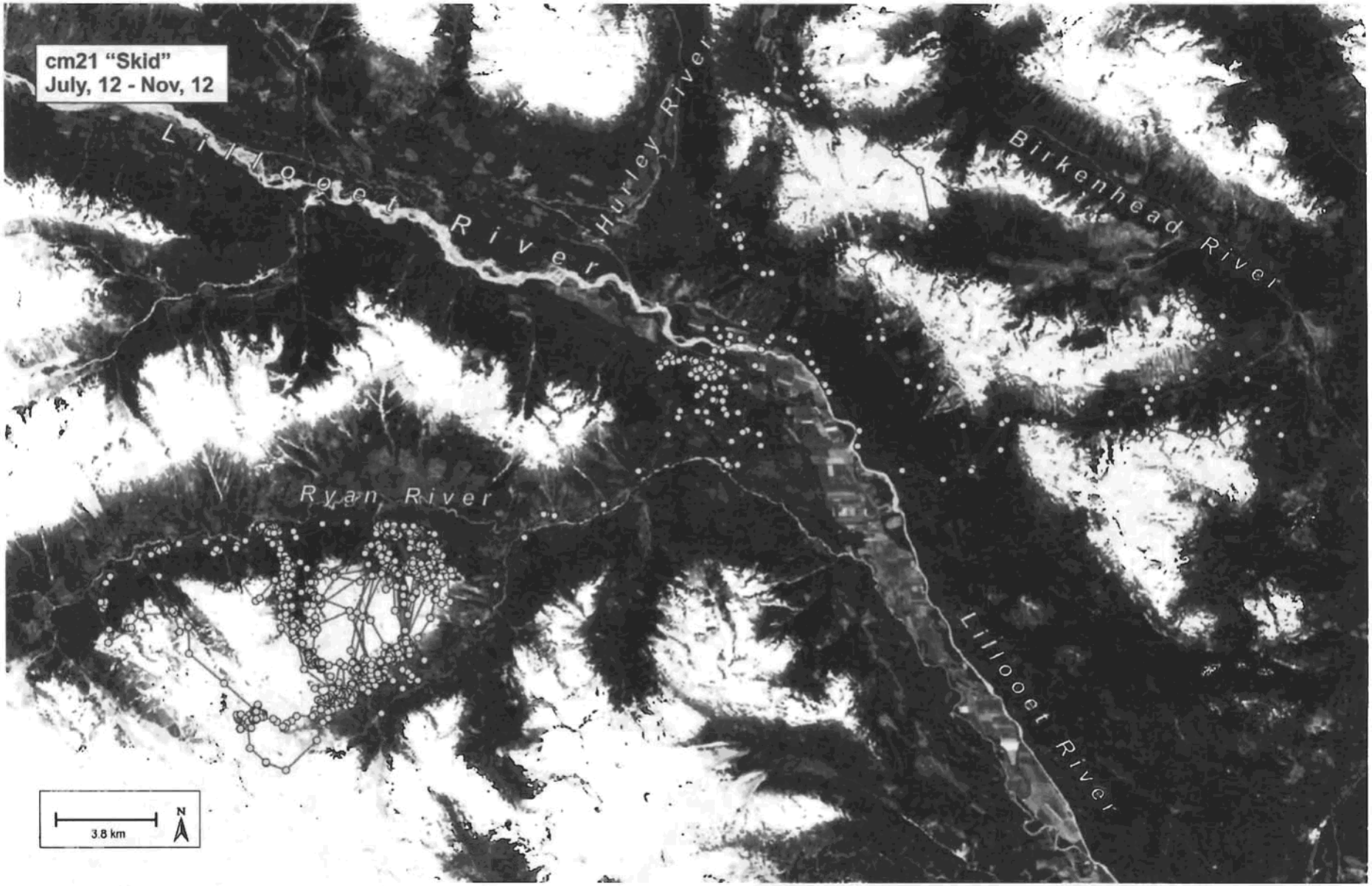

Figure 44. Known movement by grizzly bear CM21 ("Skid") during 2012 and since previous data download.

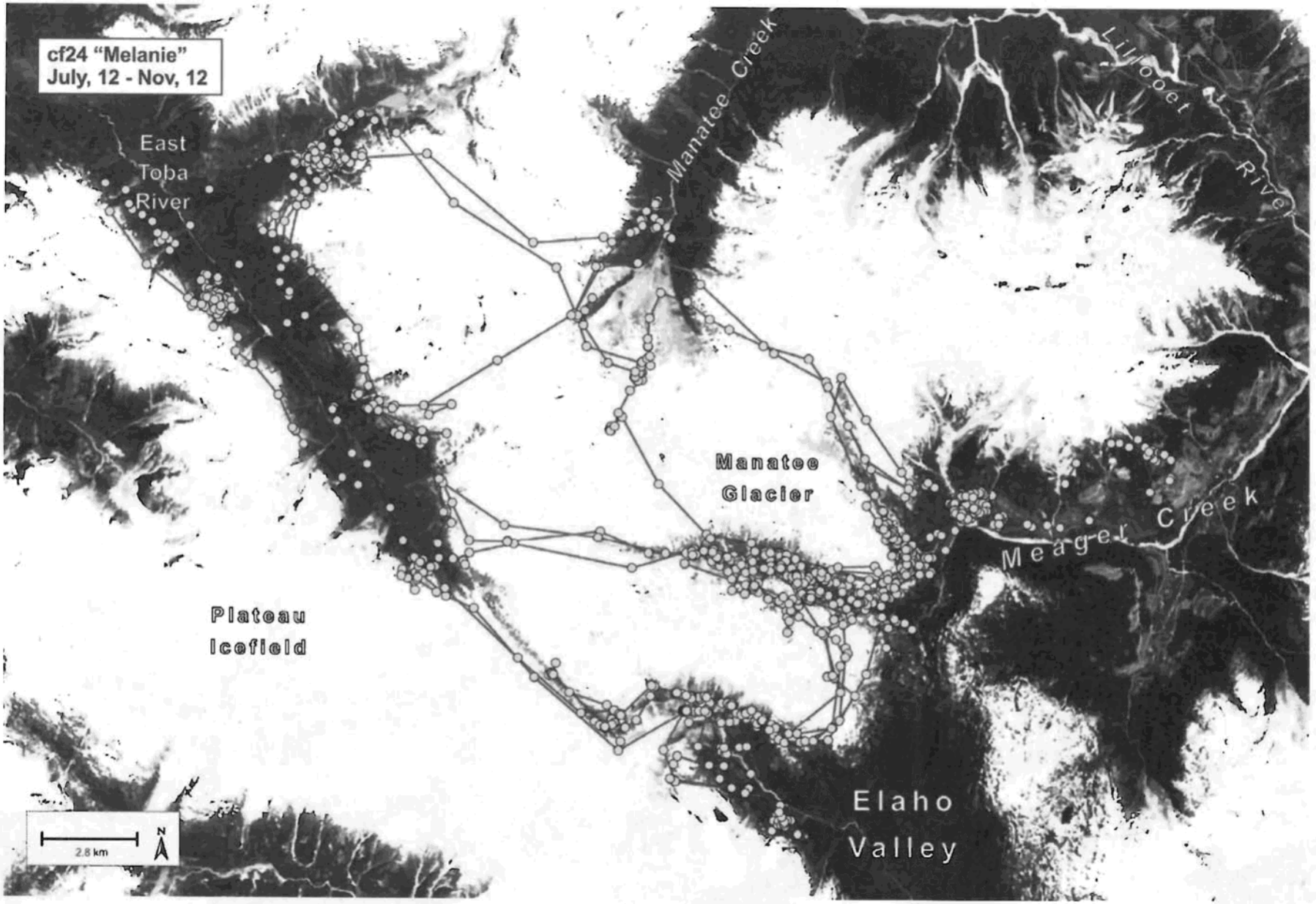

Figure 45. Known movement by grizzly bear CF24 ("Melanie") during 2012 and since previous data download.

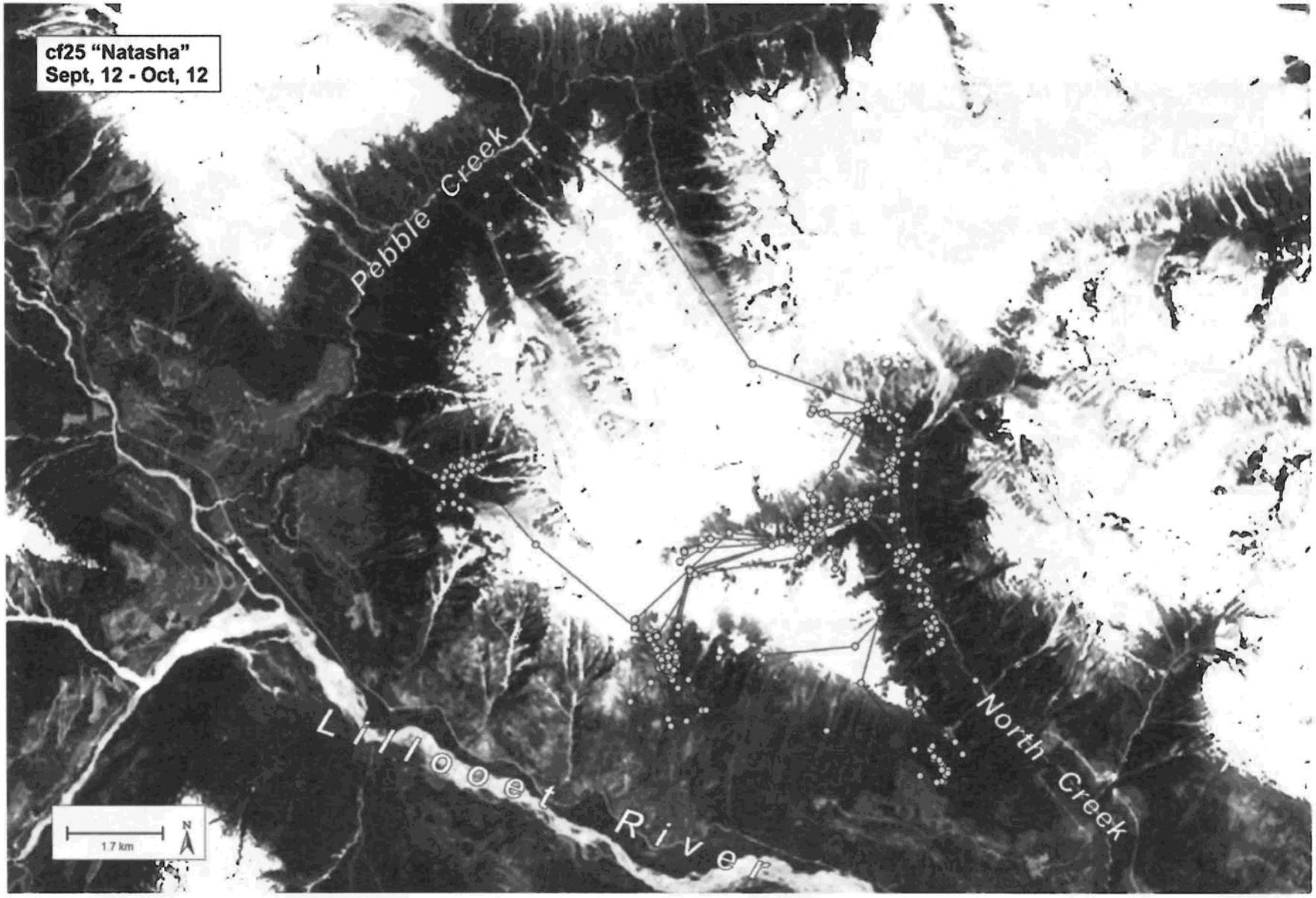

Figure 46. Known movement by grizzly bear CF25 ("Natasha") during 2012 and since previous data download.

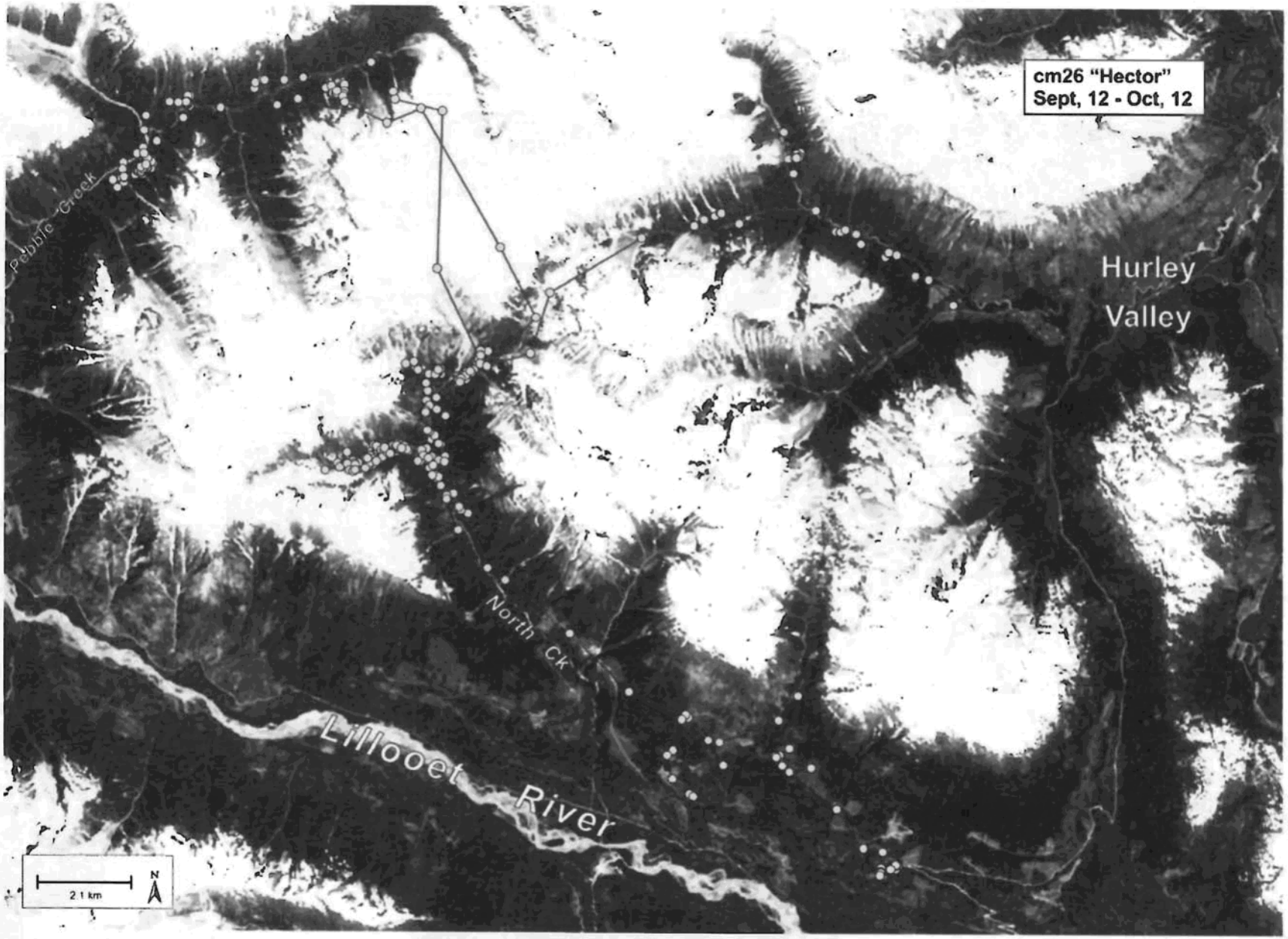

Figure 47. Known movement by grizzly bear CM26 ("Hector") during 2012 and since previous data download.

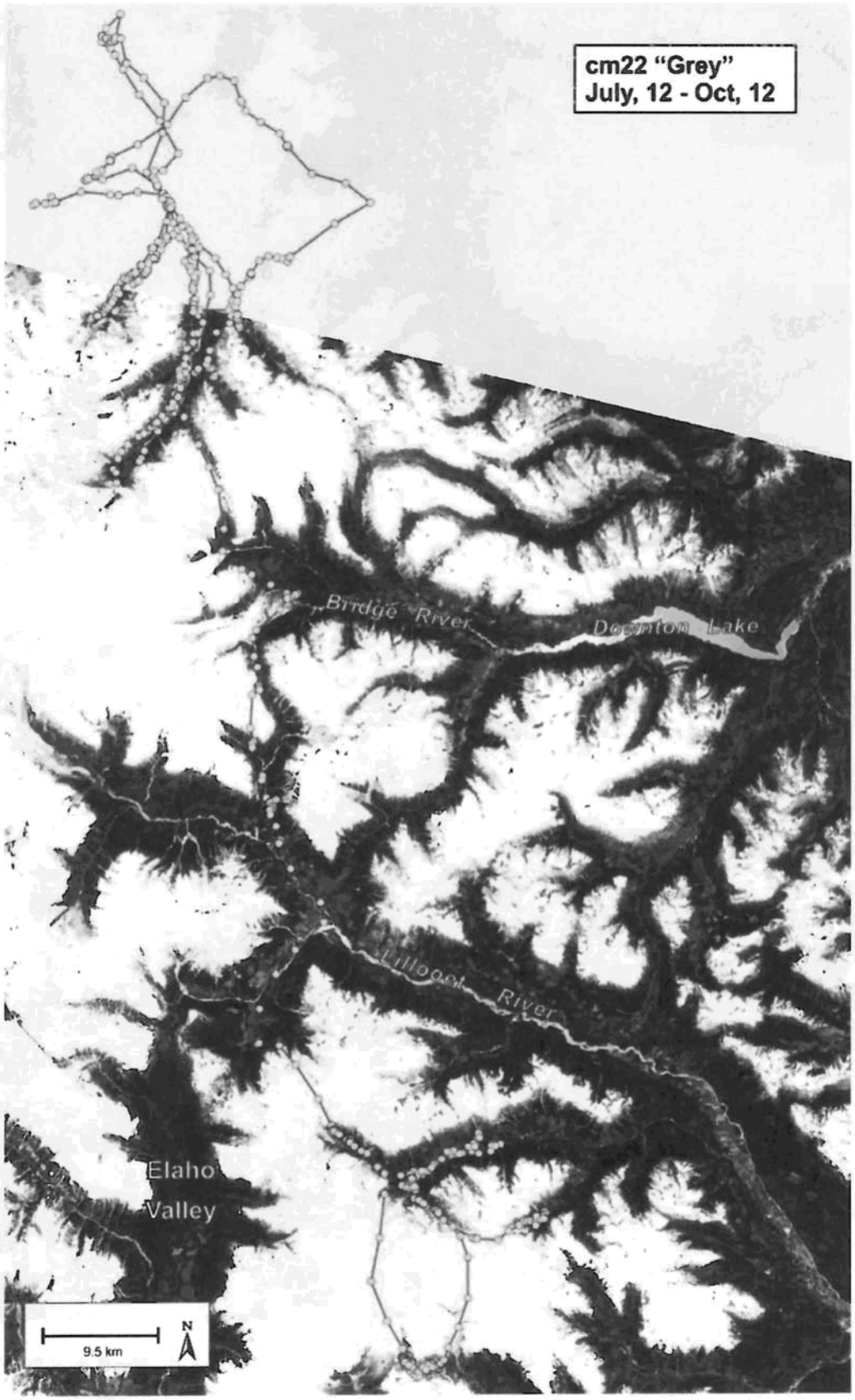

Figure 48. Known movement by grizzly bear CM22 ("Grey") during 2012 and since previous data download.

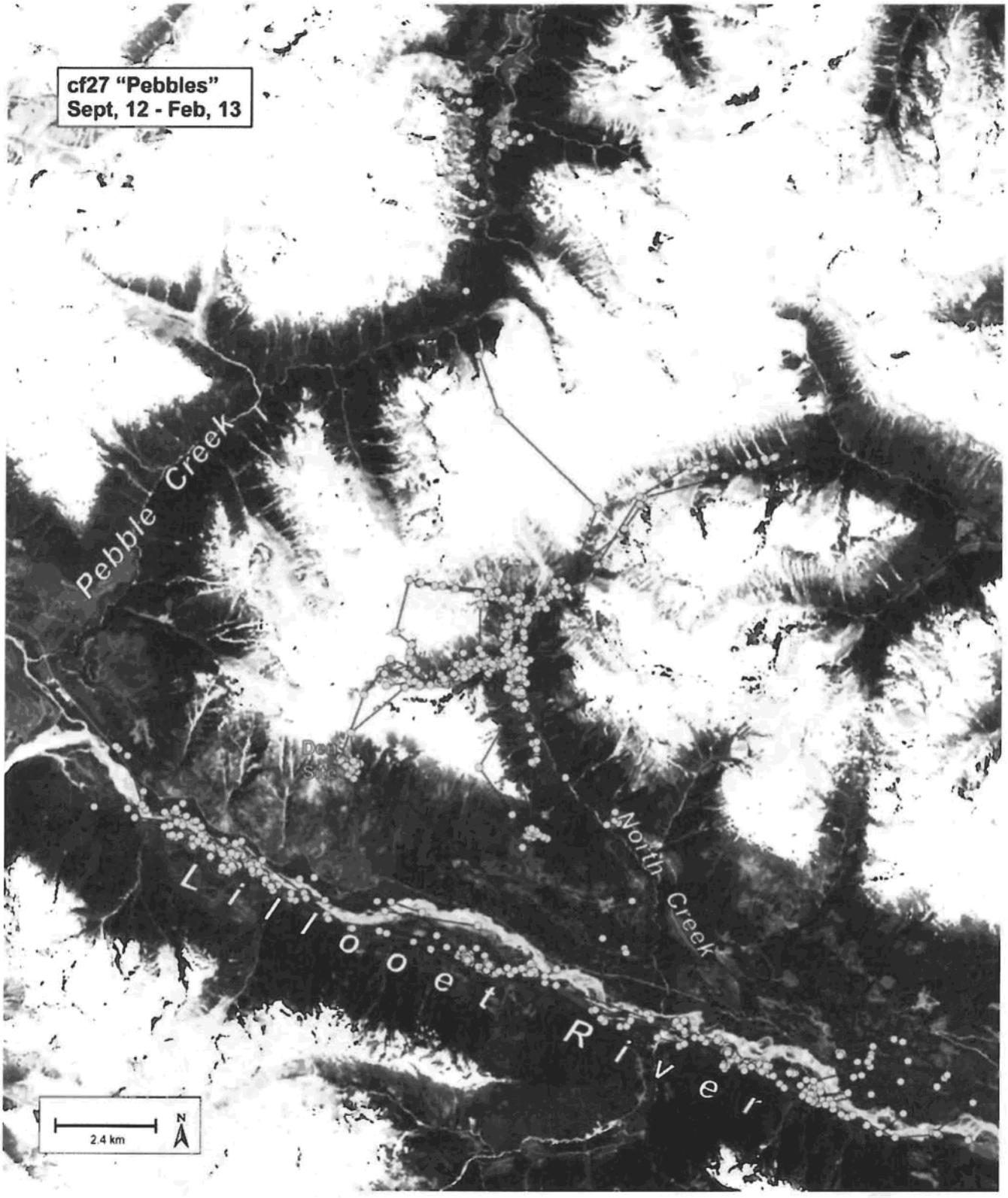

Figure 49. Known movement by grizzly bear CF22 ("Pebbles") during 2012 and since previous data download.

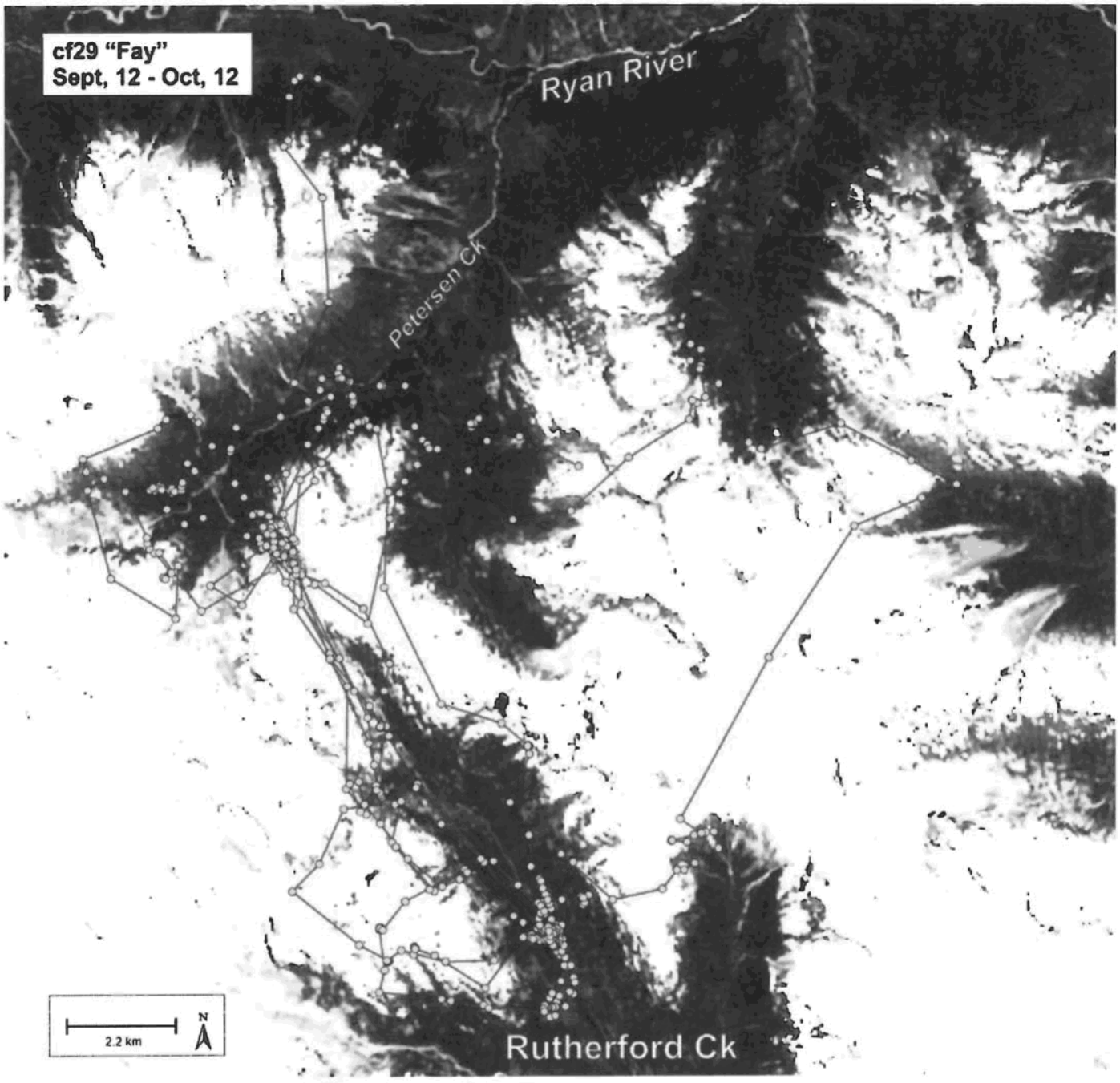

Figure 50. Known movement by grizzly bear CF29 ("Fay") during 2012 and since previous data download.

LITERATURE CITED

Apps, C. D., and B. N. McLellan. 2008. Grizzly bear habitat selection and suitability across multiple scales in the Flathead and lower Elk drainages, British Columbia. Aspen Wildlife Research, and Ministry of Forests and Range, Revelstoke, British Columbia.

Apps, C. D., B. N. McLellan, J. G. Woods, and M. F. Proctor. 2004. Estimating grizzly bear distribution and abundance relative to habitat and human influence. Journal of Wildlife Management 68:138-152.

Apps, C., D. Paetkau, S. Rochetta, B. McLellan, A. Hamilton, and B. Bateman. 2013. Grizzly bear population abundance, distribution, and connectivity across British Columbia's southern Coast Ranges. Version 2.0. Aspen Wildlife Research and Ministry of Environment, Victoria, British Columbia.

Boyce, M. S., P. R. Vernier, S. E. Nielsen, and F. K. A. Schmiegelow. 2002. Evaluating resource selection functions. Ecological Modelling 157:281-300.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information theoretic approach. Springer-Verlag, New York, New York, USA.

CCAC (Canadian Council on Animal Care). 2003. Guidelines on the care and use of wildlife. Canadian Council on Animal Care, Ottawa, ON. http://www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/GDLINES/Guidelis.htm

Hamilton, A. N., D. C. Heard, and M. A. Austin. 2004. British Columbia grizzly bear (*Ursus arctos*) population estimate 2004. British Columbia Ministry of Water Land, and Air Protection, Biodiversity Branch. Victoria.

Kareiva, P., and U. Wennergren. 1995. Connecting landscape patterns to ecosystem and population processes. Nature 373:299-302.

McLellan, B. N. 1998. Maintaining viability of brown bears along the southern fringe of their distribution. Ursus 10:607-611.

Ritchie, M. E. 1997. Populations in a landscape context: sources, sinks, and metapopulations. Pages 160-184 in J. A. Bissonette, editor. Wildlife and landscape ecology: effects of pattern and scale. Springer, New York, New York. USA.

Woodbury, M. R., ed. 1996. The chemical immobilization of wildlife. Canadian Association of Zoo and Wildlife Veterinarians, Winnipeg, Manitoba, Canada.

APPENDIX 1. Capture/collaring details & status of study animals within the Sea to Sky Planning Area & environs.

Study Animal	CF01	CF02	CM03	CF04	CF05	CM06	CF07	CM08
Name	Ashley	Callie	Kahn	Daphne	Chloe	Mercury	Rhea	Keith
Capture/Recapture Date	03/08/2007	11/08/2007	11/08/2007	22/06/2008	23/06/2008	25/06/2008	07/07/2008	02/10/2008
Recapture?	no	no	no	no	no	no	no	no
Capture Method	Snare	Snare	Snare	Snare	Snare	Snare	Snare	heli-darting
Capture Location	Deserted Pass	Upper Callaghan	Deserted Pass	upper Peterson	Rutherford	Rutherford	upper Ashlu	upper Ashlu
Coordinates	456159E, 5547926N	481849E, 5562360N	455204E, 5550528N	488653E, 5582958N	496673E, 5576836N	496673E, 5576836N	456460E, 5547336N	456996E, 5547468N
Ear Tag Left	none	none	none		301 Red	325 Red	321 Red	322 Red
Ear Tag Right	none	none	none	313 Red				
Sex	female	female	male	female	female	male	female	male
Age Class	adult	adult	adult	adult	adult	adult	adult	adult
Est. Age	6 - 7	12	14-15	4	6	6	17	20
Related bears at site?	no	no	no	no	no	no	no	no
Lactating?	no	no	n/a	no	no	n/a	no	n/a
Wt at Capture (lbs)	est 220	240	est 500+/- 100	145	210	310	390	--
Zool. Length (cm)		188	200	163	166	183	190	206
Collar (Lotek GPS)	4400M	4400M	4400M	4400M	4400M	4400M	4400M	4400M
Collar ID	1344	1451	1343	1349	1348	1452	1345	1342
Collar Frequency	150.439	150.681	150.281	150.980	150.879	150.740	150.539	150.340
Date of Last Download	Sep-07	Oct-07	Sep-07	Oct-08	n/a	Oct-08	Oct-08	Oct-08
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	0.68	0.87	0.65	0.89	--	0.86	0.79	0.87
Status	uncollared	uncollared	uncollared	uncollared	uncertain	uncollared	uncollared	uncollared
Dead?	unknown	unknown	unknown	unknown	unknown	unknown	no	unknown
Mortality Cause	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Last Live Location	18/09/2007	06/10/2007	05/09/2007	23/10/2008	12/10/2008	14/06/2009	23/10/2008	18/06/2009
Collar Retrieved?	yes	yes	yes	Yes	no	Yes	no	yes
Match to DNA Sampling	F53	F93	M58	F88	F22	M176	F55	M56

Study Animal	CF02	CM09	CF10	CF11	CF01	CF12	CF13	CM14
Name	Callie	Bruno	Power	Phantom	Ashley	Phoebe	Juno	Atlas
Capture/Recapture Date	11/06/2010	12/06/2010	11/06/2010	24/07/2010	24/07/2010	27/07/2010	27/07/2010	27/07/2010
Recapture?	yes	no	no	no	yes	no	no	no
Capture Method	heli-darting	heli-darting	heli-darting	Snare	Heli-darting	snare	snare	snare
Capture Location	Brandy wine	Ryan	Rutherford	Clowhom Pass	Upper Ashlu	back Petersen	upper Ryan	Rutherford
Coordinates	485392E, 5545931N	TBA	501322E, 5570170N	463025E, 5526819N	457449E, 5545950N	490452E, 5582591N	473936E, 5588891N	496294E, 5576187N
Ear Tag Left			335 Red	345 Red		348 Red		
Ear Tag Right	332 Red	309 Red			306 Red		331 Red	305 Red
Sex	female	male	female	female	female	female	female	male
Age Class	adult	adult	adult	adult	adult	adult	adult	adult
Est. Age		20	18	9	14	10	15	17
Related bears at site?	2 COY	no	breeding male	3 COY	2-3 yr cubs snared	2 2-yr cubs	at least 1 cub	no
Lactating?	n/a	n/a	no	yes	n/a	yes	yes	n/a
Wt at Capture (lbs)	245	478	245	215	348	200	250	450 (est)
Zool. Length (cm)	174	193	170	168	184	164	175	186
Collar (Lotek GPS)	4400M	4400M	4400M	4400M	4400M	4400M	4400M	4400M
Collar ID	1347	1960	1346	1451	1344	1452	1343	919
Collar Frequency	150.778	150.959	150.640	150.681	150.439	150.740	150.281	151.649
Date of Last Download	Oct-11	Nov-10	Oct-11	Jun-11	Jun-11	Jun-11	May-11	Oct-11
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	0.91	0.93	0.90	0.81	0.84	0.87	0.88	0.55
Status	uncollared	uncollared	uncollared	uncollared	uncollared	uncollared	uncollared	uncollared
Dead?	no	unknown	unknown	unknown	unknown	unknown	yes	no
Mortality Cause	n/a	n/a	n/a	n/a	n/a	n/a	avalanche	n/a
Last Live Location	27/11/2011	27/11/2010	06/07/2012	21/11/2011	17/10/2010	26/06/2011	22/05/2011	09/11/2011
Collar Retrieved?	yes	yes	yes	yes	no	yes	yes	yes
Match to DNA Sampling	F93	M262	F89	F25	F53	F327	F13	M30

Study Animal	CF15	CF12	CM16	CM17	CF02	CM18	CM19	CF20
Name	Hope	Phoebe	Titus	Huck	Callie	Boulder	Silt	Harriet
Capture/Recapture Date	02/08/2011	04/08/2011	04/08/2011	22/09/2011	04/07/2012	19/07/2012	20/07/2012	20/07/2012
Recapture?	no	no	no	no	yes	no	no	no
Capture Method	snare	snare	snare	snare	helicopter	snare	snare	snare
Capture Location	Headqrters Pass	back Petersen	back Petersen	Tenquille Ck	Callaghan	Pebble Ck	Upper Lillooet	Hurley
Coordinates	503396E, 5603056N	490452E, 5582591N	490452E, 5582591N	511415E, 5596443N	484470E, 5548153N	479424E, 5616777N	457087E, 5617870N	TBD
Ear Tag Left	351 Red	348 Red					601 blue	602 blue
Ear Tag Right			358 Red	359 Red				
Sex	female	female	male	male	female	male	male	female
Age Class	adult	adult	adult	adult	adult	adult	adult	adult
Est. Age	12	9	8	720 (??)		41974	12	19
Related bears at site?	2 or maybe 3 yearlings	no, just CM16 Titus	no, just CF12 Phoebe	no	no	no	no	2 yearlings
Lactating?	n/a	n/a	n/a	n/a	no	n/a	n/a	no
Wt at Capture (lbs)	265	285	245	474	190	375	395	203
Zool. Length (cm)	179	169	176	206	170	188	197	170
Collar (Lotek GPS)	7000MU	7000MU	4400M	7000MU	7000MU	7000MU	IridiumTrack	7000MU
Collar ID	31751	31752	1342	31747	1348	1450	33016	523
Collar Frequency	150.838	150.818	150.340	150.939	150.879	150.589	150.380	149.298
Date of Last Download	Oct-11	Oct-11	Nov-11	Oct-12	Oct-12	Oct-12	n/a	n/a
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	0.96	0.97	0.91	0.92	TBD	TBD	TBD	TBD
Status	uncollared	uncollared	uncollared	collared	collared	collared	collar in recovery	collared
Dead?	no	no	no	no	no	no	no	no
Mortality Cause	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Last Live Location	02/08/2012	27/08/2012	17/06/2012	11/10/2012	11/10/2012	11/10/2012	11/08/2012	
Collar Retrieved?	yes	yes	yes	no	no	no	no	no
Match to DNA Sampling	F139	F327	M249	M105	F93	TBD	TBD	TBD

Study Animal	CM21	CM22	CM23	CF24	CF25	CM26	CF27	CM14
Name	Skid	Grey	Shaggy	Melanie	Natasha	Hector	Pebbles	Atlas
Capture/Recapture Date	24/07/2012	24/07/2012	24/07/2012	29/07/2012	15/09/2012	16/09/2012	16/09/2012	16/09/2012
Recapture?	no	no	no	no	no	no	no	yes
Capture Method	snare	snare	snare	helicopter	helicopter	helicopter	helicopter	helicopter
Capture Location	back Petersen	Petersen	back Ryan	back Meager	North Creek	Hurley	Pebble/McPa rlon Pass	Rutherford
Coordinates	484602E, 5582543N	488661E, 5582480N	TBD	455780E, 5599686N	481173E, 5608494N	494867E, 5612234N	482849E, 5622463N	TBD
Ear Tag Left		603 blue			357 red			
Ear Tag Right	604 blue		605 blue	606 blue				305 red
Sex	male	male	male	female	female	male	female	male
Age Class	subadult	adult	adult	adult	adult	adult	adult	adult
Est. Age	3 to 4	15		7	15	15		
Related bears at site?	no	no	no	no	no	no	2 yearling cubs	no
Lactating?	n/a	n/a	n/a	no	no	n/a	no	n/a
Wt at Capture (lbs)	193	398	293	350(est)	398	498	343	402
Zool. Length (cm)	161	196	188	179	175	198	178	186
Collar (Lotek GPS)	IridiumTrack	7000MU	7000MU	IridiumTrack	IridiumTrack	IridiumTrack	IridiumTrack	7000MU
Collar ID	33021	1960	1452	33018	33019	33015	33020	920
Collar Frequency	150.800	150.959	150.740	150.480	150.520	150.310	150.760	151.547
Date of Last Download	n/a	Oct-12	n/a	n/a	n/a	n/a	n/a	n/a
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Status	collared	collared	collared	collared	collared	collared	collared	collared
Dead?	no	no	no	no	no	no	no	no
Mortality Cause	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Last Live Location	30/11/2012	11/10/2012		29/11/2012	27/10/2012	28/10/2012	13/02/2013	
Collar Retrieved?	no	no	no	no	no	no	no	no
Match to DNA Sampling								M30

Study Animal	CF28	CF29??
Name	Peanut	Fay (Power?)
Capture/Recapture Date	17/09/2012	18/09/2012
Recapture?	no	possibly
Capture Method	helicopter	helicopter
Capture Location		Ryan
Coordinates	TBD	490467E, 5588752N
Ear Tag Left		
Ear Tag Right		
Sex	female	female
Age Class	subadult	adult
Est. Age	3	14
Related bears at site?	sibling with her	no
Lactating?	no	no
Wt at Capture (lbs)	203	318
Zool. Length (cm)	160	164
Collar (Lotek GPS)	4400S	IridiumTrack
Collar ID	1457	33017
Collar Frequency	150.500	150.460
Date of Last Download		n/a
Fix Interval (hrs)	1:00	1:00
Fix Success Rate	TBD	TBD
Status	collared	collared
Dead?	no	no
Mortality Cause	n/a	n/a
Last Live Location		
Collar Retrieved?	no	no
Match to DNA Sampling		

APPENDIX 2.

HCTF PROGRAM-SPECIFIC REPORTING

Measures of Results

During July through September, 2012, we captured 15 grizzly bears and collared 14 of these (7M, 7F), 12 of which were new study animals. Study animals were captured by both helicopter-assisted ground-snaring as well as helicopter aerial darting. Study animals were fit with either Lotek GPS7000MU collars or Lotek IridiumTrackM collars, both models were programmed for one-hour GPS fix attempts. In total, data were collected by collars deployed on 21 (10M, 11F) grizzly bears within the study area during all of part of this year. Four study animals either could not be found during data download flights or there was a communication problem with their collars that precluded data acquisition. Six collars were recovered either by pick-up because they were dropped, or by recapture either because they were in "recovery" mode and were no longer obtaining GPS fixes or opportunistically because they were nearing the end their expected battery life. Periodic and opportunistic downloads were conducted on several bears through the summer and fall, and fixed-wing aircraft search and download flights were conducted in June and October. Data quality has been high, with GPS fix success ranging from 79 - 97%. At the time of HCTF reporting (March 2013), the number of existing collared bears is 15, although we expect some collars will be dropped this spring. Also, one of these collars is known to be malfunctioning and will require recovery through recapture this spring. For this study to date, GPS collars have been deployed 34 times on 28 or 29 (depending on results of a pending DNA test) adult grizzly bears (7M, 13F). In addition to the annual report, graphics, powerpoint, and associated communication tools have and continue to be developed.

Expected Benefits of the Study

Despite a wide range of land resource demands, there is little known of grizzly bear space-use and movement patterns or influential factors in the southern Coast Ranges. This information is important in evaluating, mitigating, and monitoring cumulative effects of existing and proposed resource development. Such knowledge can be especially valuable when also considered in the context of spatial predictions of population abundance, distribution and connectivity at the regional level. This study is appropriate for industry support, but partnership with HCTF is essential to such collaboration. As such, considerable value-added can be expected from HCTF funding. Without this study, assessment, mitigation and monitoring of cumulative effects will be based on assessments and/or subjective models with little to no empirical foundation. Such best-guess decision-making may compromise effective conservation to the goal of recovering and maintaining a healthy and viable regional grizzly bear population.

Extension/Public Information/Participation/Partners

Opportunities are being taken to communicate our research activities, preliminary results, and grizzly bear conservation issues to public, government, and industry groups. To this end, we have developed and are annually updating a poster describing grizzly bear research and conservation in the region. We have also developed a powerpoint presentation for delivery within appropriate venues. To date, the project has been featured and contributed to presentations that have included the Ministry of Environment (Region 4) annual general meeting, the WildLinks conferences with focus on Canada-US transboundary conservation of large carnivores between BC and the NW United States, as well as the International Bear Association 2011 conference in Ottawa. Beyond what can be provided through presentation, specifics of our work and preliminary results/outputs are detailed in our annual report. This includes text, tabular, and graphic (map) summaries of grizzly bear movements, behaviour, ecology, and associated landscape value. Finally, this research and its conservation utility has been discussed within occasional communications with local media coverage. Further, project partners are presently in discussion regarding a more formalized press release about the study in the context of regional grizzly bear conservation. HCTF is acknowledged in reports, posters, and presentations related to this work.

The study is a collaborative effort among Clayton Apps, Steve Rochetta (FLNRO) Bruce McLellan (FLNRO), and Tony Hamilton (MOE). Partnership funding this year has been through the provincial government and an industry contribution Future partnerships may include industry and NGO groups, particularly in extension of outputs to conservation and recovery planning.

Photographic Record

Various aspects of field work (including capture) and both landscapes and site-specific habitat conditions within the study area have been documented using digital photo, video and remote cameras. Select photos are available to partners upon request.

GRIZZLY BEAR SPACE-USE & MOVEMENTS RELATIVE TO HABITAT & HUMAN INFLUENCE IN THE SOUTHERN COAST RANGES, BRITISH COLUMBIA

Annual Progress & Summary Report

2013/14

Prepared by:

Clayton Apps, PhD, RPBio

Aspen Wildlife Research Inc.

In collaboration with:

Steve Rochetta & Bruce McLellan

Ministry of Forests, Lands & Natural Resource Operations

Tony Hamilton, Ministry of Environment

March, 2014

BRITISH COLUMBIA

FORESTS, LANDS & NATURAL RESOURCE OPERATIONS

HABITAT CONSERVATION TRUST FOUNDATION

This report is formatted for double-sided printing

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PREFACE

This report is a summary of progress and data toward specific objectives within an active research program. Work to date on different aspects of the program are addressed herein. As such, this report supersedes all previous reports pertaining to grizzly bear space-use, movements, and ecology within landscapes of the Sea to Sky Planning Area.

The summaries presented within this report are intended only to demonstrate progress toward study objectives and are not intended for direct decision-support independent of analysis and interpretation by the principal researcher. However, given existing data, annual reports may include preliminary inferences relevant to specific landscapes. Such discussion may be qualified with recommendations to address data gaps or to assess temporal trends where appropriate confidence is lacking. This said, the most important outcome of this research program is in fact the development of empirically-derived predictive models to support resource planning, mitigation, and monitoring.

ACKNOWLEDGEMENTS

The field work described in this report to date was funded directly and/or in-kind by the Habitat Conservation Trust Foundation (Project 2-464) and the British Columbia Government through the Ministry of Forests, Lands and Natural Resource Operations (FLNRO). Additional funding for 2013/14 was provided by Sequoia Energy. Funding for previous years was contributed by the Sea to Sky LRMP Implementation Program, Vancouver 2010 Olympic Committee, the Forest Investment Account (FIA) through CRB Logging and Northwest Squamish Forestry Ltd., Ashu Creek Investments LP and Tyson Creek Power Corp. During 2008 through 2013, capture work specific to GPS-based sampling of grizzly bear space-use and movements was conducted by Steve Rochetta, Clayton Apps, and Bruce McLellan, with assistance from Matt Rochetta, Clay Wilson and Steve Gray. Safe and proficient aircraft services were provided by Blackcomb Helicopters and Bighorn Helicopters, and also by Dave Maer who piloted download flights of collared bears. Genetic analyses were conducted by the staff of Wildlife Genetics International under the supervision of David Paetkau. We would also like to thank FLNRO Region 3 (Kamloops) for their interest in and support for this project, and especially Donna Romain, ecosystems biologist.

Recommended Citation:

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SUMMARY

BC's southern Coast Ranges represent a southwestern lobe of grizzly bear distribution in North America. In this region, there has until recently been little known of grizzly bear population abundance, distribution, connectivity, or factors influencing them and the foraging and movements of individuals. This knowledge gap has been of concern given the wide range of land resource demands, particularly in the southern Coast Ranges. Mounting cumulative impacts are expected to result from the area's growing recreational popularity, associated development trends, existing and proposed industrial activities, and its accessibility from the nearby lower mainland. Currently, four of the five grizzly bear population units (GBPUs) in this region are considered Threatened and are designated for recovery by Cabinet in the Sea to Sky Land and Resource Management Plan (LRMP). Addressing grizzly bear conservation issues such as mortality risk, habitat effectiveness and population connectivity requires first an understanding of core, peripheral and linkage landscapes at the population level. This is being achieved through a regional population study near completion (Apps et al. 2013). Outputs from this work have also helped to highlight landscapes where a more detailed understanding of grizzly bear movements, seasonal foraging habitats, and potential human influences is appropriate and feasible.

In light of the above, grizzly bear conservation has been of particular focus within and around the Sea to Sky LRMP planning area (defined by the Squamish Forest District), an area subject to a burgeoning spectrum of land uses and an expanding human population. The aforementioned regional study is modeling population abundance, distribution and connectivity. However, given current and proposed development within and adjacent to landscapes occupied by grizzly bears, a detailed understanding of the movements and seasonal foraging patterns of resident animals relative to influential factors is required to assess and monitor cumulative impacts of existing and proposed development and to implement effective mitigation strategies.

The overall goal of this study is to build databases in order to develop and test predictive models of fine-scale grizzly bear movements and seasonal foraging habitats. Outputs are intended to inform assessments and mitigation at landscape and operational levels of resource planning, as well as strategic land-use decisions. Products will compliment and integrate with broader-scale planning tools derived at the population level across the southern Coast Ranges.

Monitoring and researching behavioural responses of grizzly bears to habitat and human influence is a high priority within southern Coast Ranges GBPUs and especially those of the the Sea to Sky Planning Area (A. Hamilton, MOE, *pers. comm.*). The grizzly bear recovery effort within constituent GBPUs is legally mandated, Cabinet-endorsed and also supported by Squamish and Lil'wat First Nations through the Sea to Sky LRMP and parallel native land use planning. Moreover, the southern Coast Ranges are subject to a considerable number of proposals for industrial

development that require assessment, monitoring, and mitigation with respect to cumulative human impacts on grizzly bears.

This project is intended and designed to provide empirically-derived tools to best understand, predict, mitigate and monitor potential cumulative impacts on grizzly bears. This report represents year-4 of a 5-year program. Described within are project objectives, methods, and interim data and progress based on space-use and movements of 30 adult grizzly bears on which GPS collars have been deployed 35 times, collecting data for up to 2 years.

INTRODUCTION

The southwestern fringe of grizzly bear range in North America occurs largely within British Columbia and is comprised of populations that are generally restricted to the mountains and high plateaus associated with limited human access and settlement (McLellan 1998). Many of the southern grizzly bear populations that have persisted in British Columbia are considered "Threatened" (current population assumed to be 1-50% of potential; Hamilton et al. 2004). This includes the grizzly bear population units (GBPUs) that comprise the Sea to Sky Planning Area (Squamish Forest District) within British Columbia's Southern Coast Ranges.

Across the southern Coast Ranges, there has until recently been little known of grizzly bear population abundance, distribution, connectivity, or influences related to the foraging and movements of individuals. This knowledge gap has been of concern given the wide range of land resource demands. Cumulative impacts may result from the area's growing recreational popularity, associated development trends, existing and proposed industrial activities, and its accessibility from the nearby lower mainland. Currently, four of the five grizzly bear population units across the region are considered Threatened and are mandated for recovery. Addressing grizzly bear conservation issues such as mortality risk, habitat effectiveness and population connectivity requires first an understanding of core, peripheral and linkage landscapes at the regional-population level (Apps et al. 2009). Outputs at this broad scale can also help to highlight landscapes where a more detailed understanding of grizzly bear movements, foraging habitats, and potential human influences is appropriate and feasible.

Within the Sea to Sky LRMP planning area (defined by the Squamish Forest District), grizzly bear conservation has been of considerable focus. This region is subject to a burgeoning spectrum of land uses and an expanding human population. The aforementioned population study is modeling regional grizzly bear abundance, distribution and connectivity. However, given current and proposed development within and adjacent to occupied landscapes, a detailed understanding of daily and seasonal movements and foraging patterns of resident grizzly bears, relative to influential factors of habitat and human influence, is required in order to assess and monitor cumulative impacts of existing and proposed development and to implement effective mitigation strategies.

OBJECTIVES & STUDY AREA

There are two components to this study: (1) long-term monitoring of grizzly bear abundance and distribution with reference to underlying causal factors, and (2) providing detailed understanding of daily and seasonal movements and foraging patterns of resident grizzly bears relative to habitat and human factors. Both components are required to assess and monitor cumulative impacts of existing and proposed development, and to implement effective mitigation strategies. The current focus of this project is grizzly bear space-use, movements and ecology relative to local conditions of habitat and human influence. Because DNA-based monitoring has not been intensively conducted in the past three years, we refer readers to summary reports of previous years for overview and interim results of this component.

In addition to DNA-based population monitoring, we began deploying GPS collars on a sample of adult grizzly bears within the region during the summer of 2007 and the summer and fall of 2008. The program continued with HCTF partnership during spring through fall of 2010 through 2013, with varying study animals monitored 2007 through 2013. This research phase of our program involves relatively fine-scale sampling of grizzly bear space-use and movements for evaluation of seasonal habitat preferences, habitual movements, and the natural and human factors that influence them. The study area presently encompasses the Squamish-Lillooet GBPU including much of the larger Sea to Sky Planning Area, but the study area has been expanded to include the southern portion of the South Chilcotin Ranges GBPU (Figure 1).

Through this work, we intend to illuminate local grizzly bear ecology, probable requirements, and response to cumulative human activities, with derived products supporting resource management and mitigation at local planning levels. Resulting predictive outputs will integrate with, and compliment, the strategic planning tools being derived at the scale of population distribution across the southern Coast Ranges (Apps et al. 2014; Figure 2). Integrating these two scales of research will facilitate a regional grizzly bear recovery and conservation strategy that is hierarchical and spatially nested as is appropriate for wide-ranging species. Objectives are summarized as follows:

1. document detailed spatial/temporal patterns pertaining to grizzly bear movement, foraging, and denning habits;
2. evaluate the above data with respect to multi-scale natural and human factors that may influence habitual and potentially critical movement options and seasonal habitats;
3. extend research products to industry and government partners through formal reporting and spatial decision-support tools that facilitate empirical evaluation of cumulative effects;
4. contribute relevant and reliable information in an effective form to support land-use planning and statutory resource management decisions.

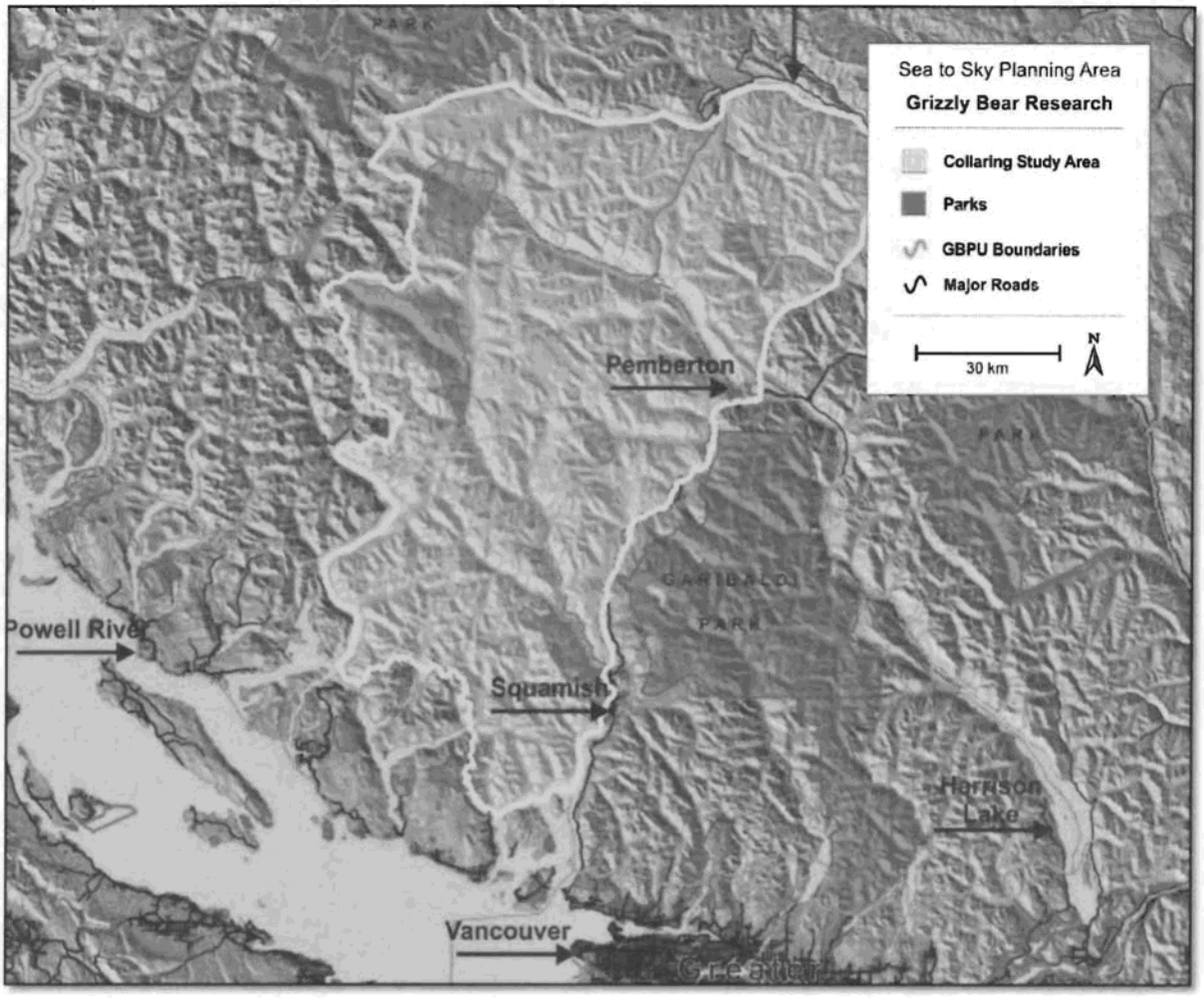

Figure 1. Area defined for detailed study of grizzly bear space-use, movements, and ecology relative to underlying conditions of habitat and human influence. Encompassed is the Squamish-Lillooet GBPU within much of the larger Sea to Sky Planning area, as well as the southern portion of the South Chilcotin Ranges GBPU.

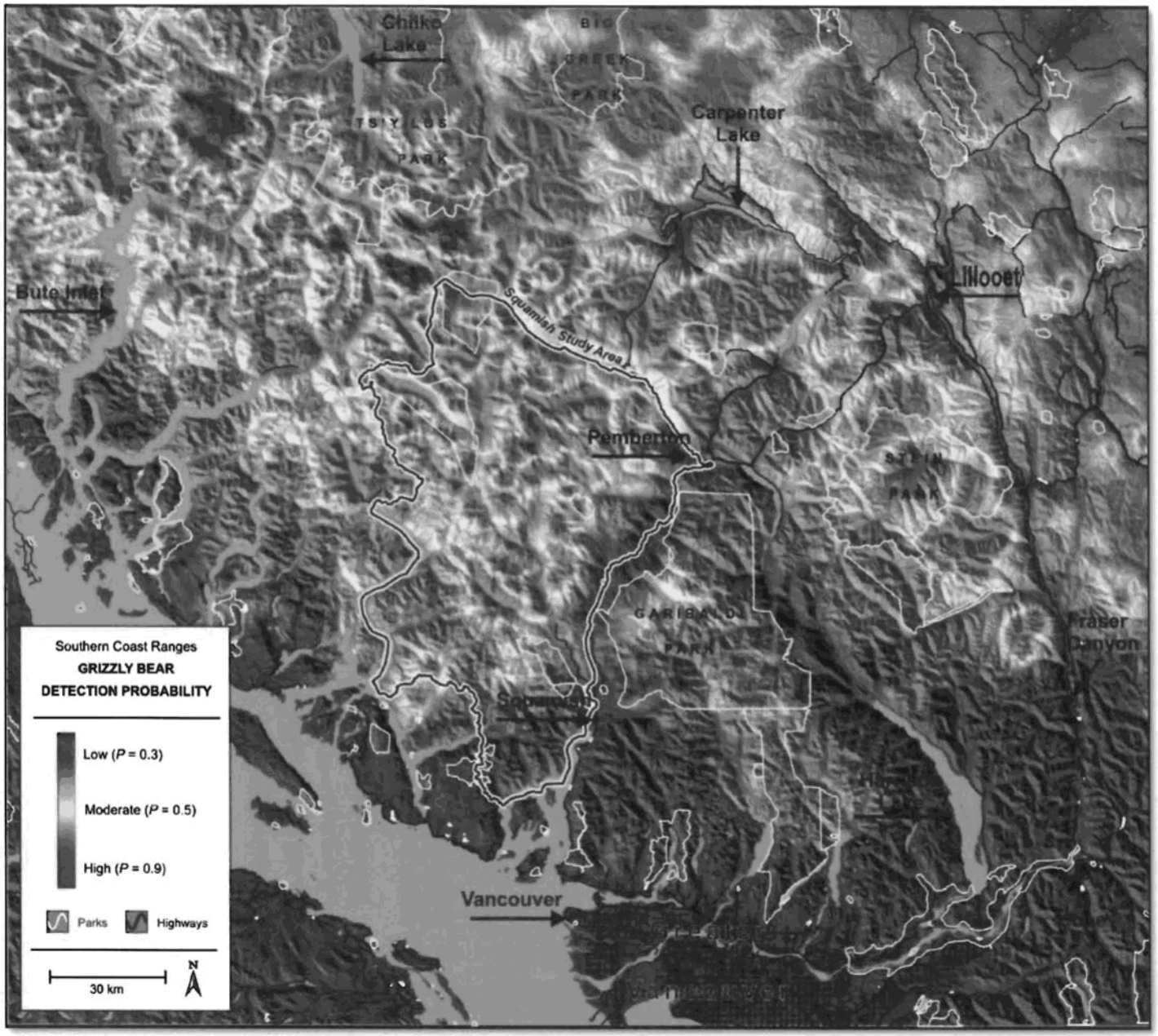

Figure 2. Grizzly bear detection probability across the southern Coast Ranges of BC from which core habitat areas and landscape linkages can be inferred (Apps et al. 2013). Note the Sea to Sky Planning Area (Squamish study area) that is the focus of this report (now expanded further north).

METHODS

A sample of adult grizzly bears are being fitted with GPS collars programmed to attempt location fixes every hour. We conducted a trapping program during spring through fall of 2007 through 2012 using cable snares and a culvert-trap, with sites accessed and monitored daily by helicopter. Potential study animals were also darted from a helicopter during 2010 - 2013 capture efforts. In accordance with provincial standards (CCAC 2003), precautions were applied to maximize animal welfare and human safety, and to ensure that the health of captured animals was not compromised and that they were rapidly returned to a free-ranging state. Our target areas for grizzly bear capture during 2007 were the Callaghan, upper Brandywine, and Ashlu drainages. In 2008, we initially focused our effort in the Ryan and Rutherford drainages, but then also included the 2007 trapping areas. Capture during 2010 included all of these landscapes. In 2011, we focused on the Rutherford and Ryan drainages but also extended north into the upper Lillooet tributaries of North and Boulder/Pebble Creeks as well as the upper Hurley and upper Birkenhead drainage including Tenquille Creek. During 2012, our focus was primarily on the upper Lillooet Valley and tributaries, extending north to Downton and Carpenter Lakes and including the Hurley and Birkenhead drainages.

Captured animals were immobilized and handled using standard and accepted techniques (Woodbury 1996). Adult grizzly bears were fitted with Lotek GPS collars (models 4400M, 7000MU, and IridiumtrackM). We inserted of canvas "rot-off" spacers into collar belting to help ensure that collars dropped from study animals within an appropriate time. Timer-activated drop-off mechanisms (set to 108 weeks) were used during the first two years but we discontinued their use in 2010 because they generally did not work and rot-off spacers were releasing within the appropriate time frame (we are now using an improved version of the Lotek timer drop-off release mechanisms). Incidentally captured black bears were released. Hair or tissue samples from handled bears are being genetically analyzed for individual identity and matched to and/or included within a database of grizzly bear detections across the larger region.

Deployed collars are expected to remain on study animals for up to 2 years of data collection (turned off during denning period), and data are being remotely downloaded through periodic overflights. We will attempt to retrieve any collars deployed longer than 2 years through helicopter darting. Collars can then be refurbished and redeployed.

Raw GPS location data that we collect from each animal are being processed, summarized, and movement vectors are being mapped with temporal referencing. Summaries are to include movement rates and space-use intensity (i.e., time/activity budgeting) relative to habitat productivity and human activity levels. Based on an adequate sample, data are to be graphically represented to depict the intensity of landscape use within home ranges, and movement routes among seasonally important core habitat areas. Movement vectors will also be summarized to identify habitually-used travel routes. We plan to update data summaries on an annual basis.

Once a sample is obtained that is considered to be spatially and temporally representative of grizzly bear movements and habitat use within the study area, more detailed analyses will be conducted. Data will be screened to minimize the influence of unacceptable spatial error on analyses and to account for potential habitat-related bias in GPS fix-success. Because animal movements are determined by perceptions at different spatial scales (Turchin 1998), our analysis will consider successively broader scales corresponding to movements at defined temporal sampling intervals. We will consider bear response to relevant variables that can be derived with available biophysical and human use inventories. Our evaluation and multi-scale modeling of habitats and movement routes selected by grizzly bears will employ analytical approaches appropriate for such data (e.g., Apps et al. 2001, Apps and McLellan 2006). Methods will involve a suite of quantitative techniques intended to improve our understanding of factors that influence grizzly bear movement behavior and how these vary among animals and with local conditions (e.g., Burnham and Anderson 1998, Boyce et al. 2002). This will result in predictive models appropriate for spatial extrapolation and decision-support.

For grizzly bear conservation planning in the region, our results will be integrated with the broader-scale DNA-based companion study of population distribution and connectivity (Apps et al. 2013). Results at both levels may be integrated within a "graph theory" modeling framework (Bunn et al. 2000). In this way, the value of any given site can reflect the consequence, to greater landscape connectivity, of degrading or blocking permeability to grizzly bear movement. Consequences are gauged in terms of the total number and size of connected suitable habitat patches at various spatial scales. This approach is ideal for conservation planning because model parameters can reflect both empirical and theoretical knowledge and can be readily tested and refined.

Along the course of this study, we will pursue any opportunity to conduct comparative analyses of human activity and/or infrastructure development on grizzly bear movements and/or habitat use. Results of these analyses will serve to refine assumptions regarding cumulative human impacts on grizzly bears in the region.

INTERIM DATA PROGRESS

2007 – Capture Efforts & Bears Collared or Detected

We set and monitored grizzly bear traps from 2 – 12 August in the Callaghan, upper Brandywine, and Ashlu drainages. During this period, we captured 3 adult grizzly bears (1M, 2F) on which we deployed GPS collars (Appendix 1). Based on DNA profiles, all 3 collared grizzly bears had been previously identified through hair-snag sampling within the region. In the database of known individuals, female CF01 ("Ashley") corresponds to F53, female CF02 ("Callie") corresponds to F93, and CM03 ("Kahn") corresponds to M58. In addition, hair samples obtained from a bear that investigated trap sites in the Tatlow Valley (Ashlu drainage) on 4/5 August were from F25, and another

trap investigation at Deserted Pass on 8 August was from CF01/F53 after her initial capture. A male trapped in Pemberton Meadows and moved to the vicinity of Meager Creek (not collared) corresponds to M29.

Collars from all 3 study animals prematurely dropped in September and October 2007 and we recovered all of them. Inspection revealed that the rot-off spacer we inserted had failed to hold (we are correcting our method of inserting the canvas spacers to prevent premature release in future collar-deployments). We have downloaded, screened and processed the data from these collars.

2007 – Summary of Data and Movements

We evaluated the performance of GPS collars during their periods of deployment on all 3 bears. CF01 carried her collar from 03 Aug – 18 Sept, during which time the collar obtained successful fixes on 68% of 1,105 hourly fix attempts. Of successful fixes, 80% were 3D (≥4 satellites used). CF02 carried her collar from 11 Aug – 06 Oct, during which time the collar obtained successful fixes on 87% of 1,339 hourly fix attempts. Of successful fixes, 90% were 3D. CM03 carried his collar from 11 Aug – 05 Sept, during which time the collar obtained successful fixes on 65% of 607 hourly fix-attempts. Of successful fixes, 79% were 3D.

Despite the mediocre performance of CM03's collar, the data revealed an interesting and important movement (Figures 14 & 15). This bear was captured and collared in Deserted Pass at the head of Ashlu Creek on 11 August. Roughly 5 days later, he began a direct movement down the Ashlu Valley. On 19 August, he began moving up Tatlow Creek, a major tributary of the Ashlu, and late the next day he moved into the pass leading to Phantom Lake at the head of the Clowhom drainage. His movements over the next 8 days indicate several nodes of what is likely foraging activity, but he moved over Mt Jimmy (at a point of 1910 m) on 24 August, having ascended ~1000 m in elevation over 4 days since leaving Tatlow Creek (gaining 450 m and 280 m in 1-hr periods). He then moved into a pass linking the Clowhom drainage with Pokosha Ck (Ashlu tributary) and remained there for several days before continuing east into Sigurd Pass and down Sigurd Creek. He took roughly 9 hrs to descend Sigurd Creek before arriving at the Ashlu floodplain near the Squamish River on 29 August. He remained in a tight area (~13 ha) near the Sigurd/Ashlu confluence for the next 7.5 days until his collar dropped and the data sequence ends.

During August – October 2007, adult-female grizzly bear CF03 (without cubs) moved extensively across an area of roughly 189 km^2. This area included the upper reaches of the Callaghan, Brandywine, Roe, and Shovelnose drainages and involved localized nodes of activity (Figure 16). During August – September 2007, adult-female grizzly bear CF01 (without cubs) moved across a 144 km^2 area focused primarily within the upper Ashlu drainage, but made 3 separate movements into the valley of the Deserted River that drains into Jervis Inlet (Figure 17). Her activities in the Deserted drainage were concentrated along the lower Deserted River near the mouth of Tsuahdi Creek, presumably associated with foraging on spawning salmon.

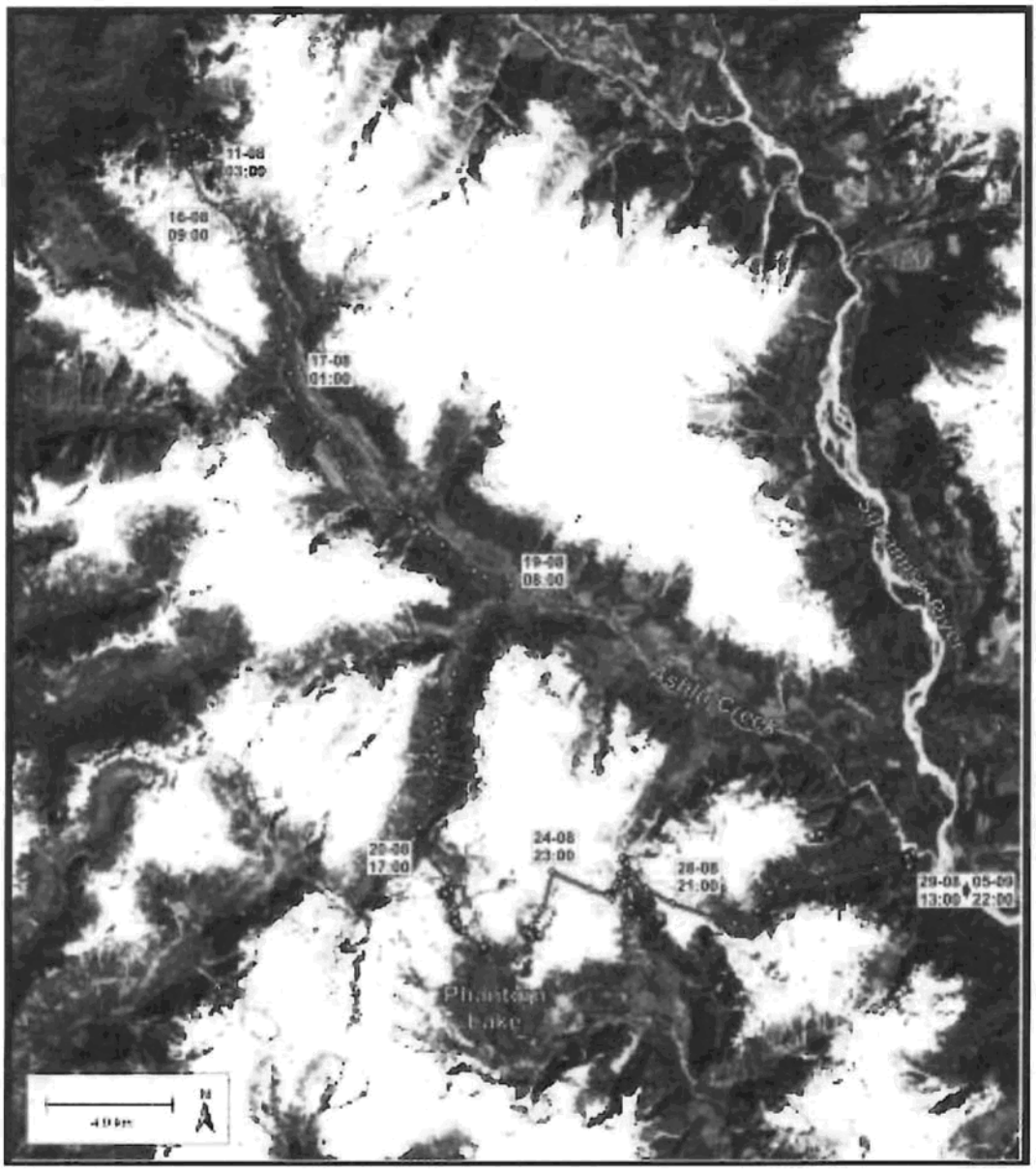

Figure 14. Known movement by grizzly bear CM03 within the Ashlu drainage during August/September 2007. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

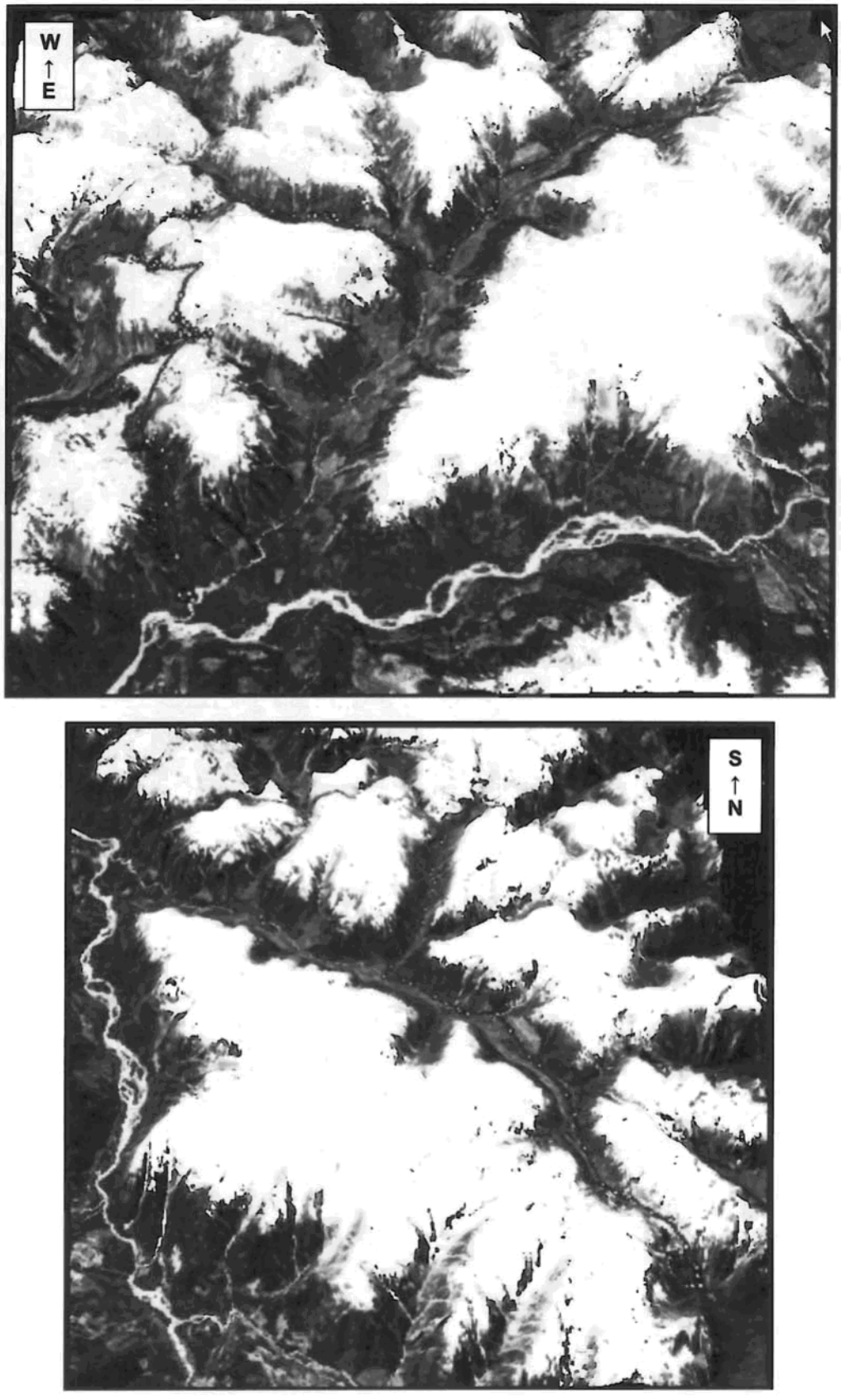

Figure 15. Orthographic perspectives of grizzly bear CM03 movement within the Ashlu drainage, Aug/Sept, 2007.

Figure 15. Continued.

Figure 16. Known movement by grizzly bear CF02 within the Callaghan drainage and environs during August - October 2007. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

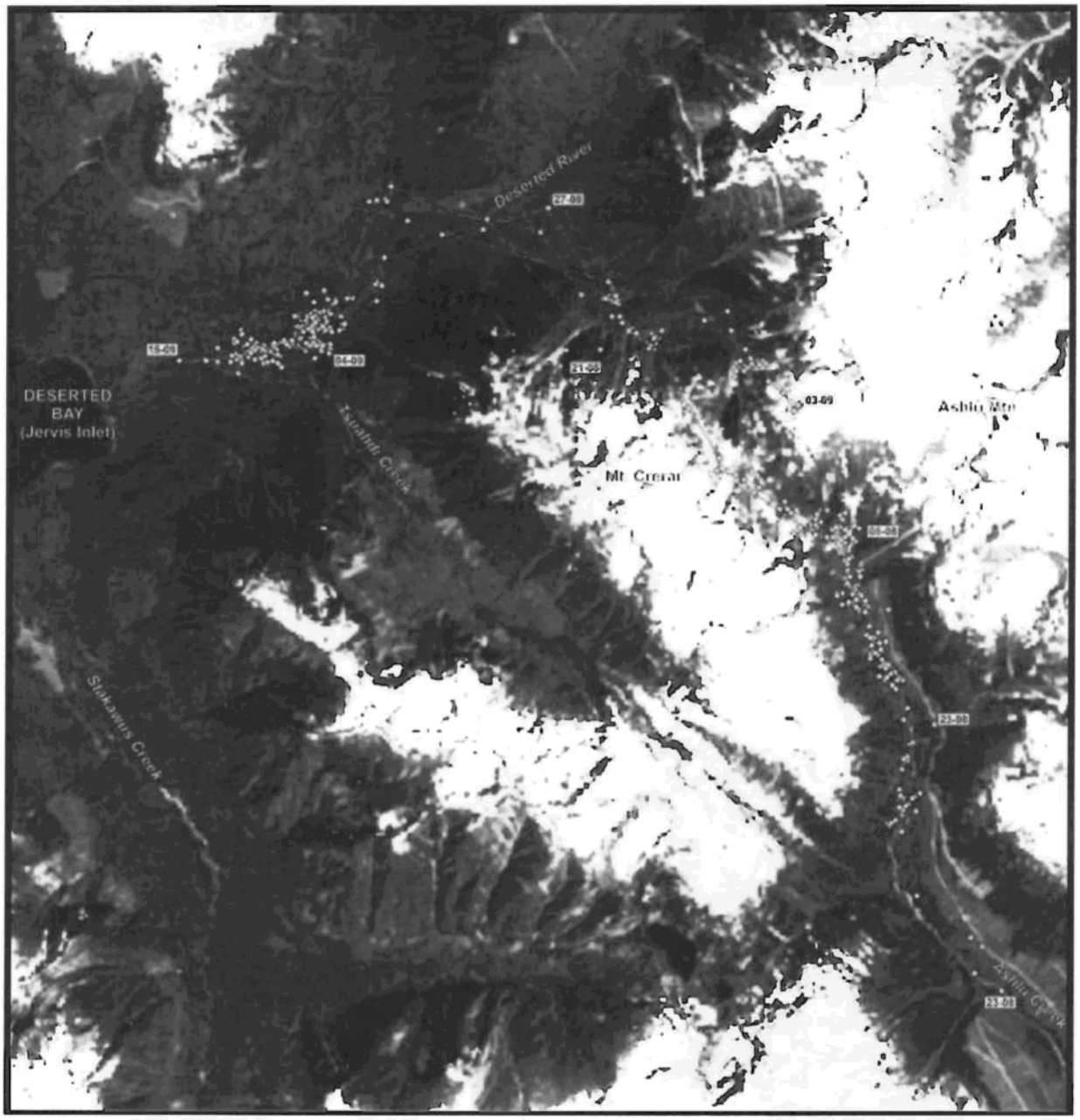

Figure 17. Known movement by grizzly bear CF01 within the upper Ashlu and Deserted drainages during August - September 2007. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

2008 – Capture Efforts & Bears Collared or Detected

Our 2008 capture work was carried out in two separate trapping sessions and one helicopter darting session.

Ryan/Rutherford Capture Effort: From 21 – 25 June, we set and monitored grizzly bear traps in the Ryan and Rutherford drainages. During this period, we captured 3 adult grizzly bears (1M, 2F) on which we deployed GPS collars (Appendix 1). Based on DNA profiles, all three collared grizzly bears had been previously identified through hair-snag sampling within the region. In the regional database of known individuals, female CF04 ("Daphne") corresponds to F88 who we had previously detected through hair-snag sampling in the Petersen and upper Rutherford during previous years. Female CF05 ("Chloe") corresponds to F22, a bear we detected 3 times by hair snagging in the upper Callaghan drainage during 2004 but not since. This is a young bear (estimated 6 years of age) and we suspect that she was a cub within her natal range in 2004 and has dispersed, but we will confirm this once we obtain her movement data and her precise age. Male CM06 ("Mercury") corresponds to M176 who we detected by hair-snagging during 2007 just north of Carpenter Lake – a linear distance of ~70 km. This is also a young bear (estimated 6 years of age) that appears to be a recent immigrant to the local area, though his home range appears to straddle the upper Lillooet Valley at present (see data summary described below).

During this June trapping session in the Ryan and Rutherford, we had several near-captures of bears from which we obtained hair samples. Some of these were bears that either had already been or were subsequently captured (e.g., F88, F22, M176). But we also nearly captured a male and a female who corresponded to M32 and F12 in our regional database. We detected both of these bears by hair-snagging on numerous occasions in 2004 and 2005. Both bears appear to be resident primarily within the Ryan Valley. However, M32 clearly moves over a more extensive area that includes the lower valley, while F12 appears to be more restricted to the upper valley. We also collected a rub tree sample that matched to M33 who we also detected in 2004.

Callaghan/Brandywine/Ashlu Capture Effort: From 2 – 10 July, our trapping effort was focused in the upper Callaghan, Brandywine and Ashlu drainages. Here, we captured and collared one bear in the upper Ashlu. This female CF07 ("Rhea") corresponds to F55 who we identified by hair-snagging during 2004 sampling and again in 2005 in the upper Ashlu drainage (as previously described in this report). From 1 - 2 October, we employed helicopter darting to capture one bear at the back end of the Ashlu Valley. This male CM08 ("Keith") corresponds to M56 in our regional database who we detected at a DNA hair-snag site along the Clowhom River in 2004 (but not since) – a minimum linear distance of ~40 km. Since this is a relatively old bear (estimated 20 years of age), his home range must be extensive and his movements should be highly relevant to our study.

We also opportunistically collected a number of hair samples this year during our work in and around the Callaghan, Brandywine and Ashlu drainages. At a culvert trap we had set in mid-July, we

nearly captured a bear that corresponded to M14. We have a good detection history of this bear dating to 2004 in the upper Ryan and 2005 in the Callaghan. In the upper Ashlu, we nearly captured a bear on at least two occasions who matched to F53 in our regional database. Again, we know of this individual through 2004 and 2005 hair-snag sampling, but this is also study animal CF01 ("Ashley") who was collared in August and September 2007 before her collar prematurely dropped.

Tzoonie Samples: During a field trip into the Tzoonie drainage in December 2008, Apps and Rochetta collected 20 hair samples from beds and rub trees in two relatively close areas along the lower Tzoonie River. Three of these samples collected from both areas yielded a viable DNA and corresponded to bear M46 who we previously identified in 2004 at two separate sites just north of Clowhom Lake roughly 15 km to the east. Interestingly, this individual was also detected near the end of July 2007 in the upper Brandywine drainage, a linear distance of ~55 km from the lower Tzoonie.

Miscellaneous: A sample from a male grizzly bear known to have been poached in Pemberton Meadows matched to M129 in our regional database. This male was detected on several occasions in during 2006 sampling of the South Chilcotin Ranges south of Carpenter Lake.

2008/09 – Summary of Data and Movements

Telemetry-search and data-download flights were conducted during October of 2008 and 2009. From this effort, 4 of the 5 collared bears were found and GPS data were successfully downloaded. Only bear CF05 ("Chloe") was not found. The signal from the collar of female CF04 ("Daphne") was in mortality mode indicating that she had either recently denned or that the collar was dropped; we had to wait the winter to confirm in 2009 that the collar is likely dropped.

Data downloaded from the 4 bears were screened and processed. We evaluated the performance of GPS collars during their periods of deployment (Table 1). Fix success was high, ranging from 79% to 89% of fix attempts. The proportion of successful fixes that were 3D (≥4 satellites used) was also high, ranging from 87% to 95%.

Table 1. Performance of GPS collars deployed on grizzly bears during 2008 in the Squamish Forest District of southwestern British Columbia. Period of data collection is from indicated capture date to 23 October, 2008.

ID	Capture Date	Fix Attempts	Successful Fixes	% Successful of Attempts	% 3D of Successful
CF04	22/06/2008	2,713	2,423	0.89	0.95
CF05	23/06/2008	--	--	--	--
CM06	25/06/2008	2,882	2,472	0.86	0.91
CF07	07/07/2008	2,593	2,052	0.79	0.87
CM08	02/10/2008	506	405	0.80	0.84

CF04 "Daphne" (Figure 18) – During June – October, 2008, the movements of female CF04 were largely constrained to upper Petersen Creek with some short forays into the Ryan Valley and headwaters of Rutherford Creek. Her collar apparently dropped on 12 October.

CF05 "Chloe" – Despite several extensive aircraft searches, this bear was not found since being collared on 23 June,2008.

CM06 "Mercury" (Figure 19) – After being collared on 25 June, 2008, bear CM06 remained largely within the upper Rutherford and Petersen valleys for the rest of June and July before embarking on a movement across the Ryan and Lillooet valleys as of mid-August. He continued movements north and remained in the upper Hurley and associated tributary valleys until mid-October at which time he returned to the Ryan using close to the exact route and pass. He then continued back south across the Ryan River and up the Petersen drainage and to the back end of the west fork, where he apparently denned on 29 October. He emerged from this den on 8 May and gradually moved down the Rutherford drainage where his collar dropped on 14 June.

CF07 "Rhea" (Figure 20) – After being collared on 17 July, 2008 female CF07 moved extensively in the Deserted River drainage as well as the upper Ashlu, upstream of the Ashlu/Tatlow confluence. She spent much of the fall obviously foraging for salmon along the Deserted River, and made several forays, including a brief movement Squamish Valley though not as far down as the river. Unfortunately, this bear could not be located during our telemetry search and data download flight of October 2009.

CM08 "Keith" (Figure 21) – Shortly after male CM08 was collared in the upper Ashlu drainage in early October, he moved into the Deserted Valley and spent most of his time moving along the Deserted River, quite obviously with a focus on salmon. He was observed and photographed by a Conservation Officer along the shore just south of Deserted Bay on around 16 October. He appears to have remained active in this valley through most of December, and he subsequently denned at the back end of the Deserted drainage on the north slope of Mt. Crerar (specific date unclear). CM08 emerged from denning on 15 April. Then, by early May, he made a rather direct movement down the Ashlu Valley, up the Tatlow, and into the Clowhom drainage via Phantom Lake. He then moved extensively among several drainages north of Clowhom Lake, where his collar apparently dropped on 18 June, 2009.

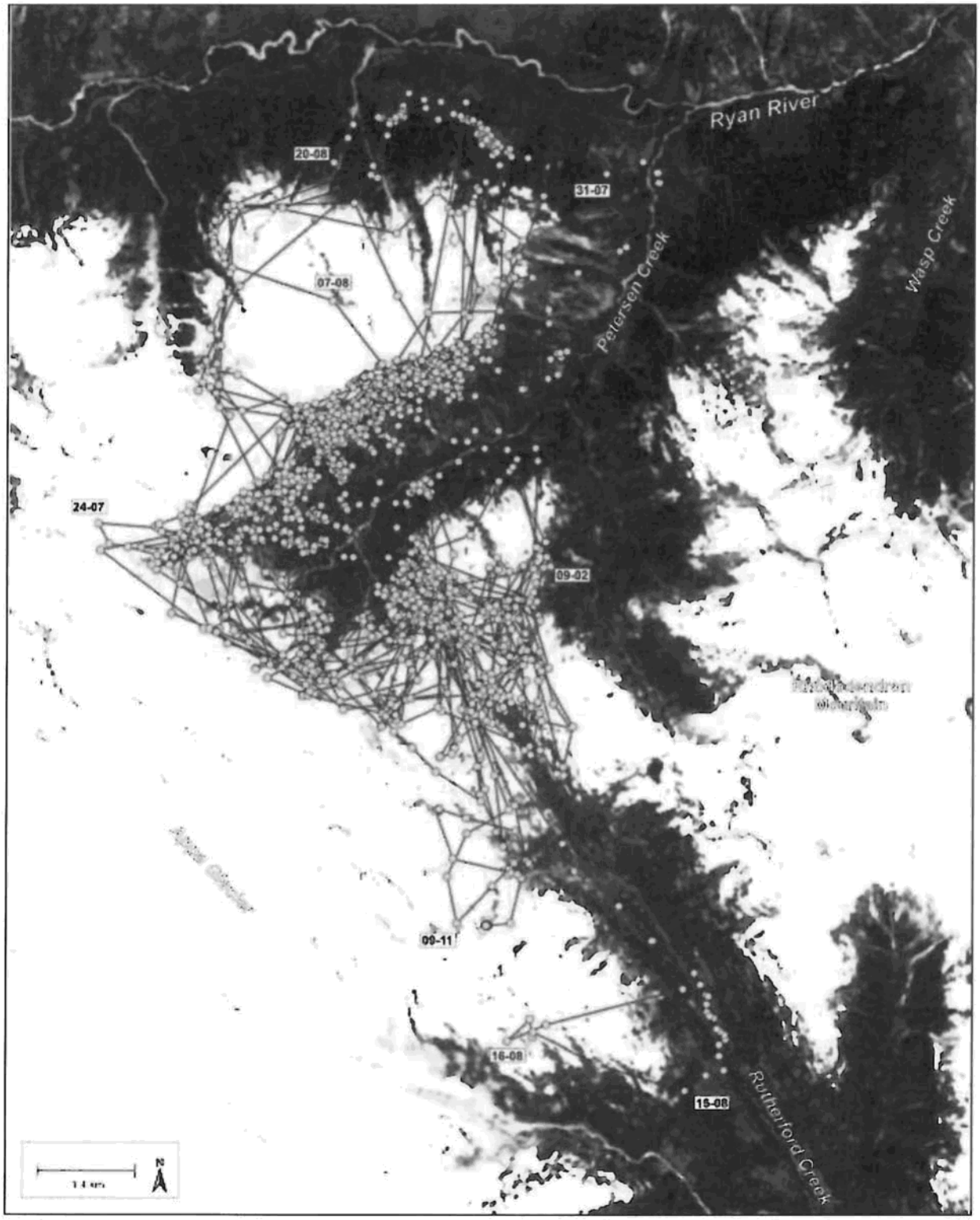

Figure 18. Known movement by grizzly bear CF04 ("Daphne") within the Ryan/Petersen and upper Rutherford drainages during June – October, 2008. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000.

Figure 19. Known movement by grizzly bear CM06 ("Mercury") within the Ryan, Rutherford, Lillooet, and upper Hurley Valleys during June, 2008 – June 2009.

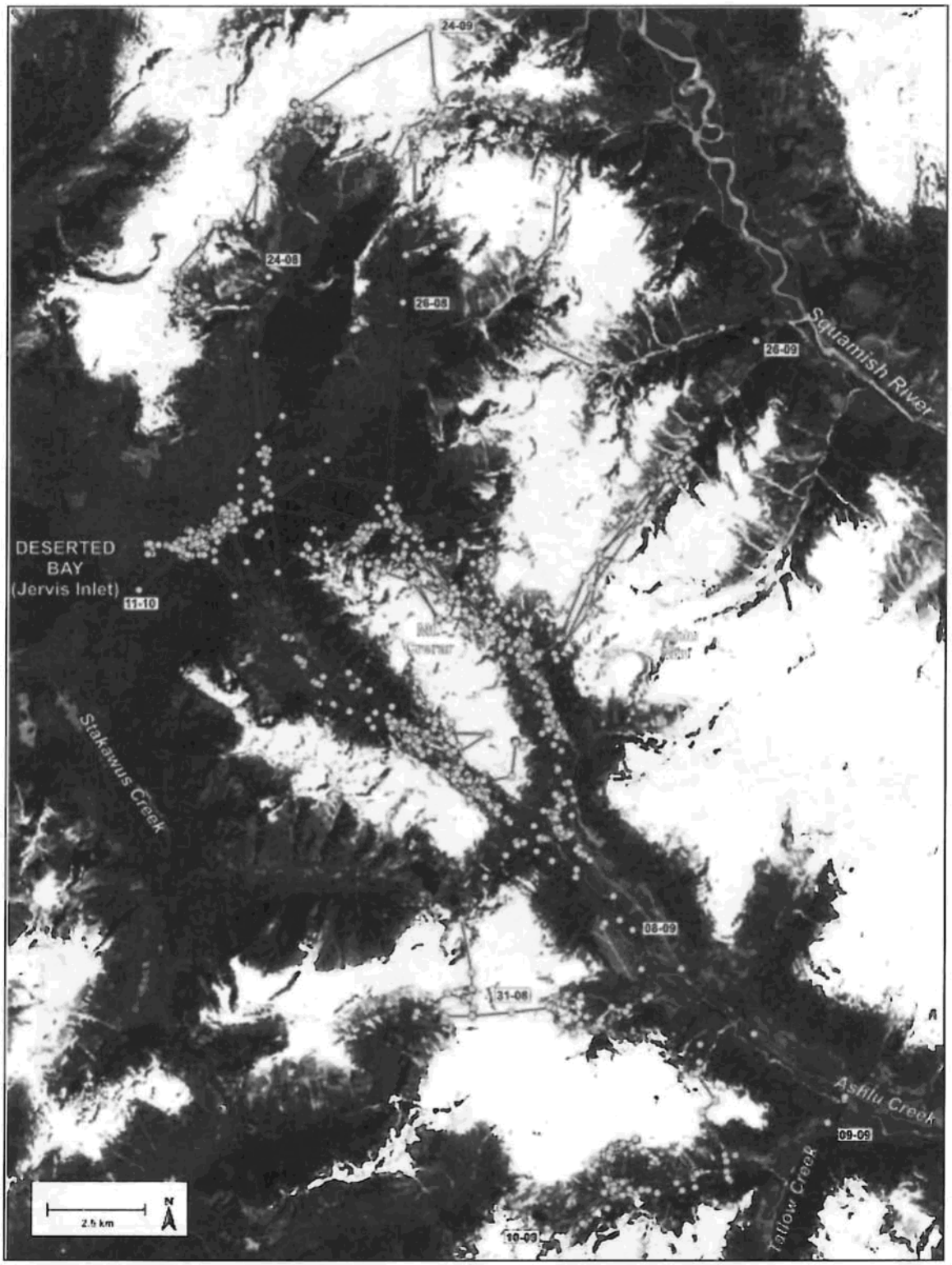

Figure 20. Known movement by grizzly bear CF07 ("Rhea") within the upper Ashlu and Deserted drainages during June – October, 2008. Data are plotted on a composite image of a Landsat 7 TM scene captured 7 July, 2000

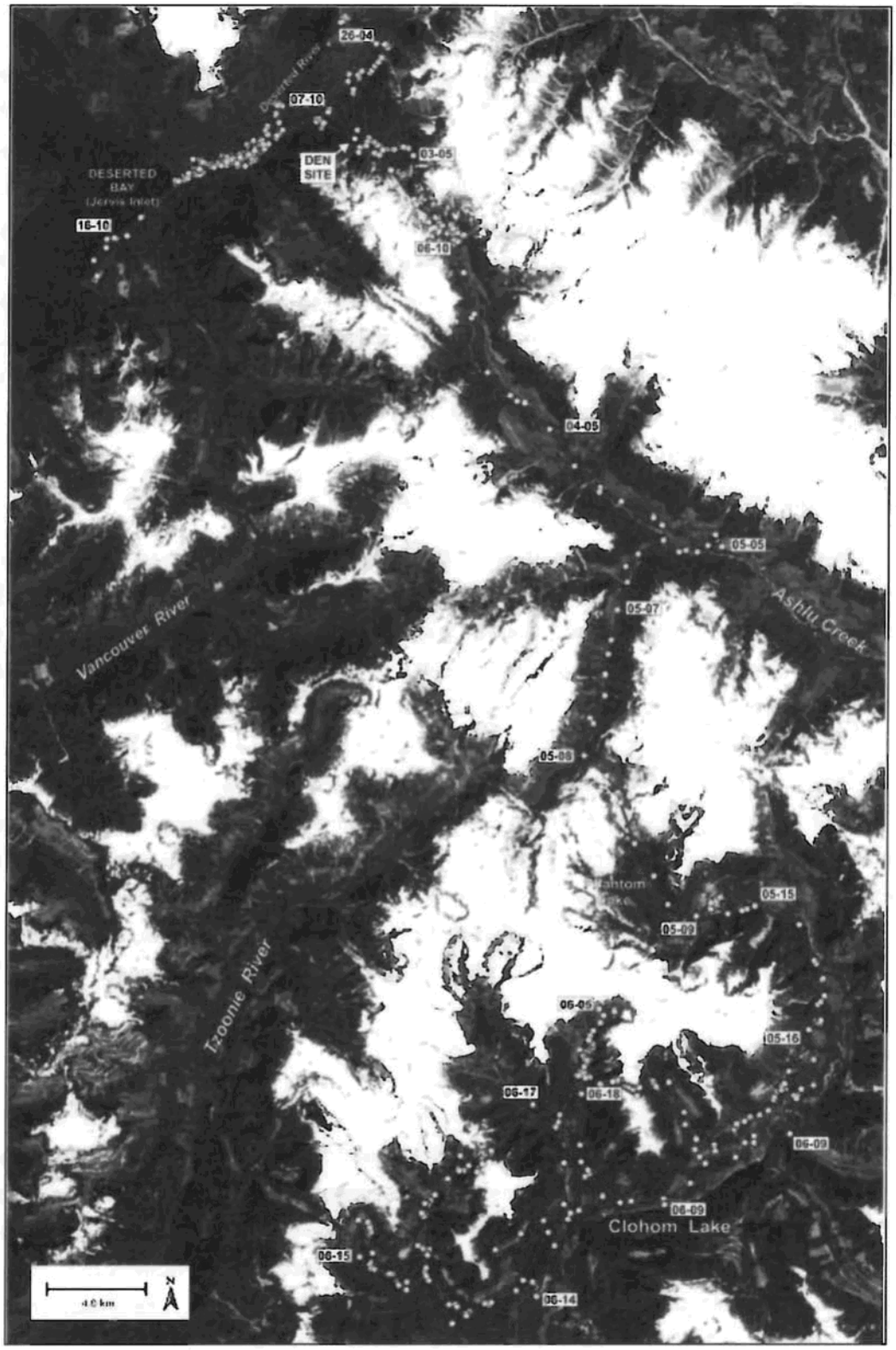

Figure 21. Known movement by grizzly bear CM08 ("Keith") within the upper Ashlu and Deserted drainages during October 2008 – June 2009.

2010 – Capture Efforts & Bears Collared or Detected

Our 2010 capture work was carried out through one helicopter darting session in June and a combined trapping and heli-darting session in July. Combined capture efforts resulted in a total of 8 new study animals (2M, 6F) on which we deployed Lotek GPS 4400M collars programmed for 1-hr fix attempts (Appendix 1). Helicopter search and darting (with Clay Wilson of Bighorn Helicopters) was carried out from 11 - 13 June and resulted in the capture of 3 new study animals (1M, 2F). Helicopter-assisted ground trapping and some opportunistic heli-darting was carried out from 22 to 28 July. This effort yielded 5 new study animals (1M, 4F). Two 2-year cubs of one of the study animals were also incidentally captured and released without collars. DNA profiles confirmed that 2 adult females were study animals previously collared (CF01 "Ashley", CF02 "Callie"). These bears and 5 others had also been previously detected through regional hair-snag/DNA sampling efforts. One bear (CF14 "Phoebe") was not previously known.

2011 – Capture Efforts & Bears Collared or Detected

Capture efforts during 2011 were carried out in late July and early Aug as well as September. Heli-trapping as previously described (snares only) was carried out from 31 July through 5 Aug. On 1 Aug, a 2-year old male was captured and released without a collar in Petersen Creek. On 2 Aug, we captured an adult female CF15 "Hope" at Headquarters Pass (b/w Hope Ck & Birkenhead R.). Two yearling cubs were with her at the time. On 4 Aug, an adult male and female breeding pair were captured and collared in Petersen Creek. An ear-tag indicated that the female was CF12 "Phoebe" who had just dropped her previous collar on 26 June. The male was a new study animal CM16 "Titus". Ground trapping was also carried out in the upper Birkenhead and Tenquille Creeks during September. During that time adult male CM17 "Huck" was captured and collared. We attempted to heli-dart one bear known to be CF05 but she did not induce due likely to a drug-delivery problem. Combined capture efforts resulted in the collaring of 4 bears (2M, 2F), 3 of which were new study animals, on which we deployed Lotek GPS 4400M and 7000MU collars programmed for 1-hr fix attempts (Appendix 1).

2010/11 – Summary of Data and Movements

Functioning collars collected data from 9 (2M, 7F) study animals during 2010 and 9 (3M, 6F) study animals during 2011. Data download flights were carried out in June and late October, between which data were also opportunistically downloaded with helicopter assistance and from the ground. Data downloaded from study animals were screened and processed. We evaluated the performance of GPS collars during their periods of deployment (Table 2). Fix success was relatively high, ranging from 79% to 97% of fix attempts with one exception (CM14, collar 919) at 55%. The proportion of successful fixes that were 3D (≥4 satellites used) was also high, ranging from 86% to 95% with the

exception of CM14 (collar 919) at 71%. Cursory inspection of data plots suggest that many if not most miss fixed were associated with heavily forested habitats.

Table 2. Performance of GPS collars deployed on grizzly bears during 2010 and 2011 in the Squamish Forest District and environs of southwestern British Columbia. Period of data collection is from indicated capture date to mid October, 2011. Attempted fixes during denning are excluded.

ID	Name	Collar	Capture Date	Fix Attempts	Successful Fixes	% Successful of Attempts	% 3D of Successful
CF04	Daphne	1349	22/06/2008	2,691	2,401	0.89	0.95
CF05	Chloe	1348	23/06/2008	6,944	6,053	0.87	0.92
CM06	Mercury	1452	25/06/2008	3,823	3,259	0.85	0.92
CF07	Rhea	1345	07/07/2008	2,593	2,051	0.79	0.87
CM08	Keith	1342	02/10/2008	2,952	2,405	0.81	0.86
CF02	Callie	1347	11/06/2010	6,465	5,863	0.91	0.93
CM09	Bruno	1960	12/06/2010	4,011	3,711	0.93	0.91
CF10	Power	1346	11/06/2010	5,001	4,510	0.90	0.93
CF11	Phantom	1451	24/07/2010	4,132	3,346	0.81	0.87
CF01	Ashley	1344	24/07/2010	2,039	1,711	0.84	0.88
CF12	Phoebe	1452	27/07/2010	4,137	3,611	0.87	0.92
CF13	Juno	1343	27/07/2010	2,722	2,403	0.88	0.94
CM14	Atlas	919	27/07/2010	6,490	3,582	0.55	0.71
CF15	Hope	31751	02/08/2011	2,019	1,942	0.96	0.94
CF12	Phoebe	31752	04/08/2011	1,800	1,737	0.97	0.91
CM16	Titus	1342	04/08/2011	2,036	1,862	0.91	0.94
CM17	Huck	31747	22/09/2011	626	579	0.92	0.90

CF02 "Callie" (Figure 21) – This previously collared bear (August - October, 2007) was recaptured and collared on 11 June, 2010. She had 2 cubs of the year at capture and they were observed with her a year later in June 2011. Over the >2 seasons she has been monitored, CF02 has ranged across 358 km^2, from the headwaters of the Soo River in the north to the lower part of Roe Creek in the south, an extent of 390 km. Her east-west extent is much less as she remains in the upper drainages including Roe, Brandywine, Callaghan and Soo, and she occasionally ventures into the extreme eastern portion of the upper Squamish drainage including the back end of Shovelnose Creek. In 2010, CF02 appears to have denned on 22 October. She remained denned until 10 May at which time she emerged for at least 3 h before denning again until 3 June. Her den site was in the very upper end of the south fork of the Brandywine drainage. Her collar remains active and functioning.

CM09 "Bruno" (Figure 22) – This male was collared in the Ryan drainage in June, 2010. He was then tracked until 28 November at which time he dropped his collar in the upper Lillooet valley. During his short monitoring period, CM09 moved extensively through the Ryan and upper Lillooet valleys over 535 km^2. A few separate movements were made between the two valleys, one being via a foray across the Pemberton Icefield to the headwaters of Meager Creek and then down the Meager Valley. His collar has been retrieved.

CF10 "Power" (Figure 23) – This female was collared in the Rutherford drainage in June, 2010. Dependent cubs were not apparent but a male was observed near her so she likely was breeding. She was not observed when located in June 2011 so we could not confirm whether she was with cubs (her movements suggest she was without cubs). During the year, CF10 ranged over 983 km^2, from the upper Ryan (brief foray into the upper Lillooet), through the upper Rutherford, across the Soo and upper elevations of the Callaghan and Brandywine drainages including Rainbow Mtn and Mt. Sproatt. She appears to have denned on 25 October on Rainbow Mountain and emerged on 25 May. Her collar remains active and functioning.

CF11 "Phantom" (Figure 24) – This female was collared in the Ashlu drainage (upper reaches of the Tatlow Valley) in July, 2010. Three cubs of the year were with her at the time, and they were also present when we located her by aircraft in June and October, 2011. Due to a technical issue, her collar could not be downloaded during the October flight. To June 2011, CF11 ranged across 281 km^2, from the middle Ashlu valley, through Tatlow and Falk Creek drainages, into the upper northern reaches of the Clowhom drainage (including around Phantom Lake), and through the Tzoonie drainage with particular focus on the lower reach and estuary. She appears to have denned in a side valley of the upper Tzoonie River likely in December and emerged in on 30 April. Her collar remains active and functioning.

CF01 "Ashley" (Figure 25) – This female was collared in the upper Ashlu drainage in July, 2010. Her two 2-year old cubs were also incidentally captured at the same time (genetic samples taken). Over the next 4 months from the upper Ashlu to Deserted River and Bay, and over the height of land to side drainages of the Elaho River and Sims Creek. She apparently dropped her collar on 17 October near the Deserted River (collar pick-up pending). Combined with her previous data that extends a bit further down into the Ashlu Valley, CF01 has ranged across 234 km^2

CF12 "Phoebe" (Figures 26 & 27) – This female was collared in the Petersen branch of the Ryan River drainage in July, 2010. At this time, two yearling cubs were with her. These cubs appeared to be still with her when we located her in June, 2011, but a breeding male may also have been present. During the past year, CF12 and her cubs ranged extensively throughout the Ryan drainage, including the Petersen Valley and a foray through Wasp Creek. Several movements into the Lillooet Valley and across the Lillooet River were also apparent. She appears to have denned in Petersen Valley in December and emerged on 10 May. CF12 dropped her collar on 26 June and we

recovered it. We then recaptured her on 4 August in a snare in upper Petersen Creek together with male CM16 "Titus" (concurrent location data indicate they did not stay together after capture). She continued to range through Ryan and Petersen valleys from then until late October covering an annual MCP home range of 249 km^2. Her current collar remains active and functioning.

CF13 "Juno" (Figure 28) – This female was collared in back end of the Ryan River drainage in July, 2010. Although she appeared to be lactating, a cub was not observed. She ranged over ~160 km^2 throughout the upper Ryan Valley, with relatively tight movements suggesting that she was in fact with at least one dependent cub. She denned in the back of the Ryan on 30 October and emerged on 2 May. She died apparently from snow avalanche on 21 May and her collar was recovered.

CM14 "Atlas" (Figure 29) – This male was collared in a side valley of Rutherford Creek in July, 2010. Over the next year he ranged extensively over 1,051 km^2, from the upper Ryan Valley to Millar Creek (Pemberton Valley), and across the Rutherford, Soo, and Callaghan drainages. He appears to have denned in December at the back end of Wasp Creek and emerged on 10 May. His collar remains active and functioning.

CF05 "Chloe" (Figure 30) – This female had been collared in June, 2008 but was not found during aircraft searches in 2008 and 2009. We did find her in 2010 although we could not acquire her data because her collar was in "recovery" (low battery) mode. Multiple attempts to recapture her failed. Fortunately, her collar was still transmitting during June, 2011. We determined it was dropped and we recovered it and its data. The collar collected almost two years of data before apparent battery failure after denning in the fall of 2009. During this time (June 2008 - October 2009), CF05 ranged from the upper Brandywine, through the Callaghan, Soo, Rutherford, and upper Squamish drainages, covering 667 km^2. In the fall of 2008, she denned in the upper basin of Madeley Creek, east of Callaghan Lake, on 29 October and emerged on 17 May. In 2009, she denned on 26 October high on the SW slope of Rainbow Mountain though her collar did not obtain fixes upon emergence. It is notable that CF05 used an area closely associated with the Callaghan 2010 Olympic Nordic facility during late June and early July of 2009. The specific attractant to this site and whether it was natural or human-caused is unclear. We attempted to recapture CF05 by heli-darting in Aug, 2011 but were unsuccessful due to a drug-delivery problem.

CF15 "Hope" (Figure 31) – This female was collared on 2 Aug, 2011. From that time to her latest 25 Oct download, CF15 moved across 218 km^2, from upper Hope Creek (upper Hurley drainage), upper Birkenhead drainage, with extensive use of Tenquille Valley. She also made several forays into the Lillooet Valley and ranged into the upper reaches of Sockeye Creek and the headwaters of Noel Creek. Bear CF15 ("Hope") corresponds to F139 originally detected in the Birkenhead drainage in the 2006 hair-snag/DNA grid.

CM16 "Titus" (Figure 32) – This male was collared on 4 Aug, 2011, captured along with CF12 "Phoebe" in upper Petersen Creek. While he moved in the same local area as CF12 in the few days

following capture, it is not apparent that they were together after capture (they in fact may not have been together before capture despite the fact that they were captured together). From this time until his latest download on 28 October, CM16 used upper Petersen Creek extensively and moved from the lower to upper Ryan Valley and over the ridge into South Creek. He then moved across the Lillooet Valley and into the upper Hurley drainage, up Hope Creek and into the upper Birkenhead drainage where he used Tenquille Valley extensively. These 3 months of movement data covered 749 km^2. Bear CM16 "Titus" corresponds to M249 in the regional DNA database and was originally detected in the Birkenhead drainage in 2007.

CM17 "Huck" (Figure 33) – This male was collared on 22 Sept, 2011 by cable snare in the Tenquille Valley. From this date to his latest download on 18 Oct, CM17 moved from the Tenquille Valley to the lower Birkenhead River, obviously for salmon. Bear CM17 ("Huck") corresponds to M105 also originally detected in the Birkenhead area in 2006.

Other Detections (2010) - Hair-snag/DNA detection sampling along the lower Squamish River for long-term monitoring detected several grizzly bears previously identified through regional sampling efforts carried out since 2004. As with previous years, bears detected along the lower Squamish have all been males. Near Shovelnose Creek, bear M8 was detected 3 times and M111 once. In the Ashlu floodplain, bears M32 and M46 were detected once each. Bear M46 was also detected once near Sigurd Creek. One monitoring site in the main Ashlu drainage detected M8 once, and another site in the upper Ashlu detected M8 and M35 once each, and M56 4 times.

Other Detections (2011) - All bears captured and collared during 2011 had been previously detected and included in the regional DNA/detection database. Bear CM16 ("Titus") corresponds to M249 in the regional DNA database and was originally detected in the Birkenhead drainage in 2007. Bear CF15 ("Hope") corresponds to F139 originally detected in the Birkenhead drainage in the 2006 hair-snag/DNA grid. Bear CM17 ("Huck") corresponds to M105 also originally detected in the Birkenhead area in 2006. As discussed in the regional DNA report, this male assigns clearly to the Stein population and obviously has dispersed from there. Interestingly, "Huck" is also known to have mated with F139 (CF15 "Hope") who was also collared this year, parenting a cub who is a 50/50 Stein/McGillivray hybrid. In addition to bears captured and collared, several individuals were detected through hair-snag sites at specific locales.

At a site near Salal Creek in the upper Lillooet Valley, several previously identified males were detected. This included M256 who was originally known from 2007 sampling in the same area. This bear was detected from samples collected during June, July, August and both early and later October but not from a collection visit in September. Samples collected there in September detected M83 who was originally known from 2005 sampling in the Ryan Valley. Finally, samples collected during late October detected M216. This male was originally detected near Edmond Creek at the south end of Chilko Lake in 2007, then also in the Toba drainage in 2008.

At a site near South Creek at 14.5 km of the Lillooet Valley road, three grizzly bears were detected. Bear M247 was identified from samples collected in July. This male is originally known from 2007 sampling in the Birkenhead drainage. Samples collected in August produced F84, a female originally detected from 2005 sampling in the Ryan drainage. August samples also identified a new male (M330), possibly a dependent cub of the F84.

At a site in the upper Rutherford, three individuals were detected. Samples collected in July identified M30 who has been collared as study animal CM14 "Atlas". In August, samples identified F22 who is known as CF05 "Chloe" also from the collaring program. Both bears have been known since the 2004 Squamish-Lillooet sampling. Also, a sample collected at this site in late August identified a new female (F331).

Near Wingate Creek in the lower Elaho Valley, three males were detected from samples collected in September. This included M111 who was originally detected in the upper Lillooet Valley in 2006. Also, M216 was again detected in addition to his October detections near Salal Creek in the upper Lillooet Valley (see above for his detections in other drainages). As well, a sample corresponded to M256 who was originally known from 2007 sampling in the upper Lillooet.

Samples collected in July at a site in lower Sims Creek of the Elaho drainage detected M35, a bear that was originally detected in 2004 within the Squamish-Lillooet GBPU. Also at this site, a newly identified female (F329) was detected.

In the lower Squamish Valley, only one bear was detected from samples collected for 2011 monitoring. Male M46 was once again detected this year, both at the Ashlu floodplain in September and also near Shovelnose Creek in October. This bear was originally detected in the regional DNA survey in 2004 and in subsequent monitoring sampling in 2007 (Callaghan), 2008, and 2010.

Finally, several samples were collected opportunistically during 2011. A young (2-3 year old) male that was captured in the upper Rutherford drainage but not collared had not been previously detected and is now identified as M328 in the regional DNA database. The adult male that was illegally killed in November at kilometer 7 of the Lillooet Valley road corresponds to M133 who had been detected extensively since the 2006 grid in the regional study. And a sample opportunistically collected in September at a site in the lower Homathko Valley corresponded to a male that had previously been detected in the Southgate drainage during 2010 sampling.

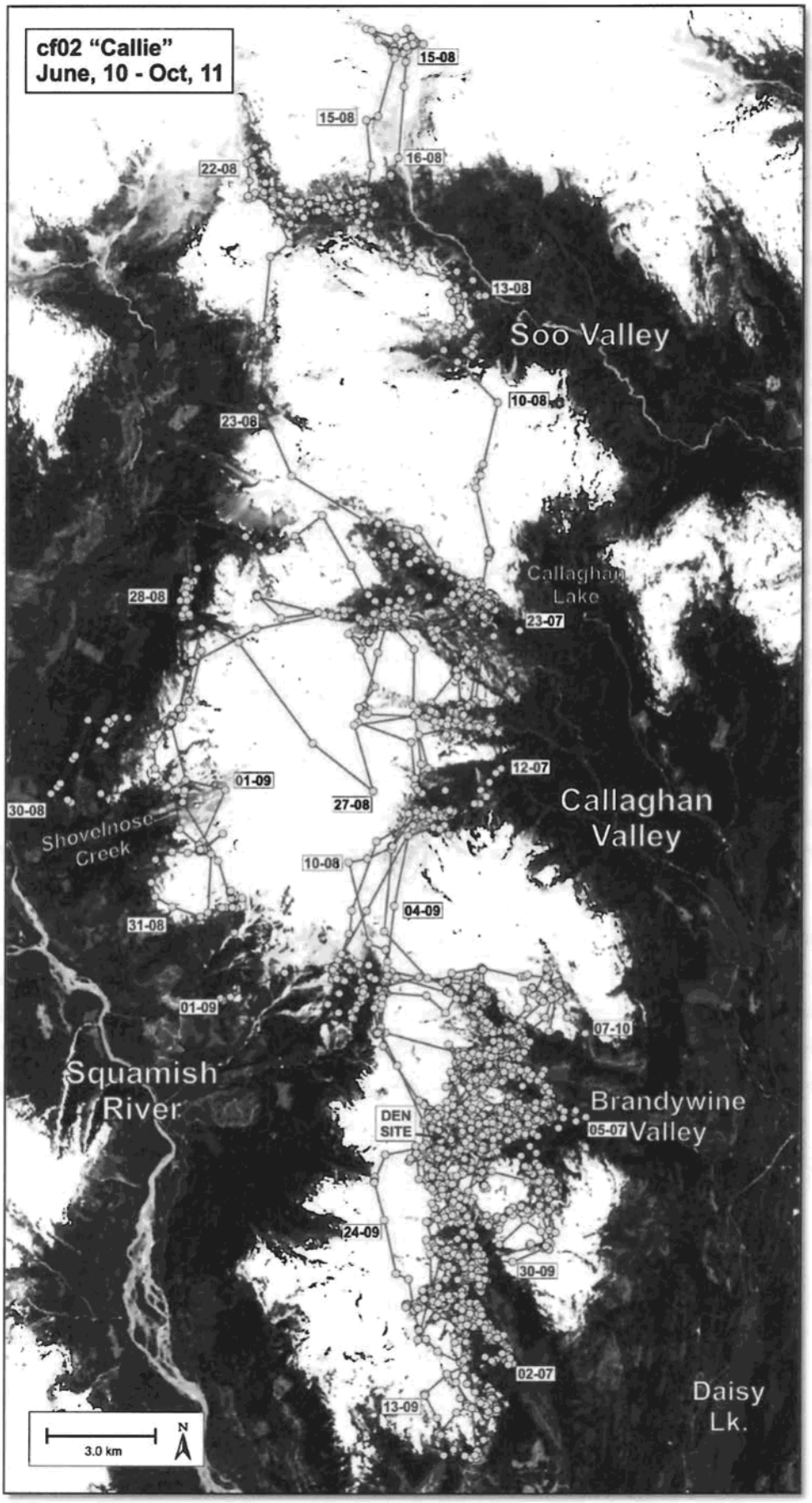

Figure 21. Known movement by grizzly bear CF02 ("Callie") during June 2010 – October 2011.

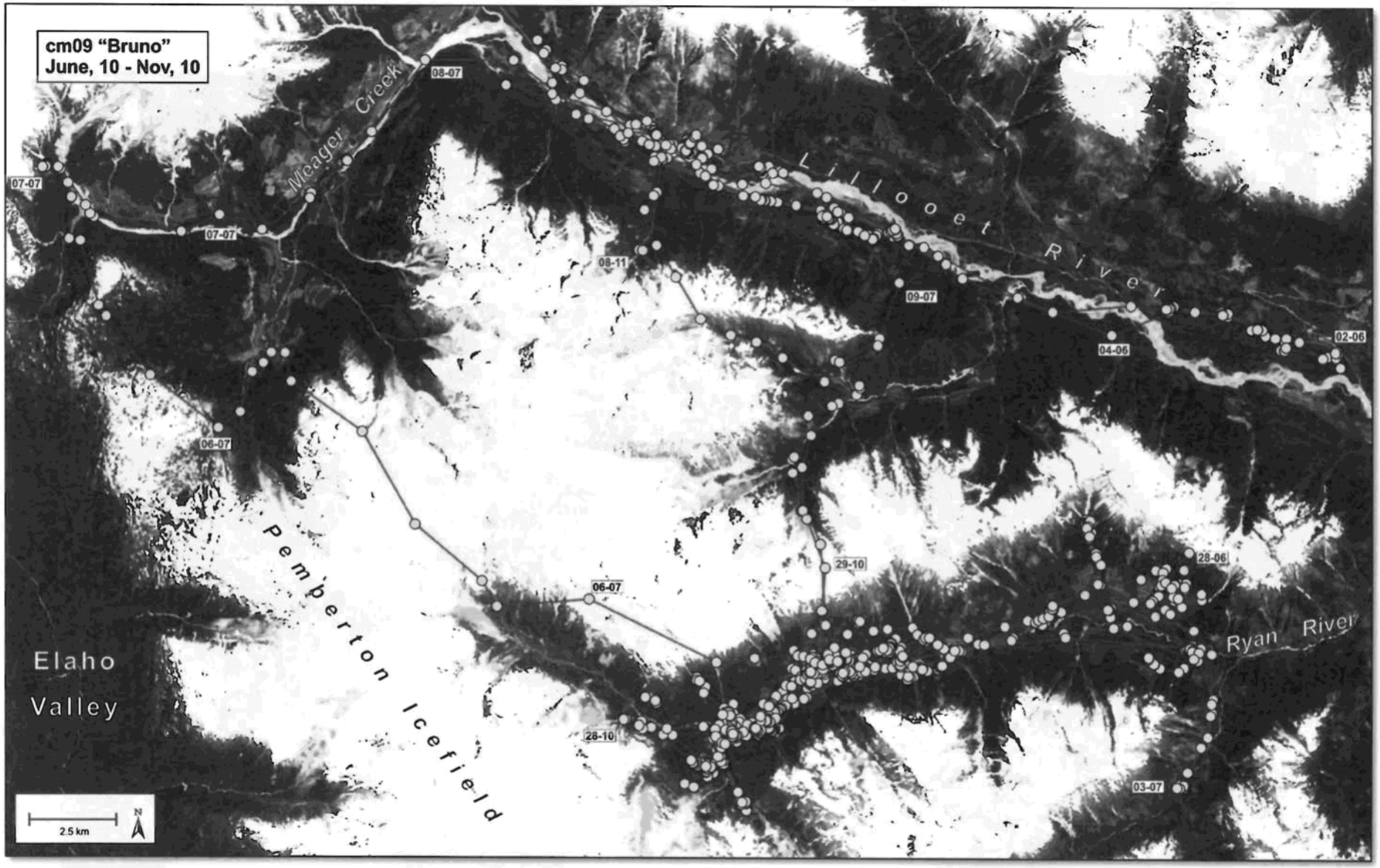

Figure 22. Known movement by grizzly bear CM09 ("Bruno") during June - November, 2010.

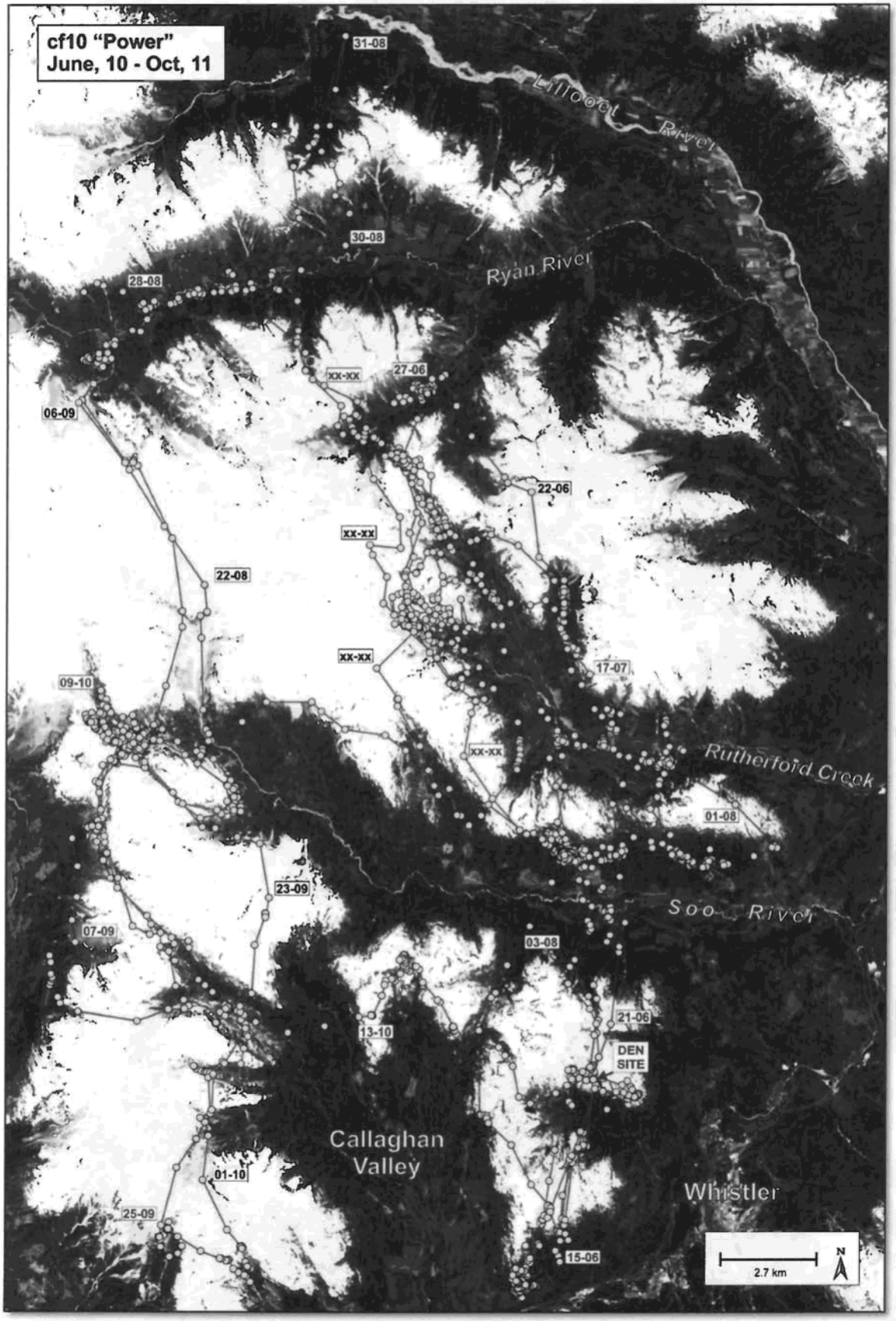

Figure 23. Known movement by grizzly bear CF10 ("Power") during June 2010 – August 2011.

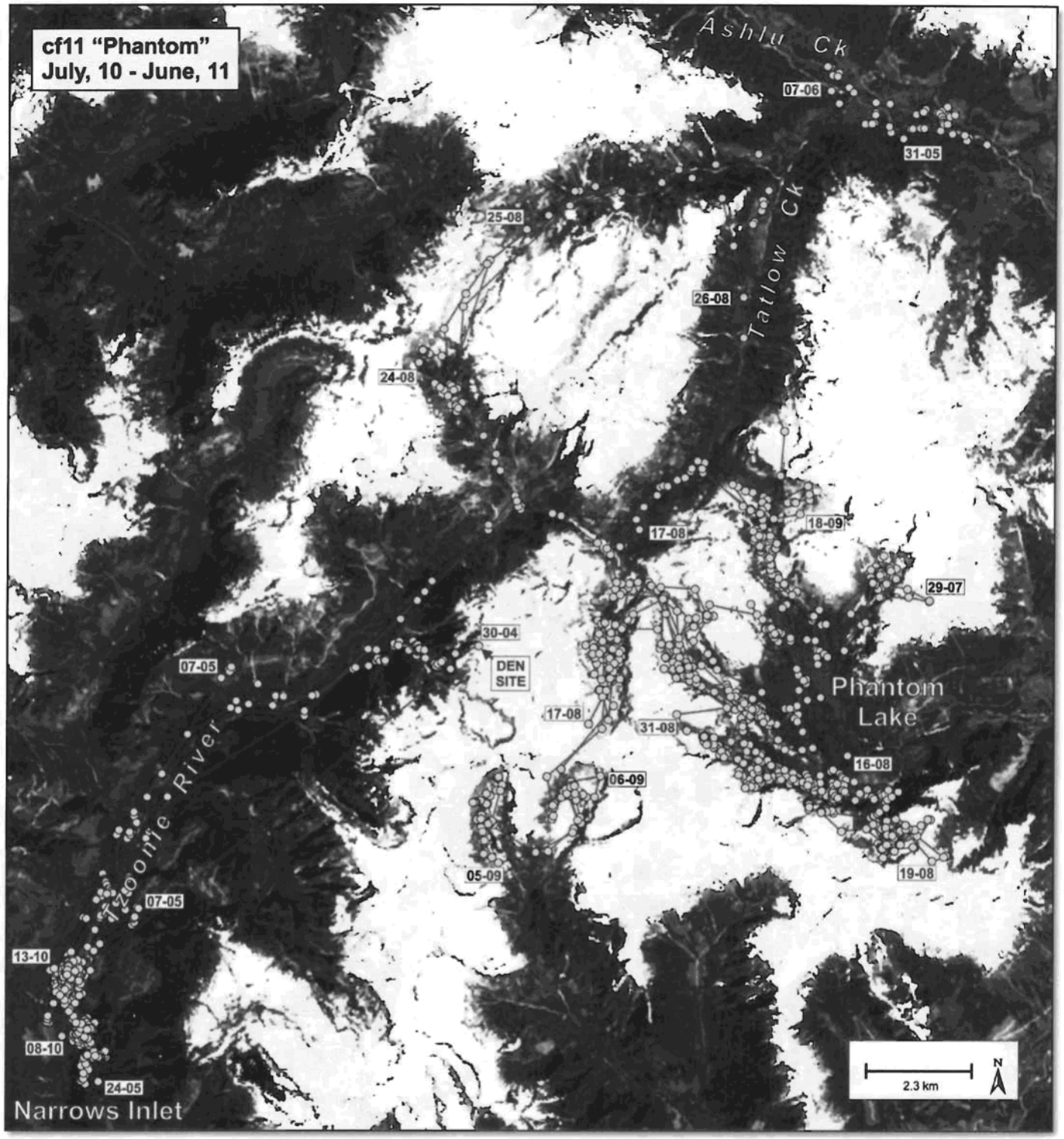

Figure 24. Known movement by grizzly bear CF11 ("Phantom") during July 2010 – June 2011.

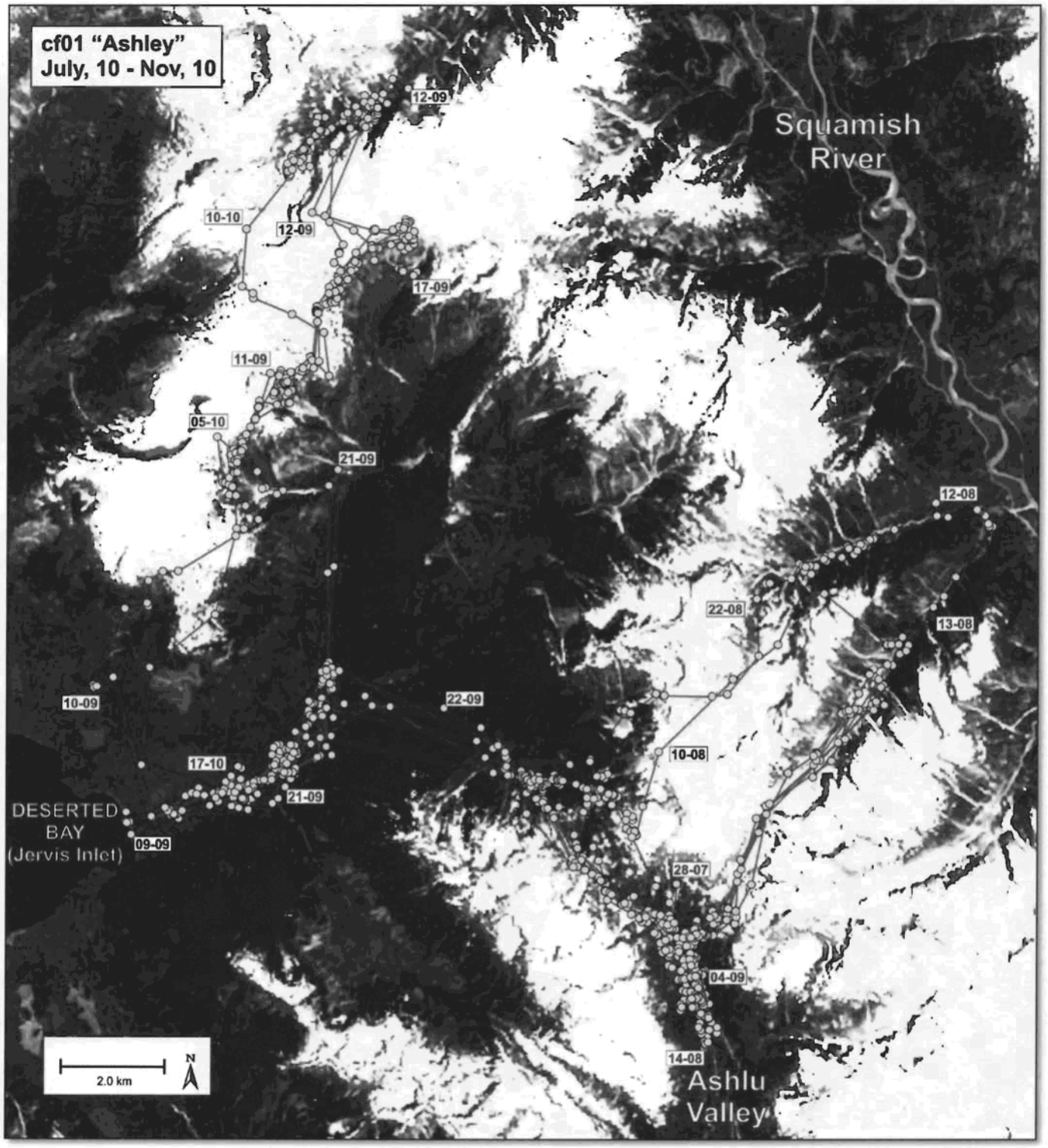

Figure 25. Known movement by grizzly bear CF01 ("Ashley") during July 2010 – November 2010.

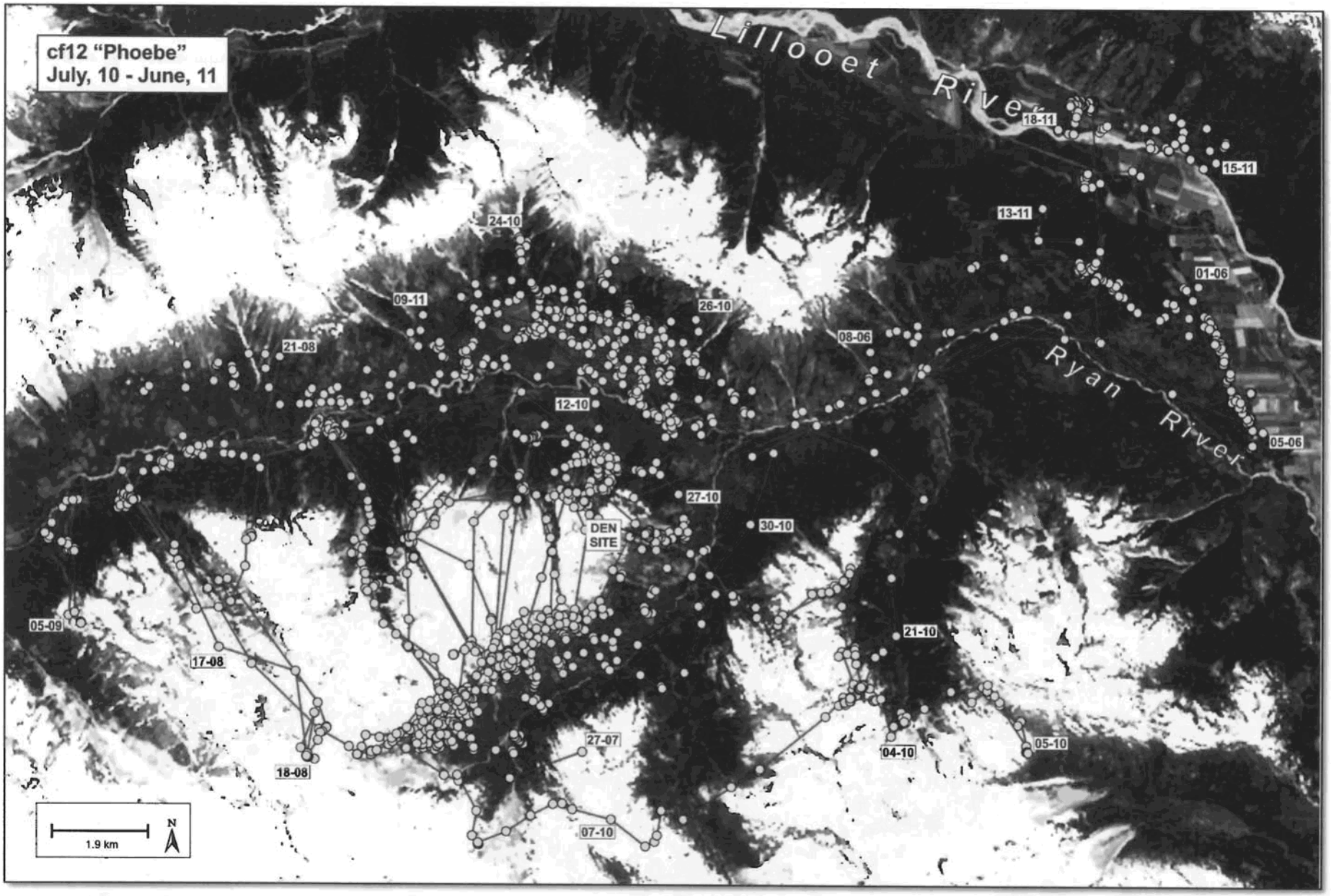

Figure 26. Known movement by grizzly bear CF12 ("Phoebe") during July 2010 – June 2011.

Figure 27. Known movement by grizzly bear CF12 ("Phoebe") during August 2011 – October 2011.

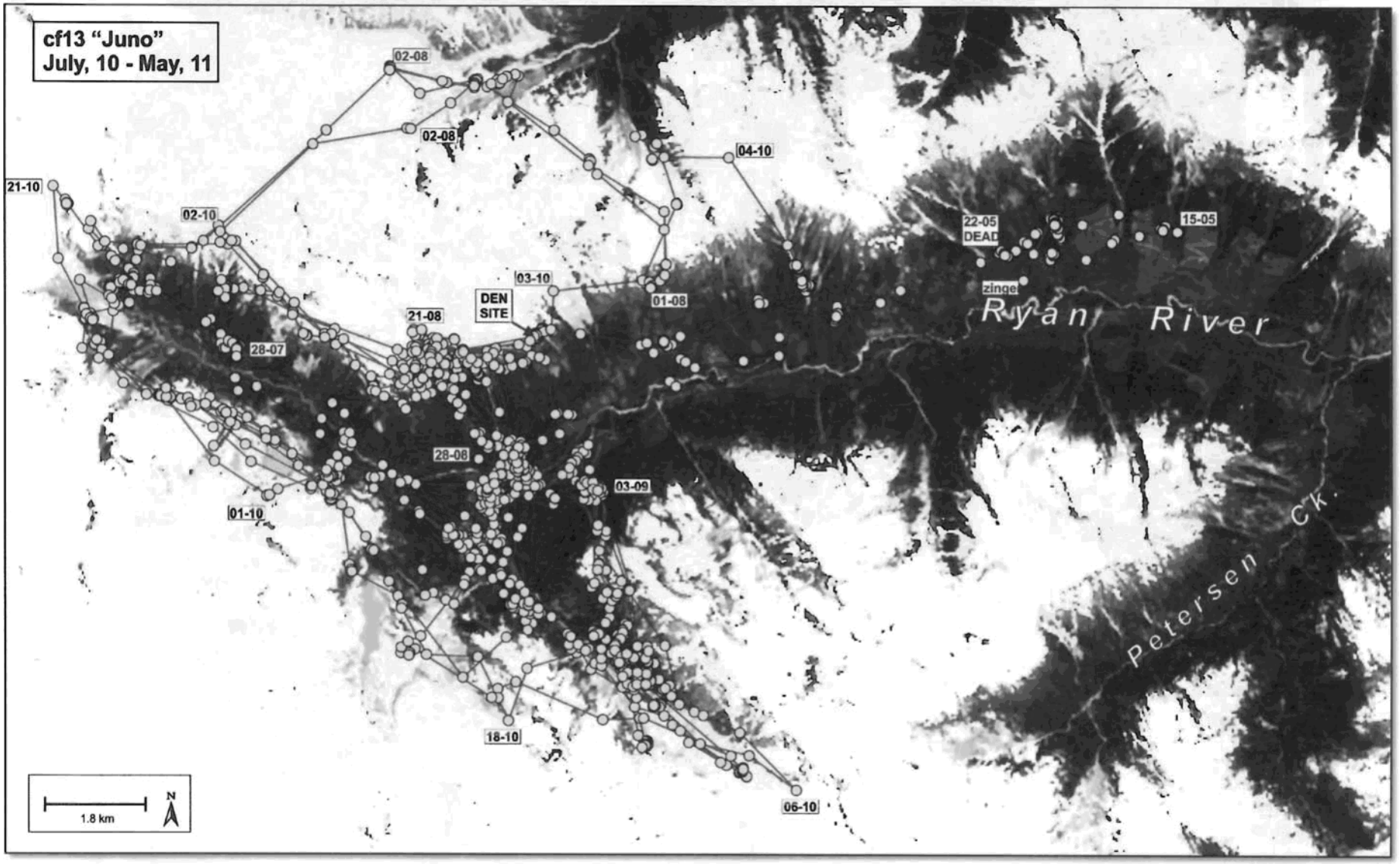

Figure 28. Known movement by grizzly bear CF13 ("Juno") during July 2010 – May 2011.

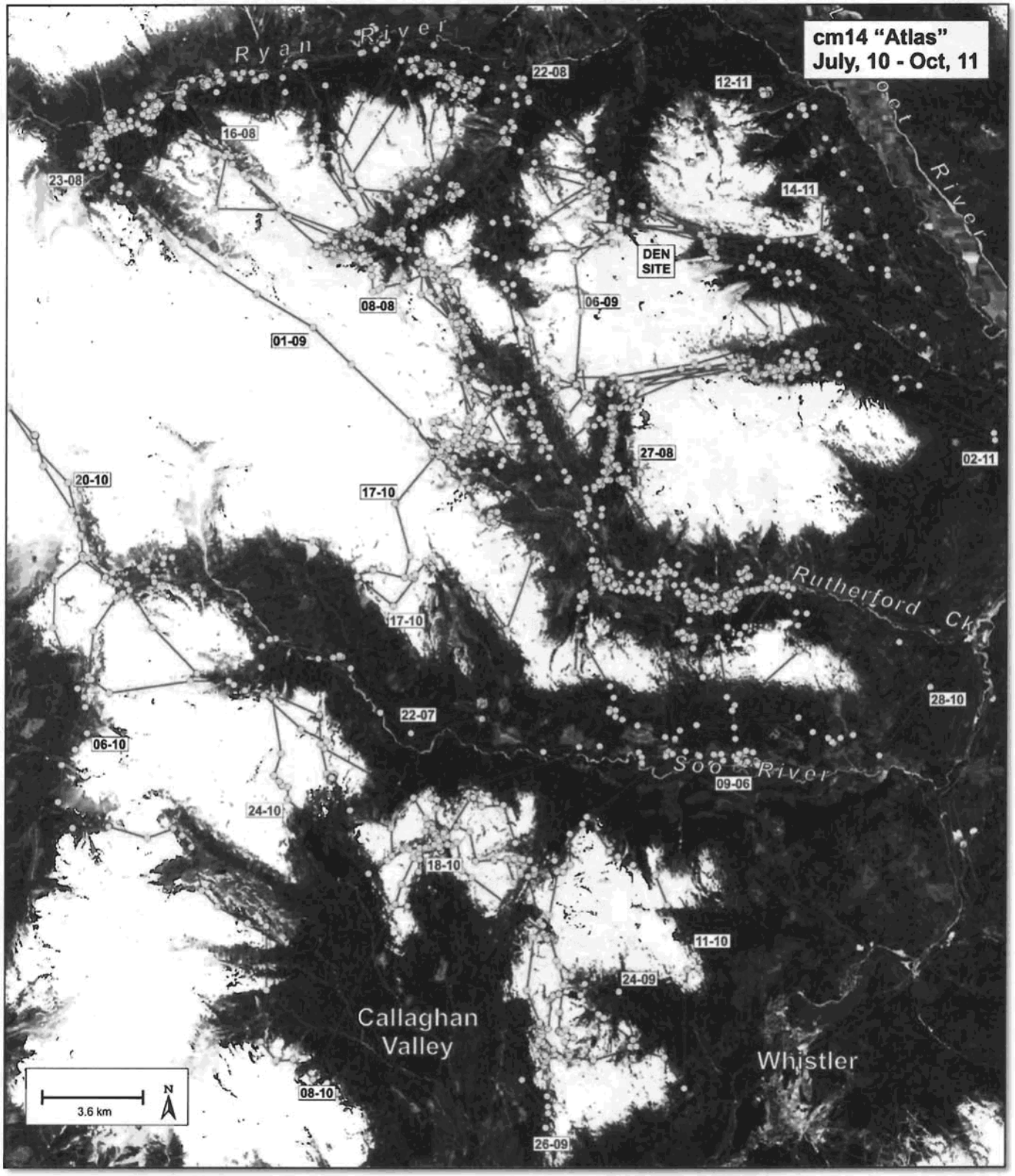

Figure 29. Known movement by grizzly bear CM14 ("Atlas") during July 2010 – October 2011.

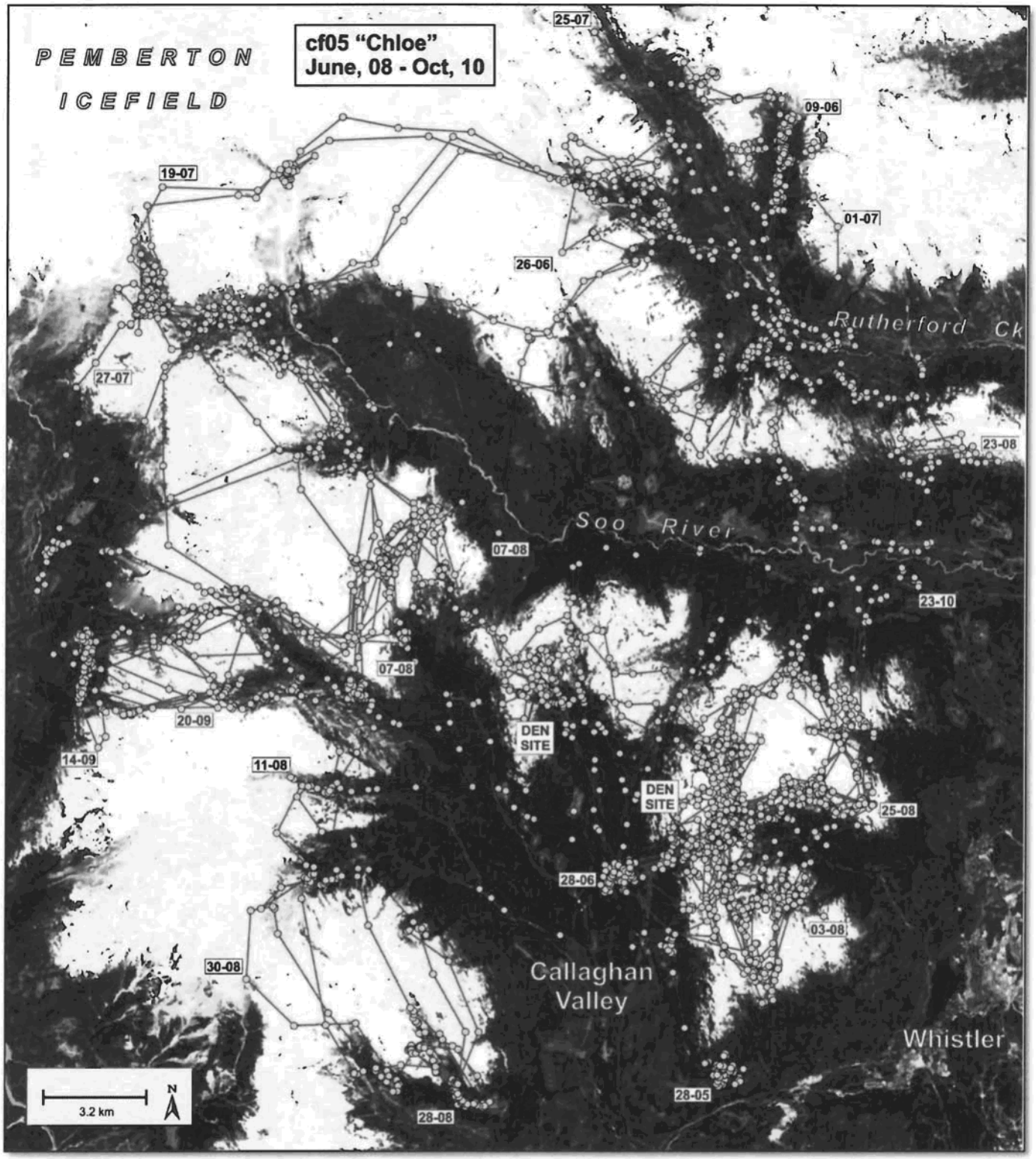

Figure 30. Known movement by grizzly bear CF05 ("Chloe") during June 2008 – October 2010.

Figure 31. Known movement by grizzly bear CF15 ("Hope") during Aug 2011 – October 2011.

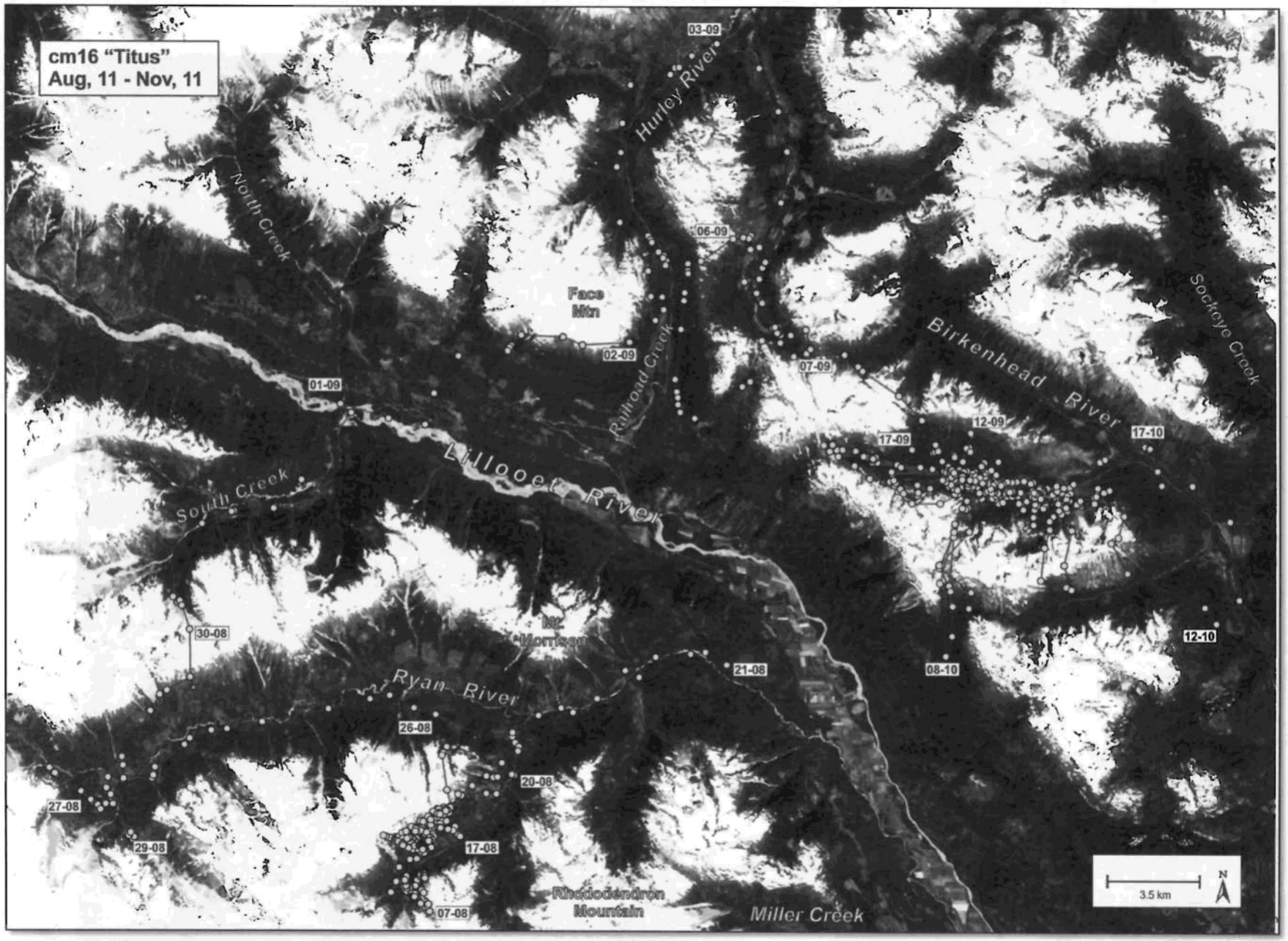

Figure 32. Known movement by grizzly bear CM16 ("Titus") during August 2011 – November 2011.

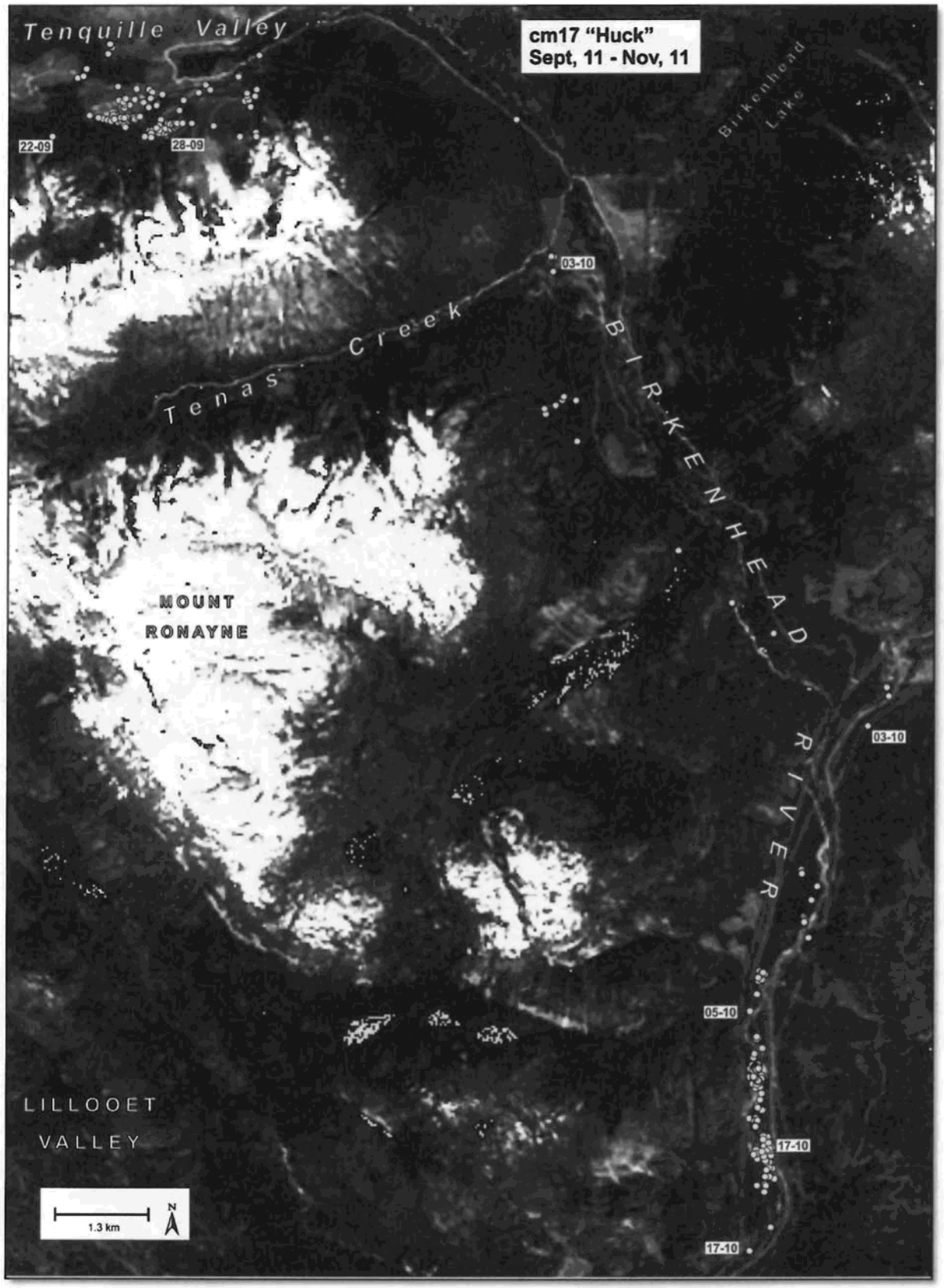

Figure 33. Known movement by grizzly bear CM17 ("Huck") during September 2011 – November 2011.

2012-13 – Capture Efforts & Bears Collared or Detected

Capture efforts during 2012 were carried out through July, August and September. Grizzly bears were captured using both helicopter-based aerial darting as well as helicopter-accessed ground snaring. During 2013, capture efforts were restricted to helicopter darting during June and September.

During 2012-13, 16 grizzly bears were captured, described in sequential order as follows. On 4 July 2012, an existing study animal CF02 "Callie" was recaptured through heli-darting and her collar was changed. On 19 July, we snare-trapped and collared an adult male CM18 "Boulder" in Pebble Creek. On 20 July, we snare-trapped and collared adult male CM19 "Silt" in the upper Lillooet Valley. On this same day we also snare-trapped and collared CF20 "Harriet" in a branch of the Hurley Valley, 6 km south of Jamie Creek, and we subsequently confirmed that she has two yearling cubs with her. On 24 July, we heli-darted and collared subadult male CM21 "Skid" and we snare-trapped adult male CM22 "Grey" both in the Petersen Valley. On this same day, we snare-trapped adult male CM23 "Shaggy" in the back of the Ryan Valley. On 29 July, we heli-darted and collared adult female CF24 "Melanie" in the back of the Meager drainage, and she is apparently not with cubs. On 15 September, we heli-darted and collared adult female CF25 "Natasha" in North Creek. On 16 September, we heli-darted and collared adult male CM26 "Hector" in the Hurley drainage, and existing study animal adult male CM14 was recaptured through heli-darting in Rutherford Creek and his collar was changed. Also on 16 September, adult female CF27 "Pebbles" was heli-darted and collared in the Pebble/McParlon pass, and she was with two yearling cubs. On 17 September, subadult female CF28 "Peanut" (offspring of CF15 "Hope") was heli-darted and collared (smaller collar used); this bear was travelling with a presumed sibling. On 18 September, adult female CF29 "Fay" was heli-darted and collared in the Ryan Valley. On 22 September, a subadult male was heli-darted in the Hurley Valley but was not collared. Finally, on 25 September, 2013, an adult female was heli-darted and collared in Hope Creek.

Combined capture efforts during 2012-2013 resulted in the collaring of 14 grizzly bears (7M, 7F), 12 of which were new study animals. On all study animals we deployed Lotek GPS 7000MU remotely-downloadable collars as well as Lotek IridiumTrackM 2-way satellite communication collars (Lotek GPS 4400S used for CF28). All collars were programmed for 1-hr GPS fix attempts. DNA profiles of all study animals have been matched to previously identified individuals within the region (Appendix 1).

2012-13 – Summary of Data and Movements

Functioning collars collected data from 21 (10M, 11F) study animals during 2012-13. Two study animals either could not be found during data download flights or there was a communication problem with their collars that precluded data acquisition. Seven collars were recovered either by pick-up because they were dropped, or by recapture either because they were in "recovery" mode and were no longer obtaining GPS fixes or opportunistically because they were nearing the end their expected

battery life. However, one of these recoveries was from a bear (CM26) that died due to an apparent gunshot.

Periodic and opportunistic downloads were conducted on several bears through the summer and fall, and fixed-wing aircraft search and download flights were conducted in June and October. Data download flights were carried out in June and late October, between which data were also opportunistically downloaded with helicopter assistance and from the ground. Data downloaded from study animals were screened and processed. The number of operating collared bears was 15 as of March 2013, down to 11 as of March 2014 due to some collars being dropped and one malfunctioning. Also, one of these collars is known to be malfunctioning and is in need of recovery this spring. For this study to date, GPS collars have been deployed 35 times on 30 grizzly bears (14M, 16F). Plots illustrating data collected during 2012-2013 are provided for individual study animals in Figures 34 - 55, below.

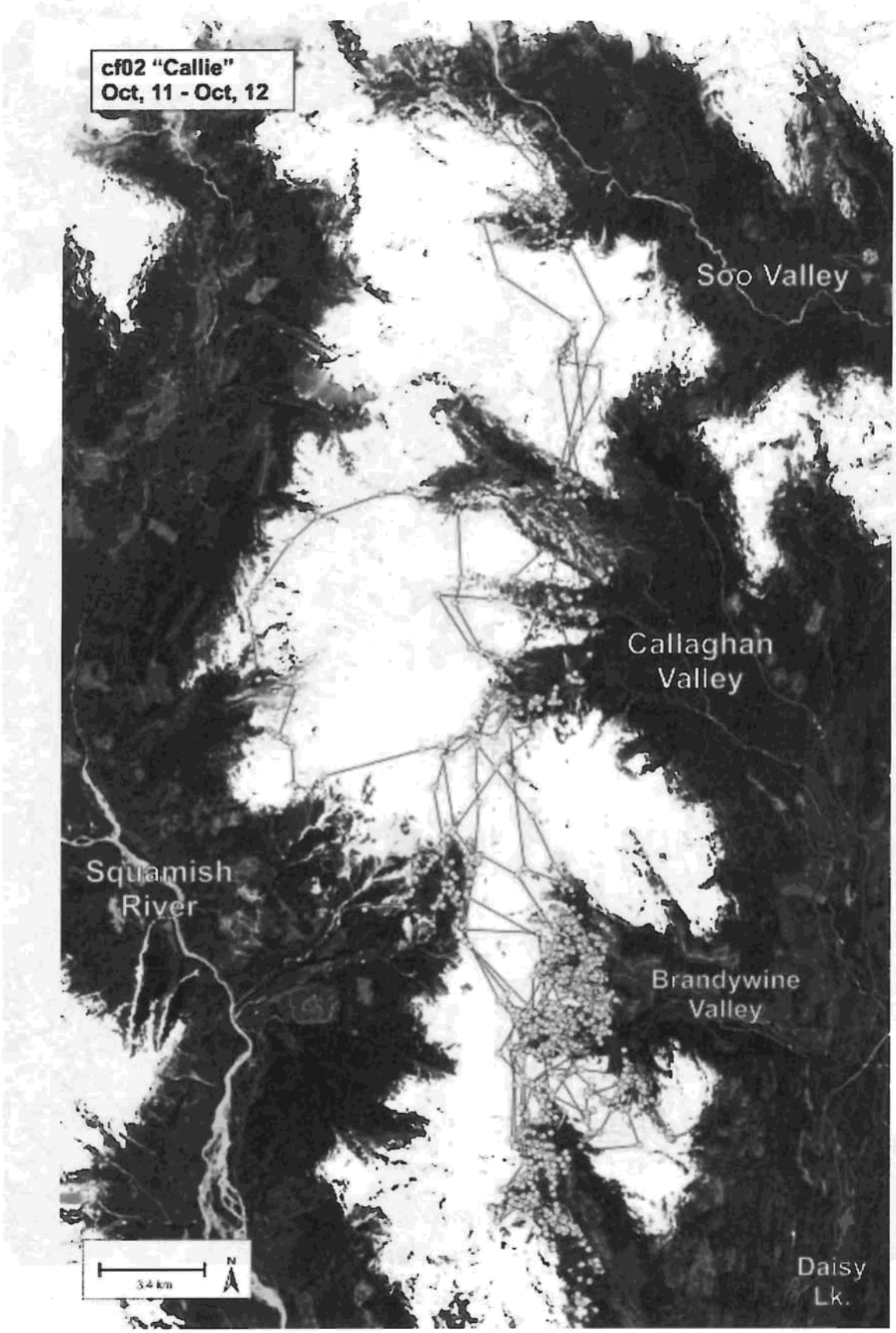

Figure 34. Known movement by grizzly bear CF02 ("Callie") during 2012 and since previous data download.

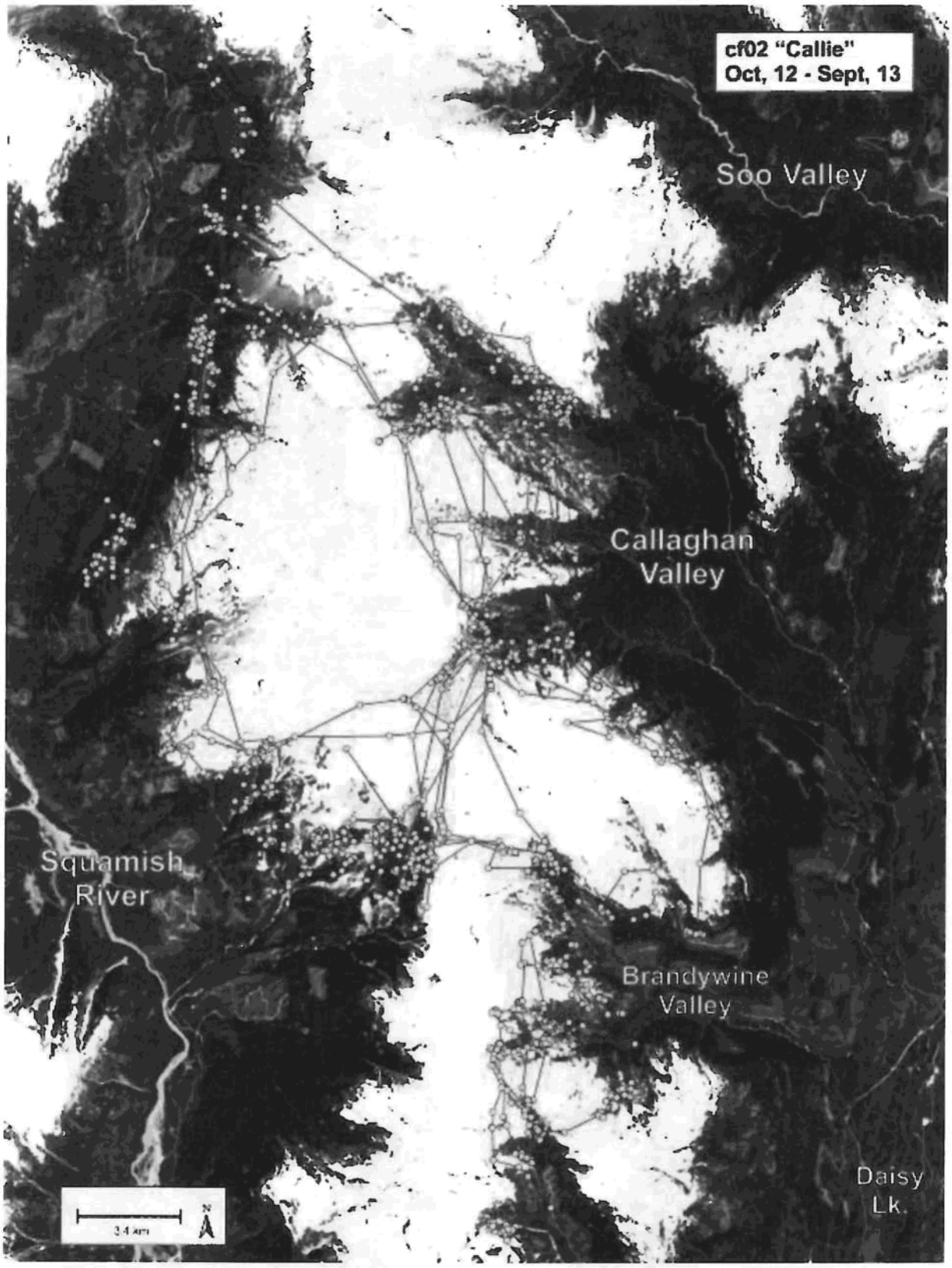

Figure 35. Known movement by grizzly bear CF02 ("Callie") during 2013 and since previous data download.

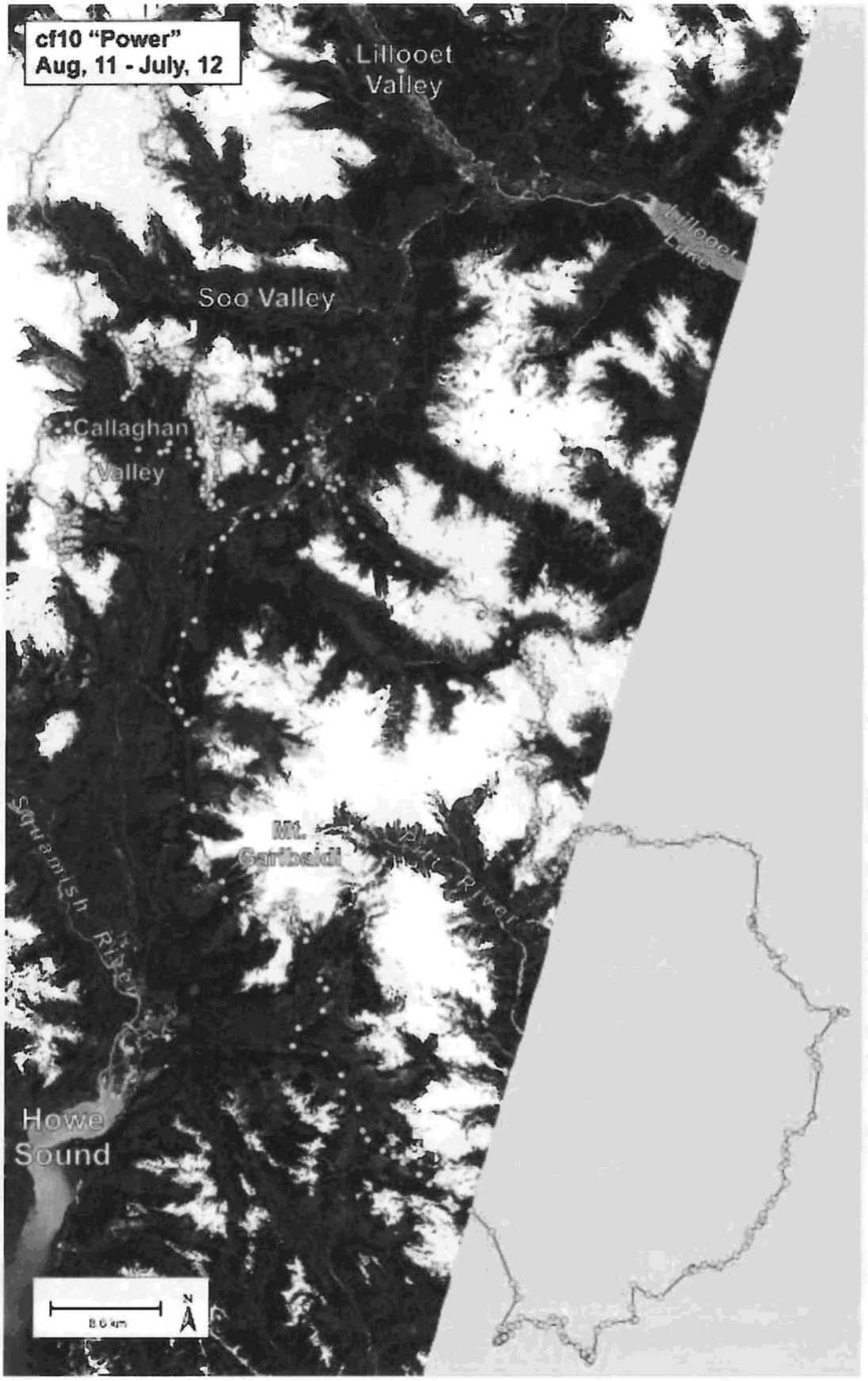

Figure 36. Known movement by grizzly bear CF10 ("Power") during 2012 and since previous data download.

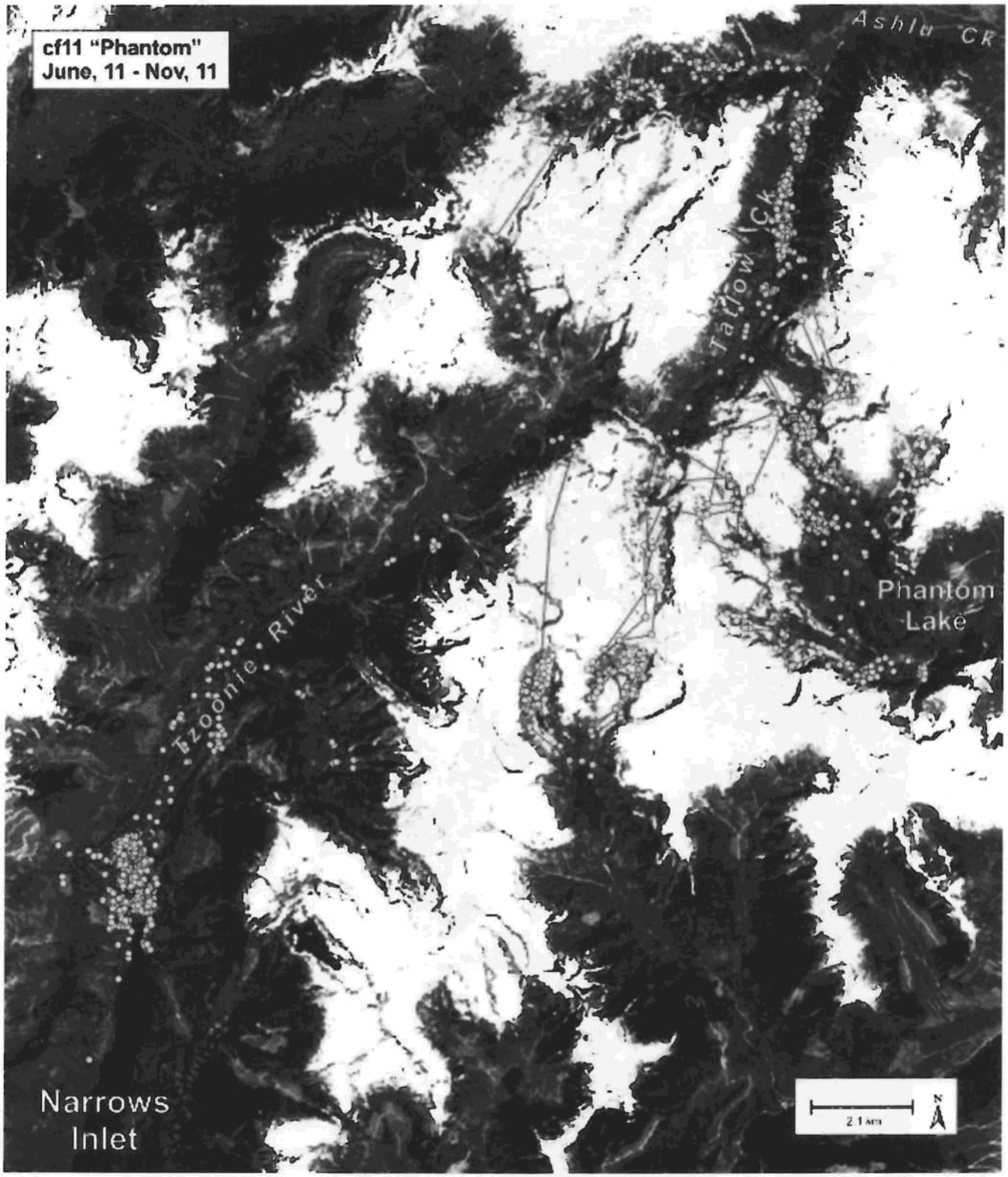

Figure 37. Known movement by grizzly bear CF11 ("Phantom") during 2012 and since previous data download.

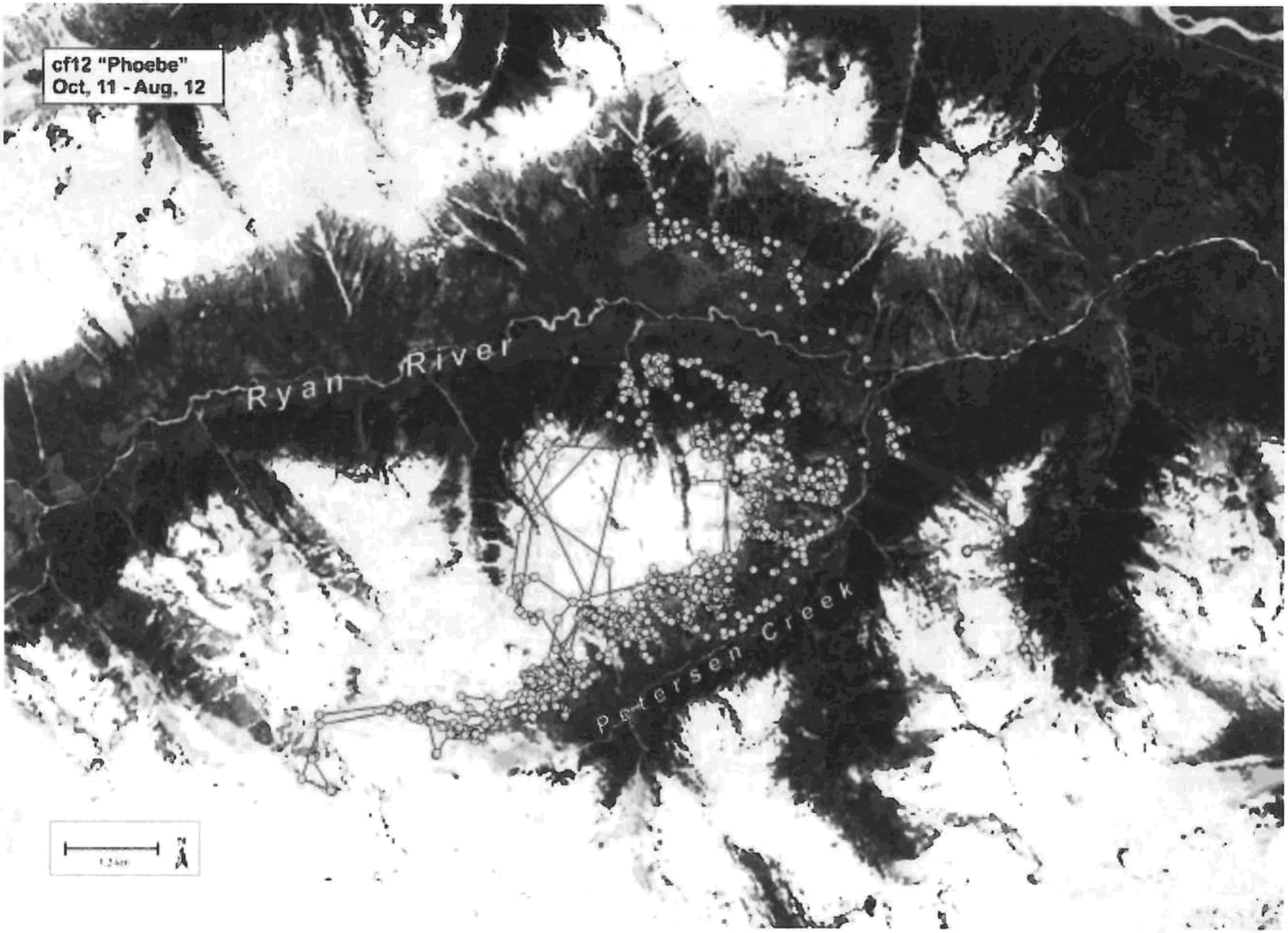

Figure 38. Known movement by grizzly bear CF12 ("Phoebe") during 2012 and since previous data download.

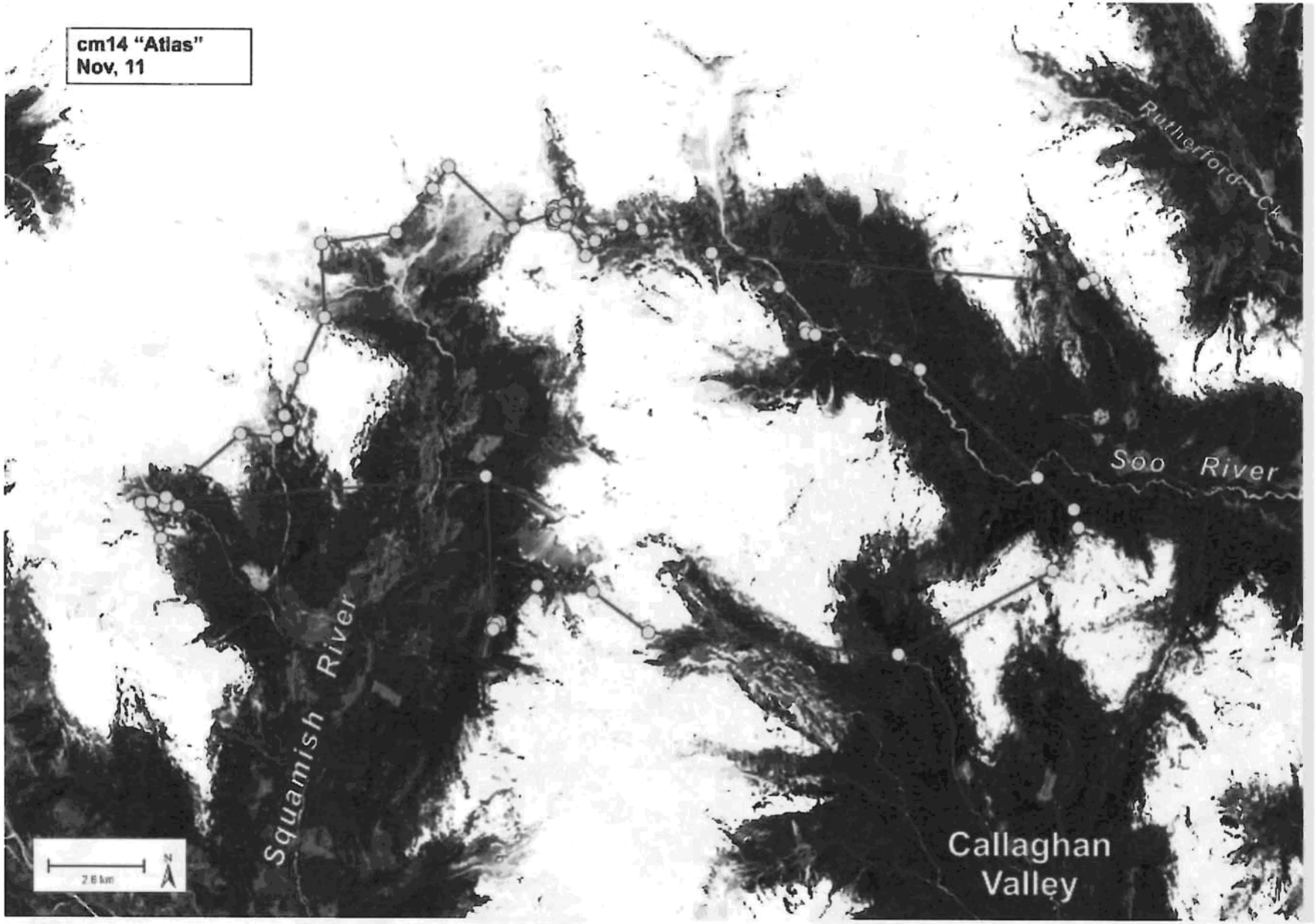

Figure 39. Known movement by grizzly bear CM14 ("Atlas") during 2012 and since previous data download.

Figure 40. Known movement by grizzly bear CM14 ("Atlas") during 2013 and since previous data download.

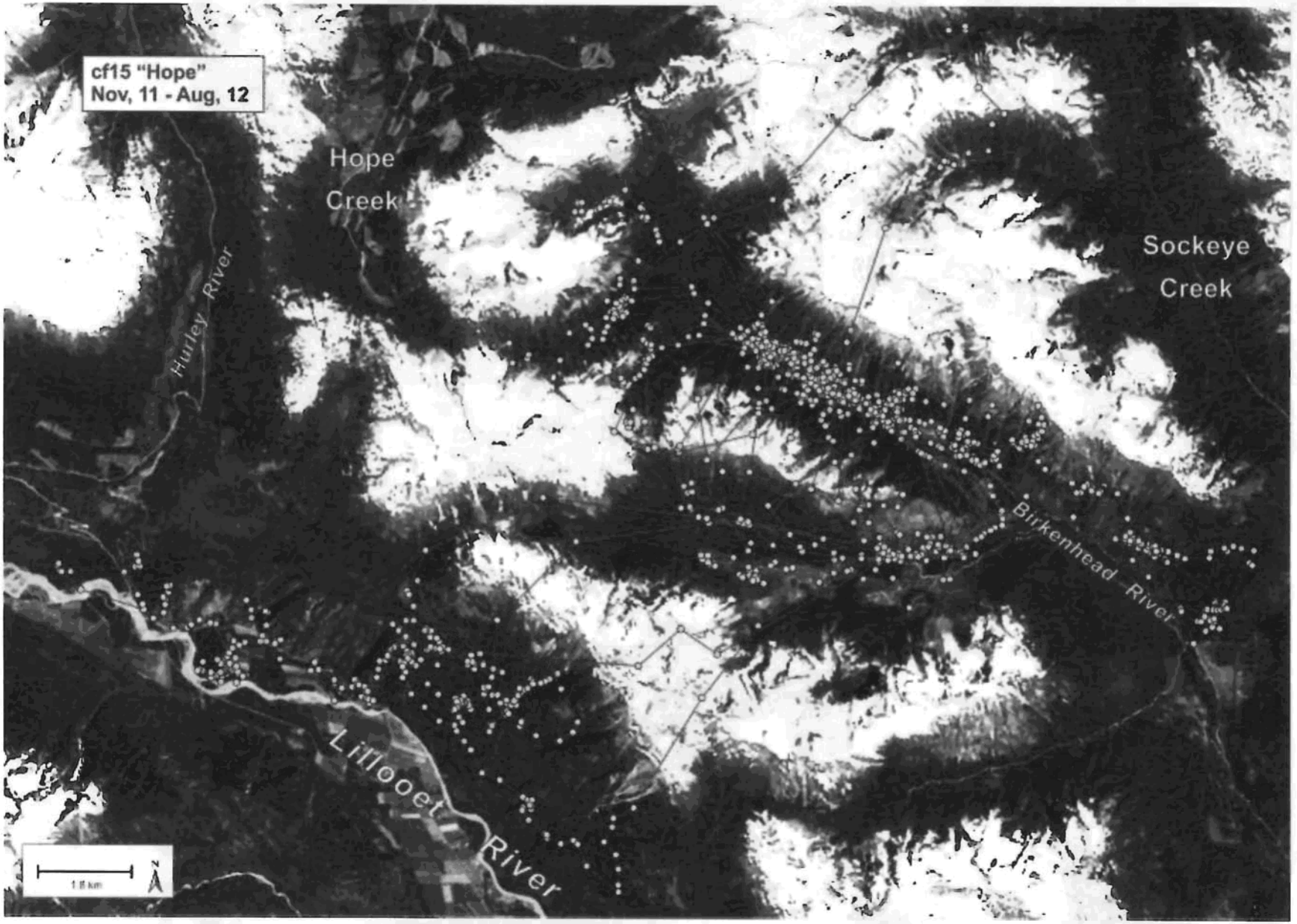

Figure 41. Known movement by grizzly bear CF15 ("Hope") during 2012 and since previous data download.

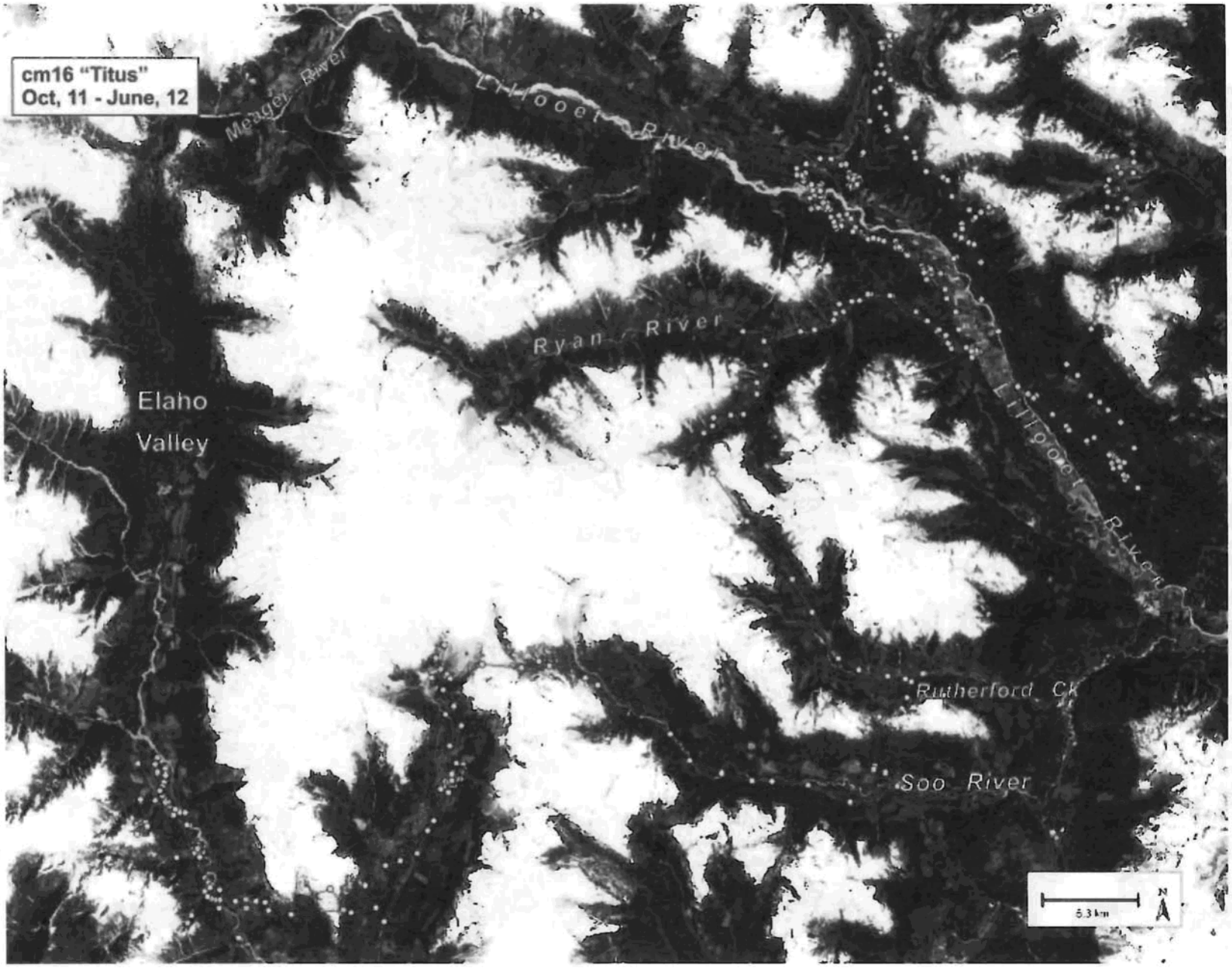

Figure 42. Known movement by grizzly bear CM16 ("Titus") during 2012 and since previous data download.

Figure 43. Known movement by grizzly bear CM17 ("Huck") during 2012 and since previous data download.

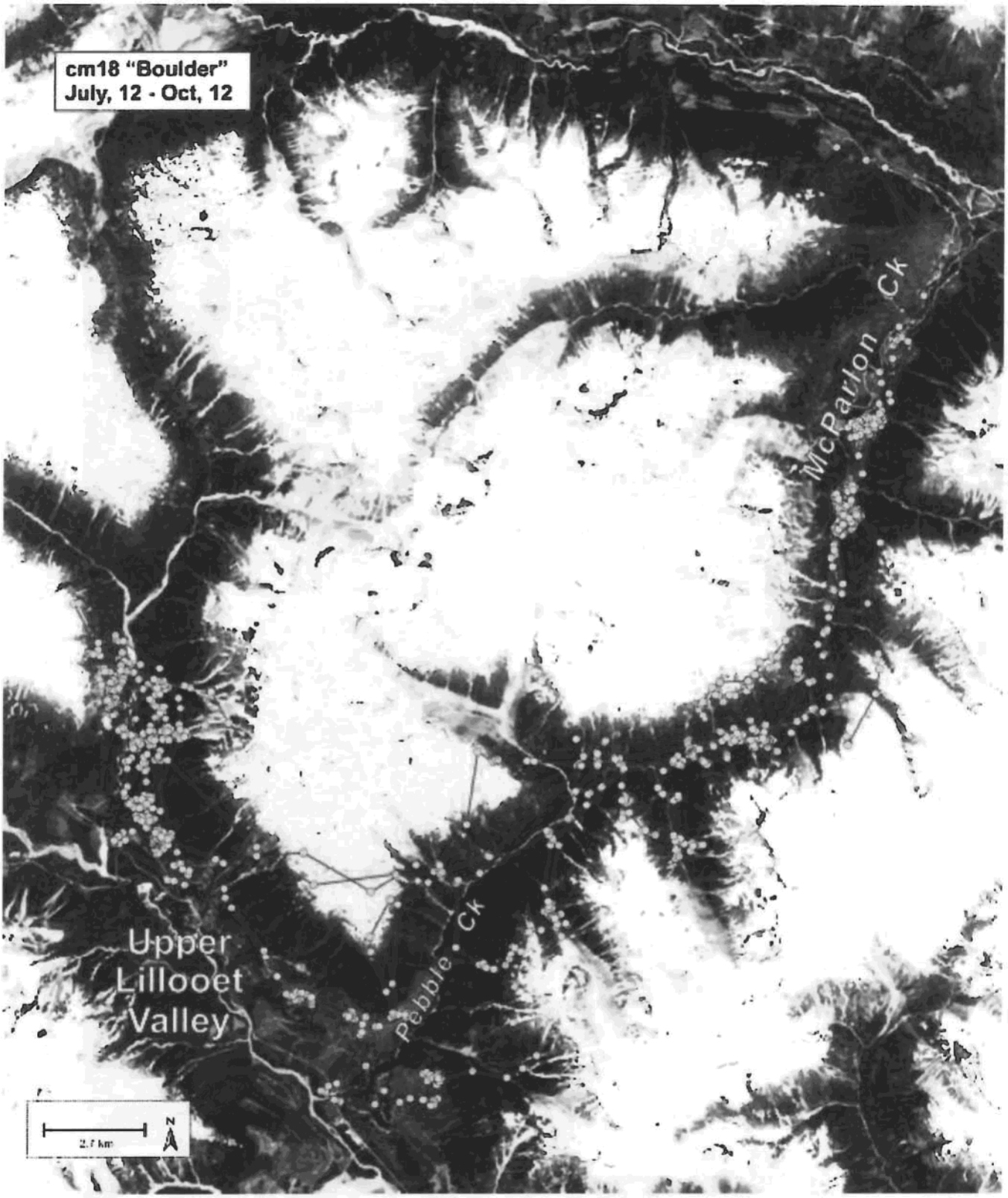

Figure 44. Known movement by grizzly bear CM18 ("Boulder") during 2012 and since previous data download.

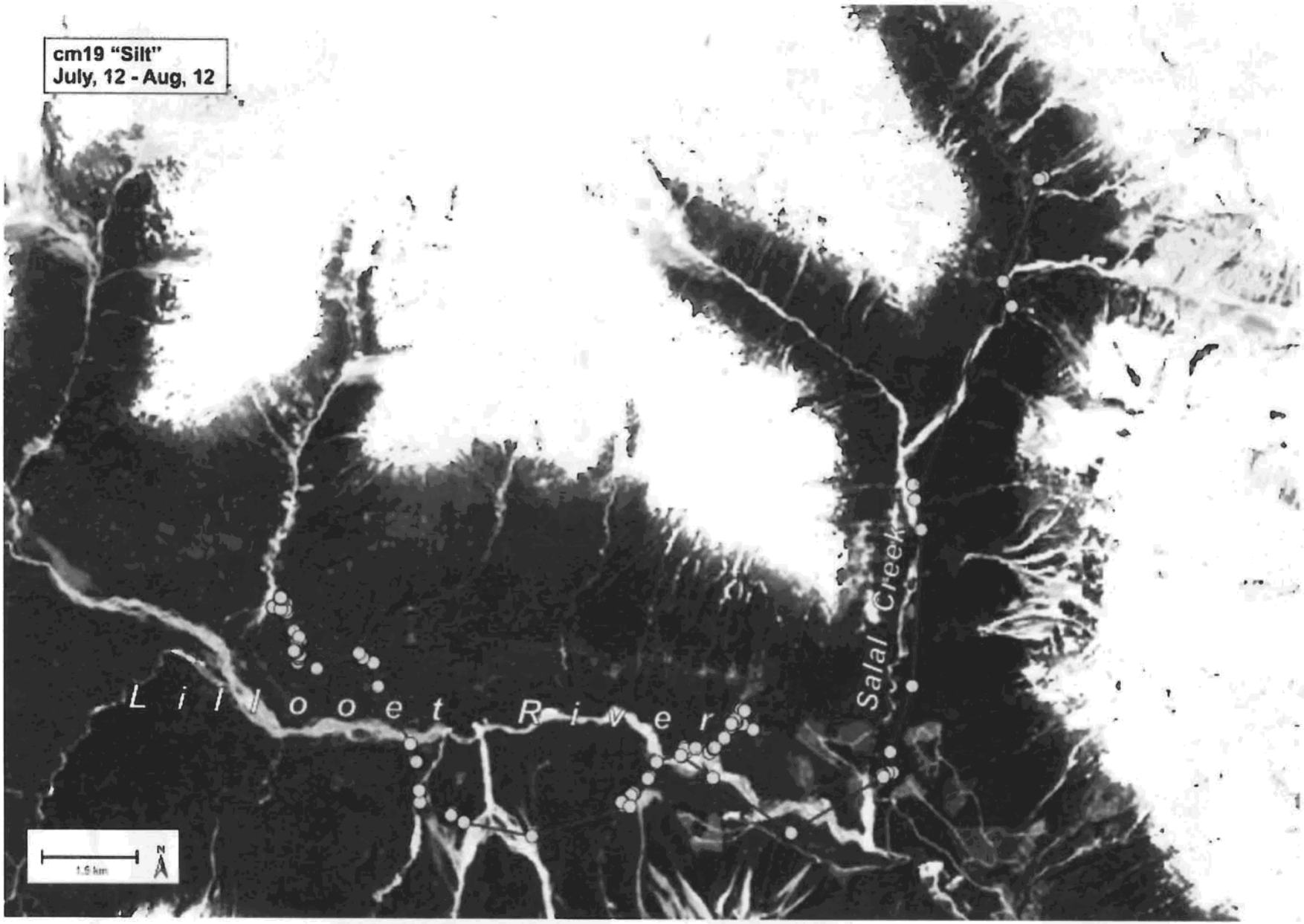

Figure 45. Known movement by grizzly bear CM19 ("Silt") during 2012 and since previous data download.

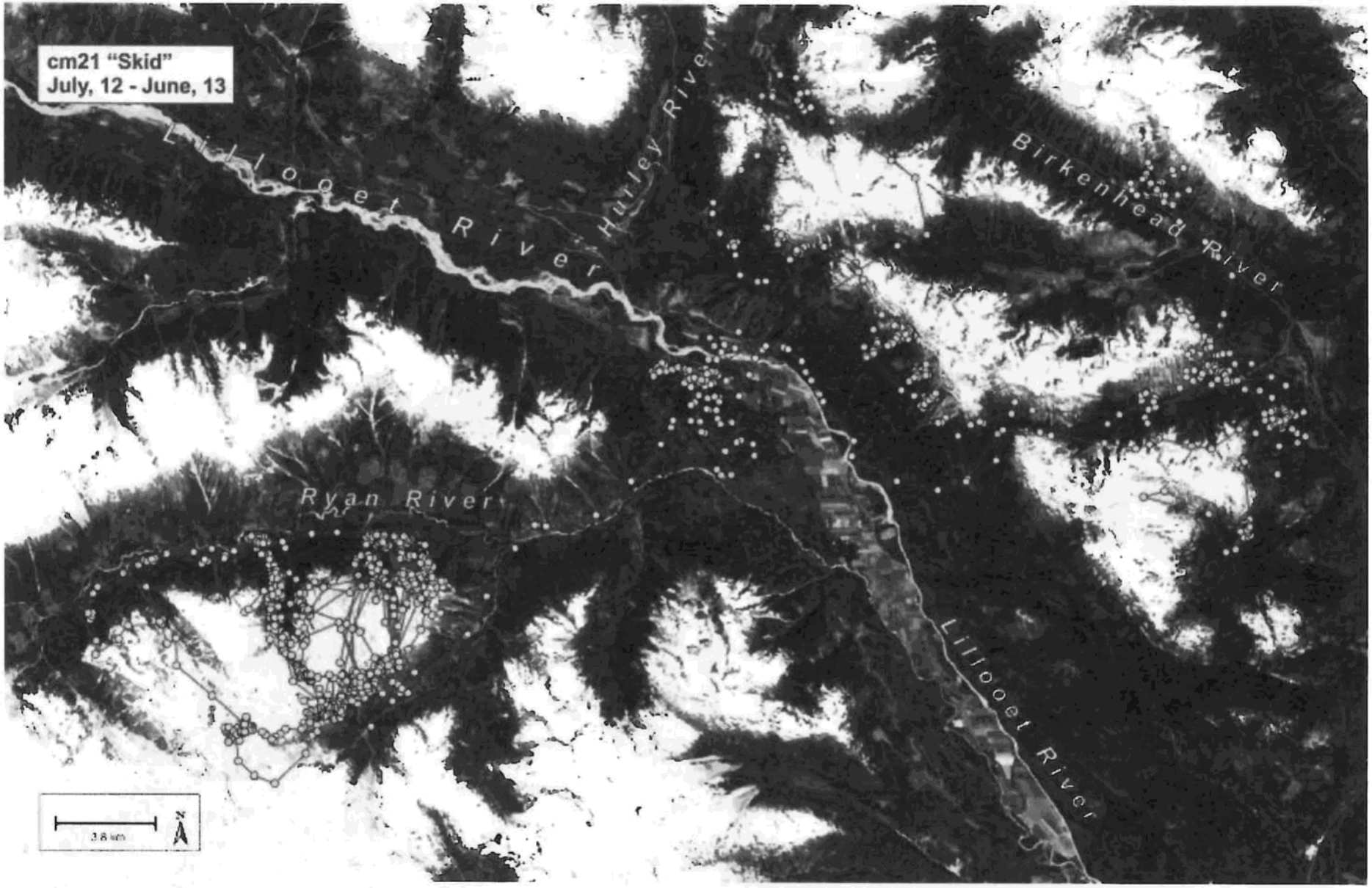

Figure 46. Known movement by grizzly bear CM21 ("Skid") during 2012 & 2013 and since previous data download.

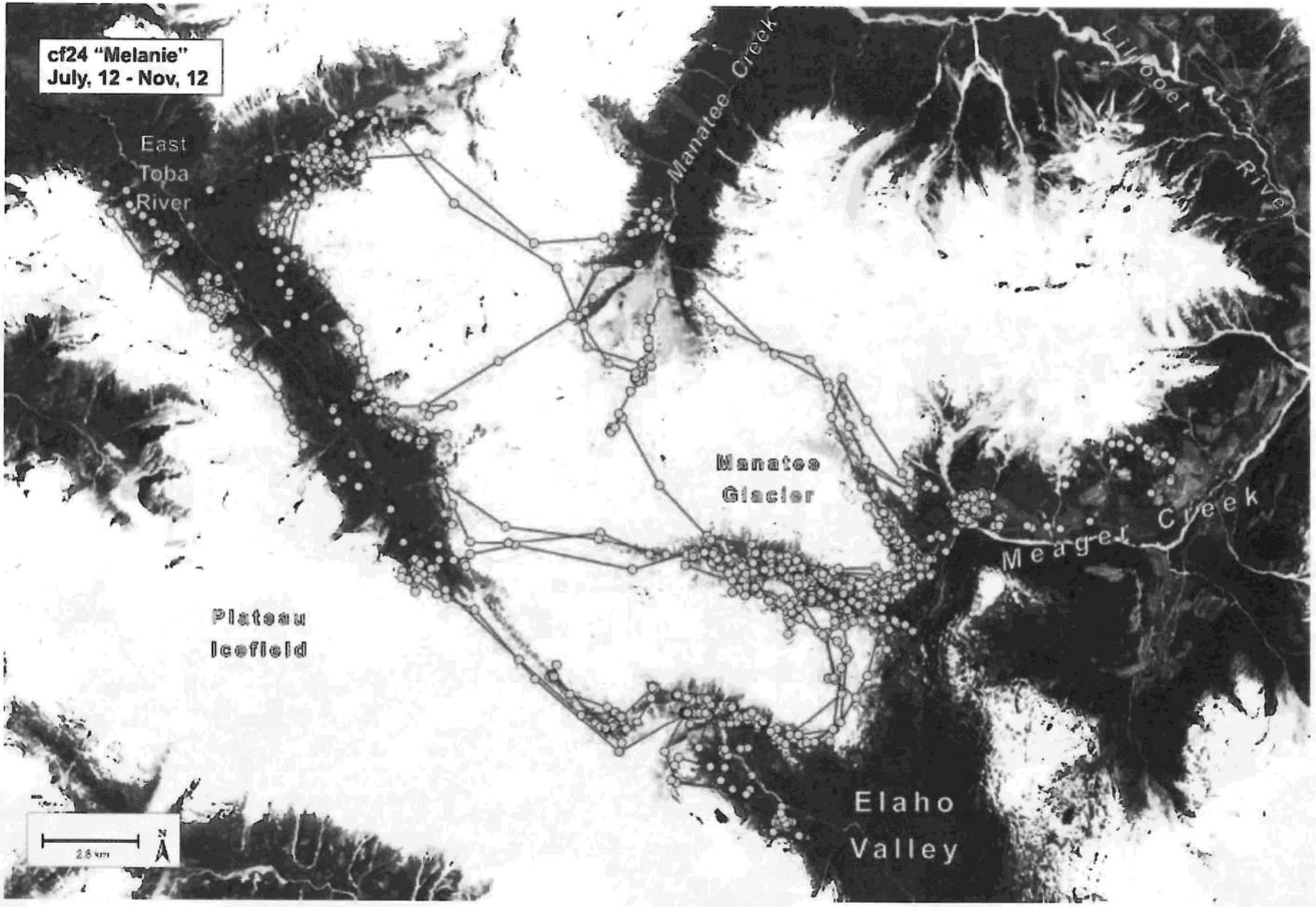

Figure 47. Known movement by grizzly bear CF24 ("Melanie") during 2012 and since previous data download.

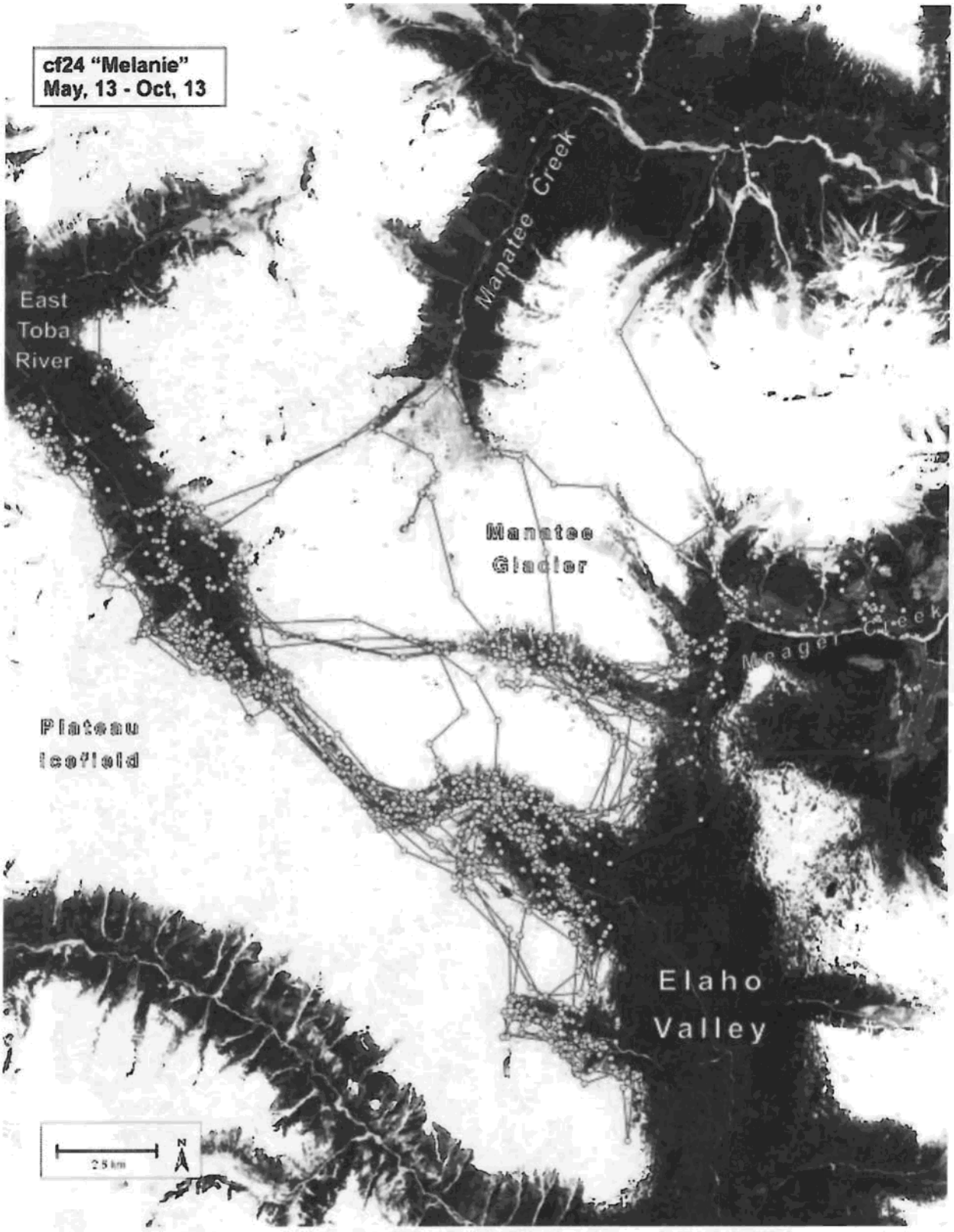

Figure 48. Known movement by grizzly bear CF24 ("Melanie") during 2013 and since previous data download.

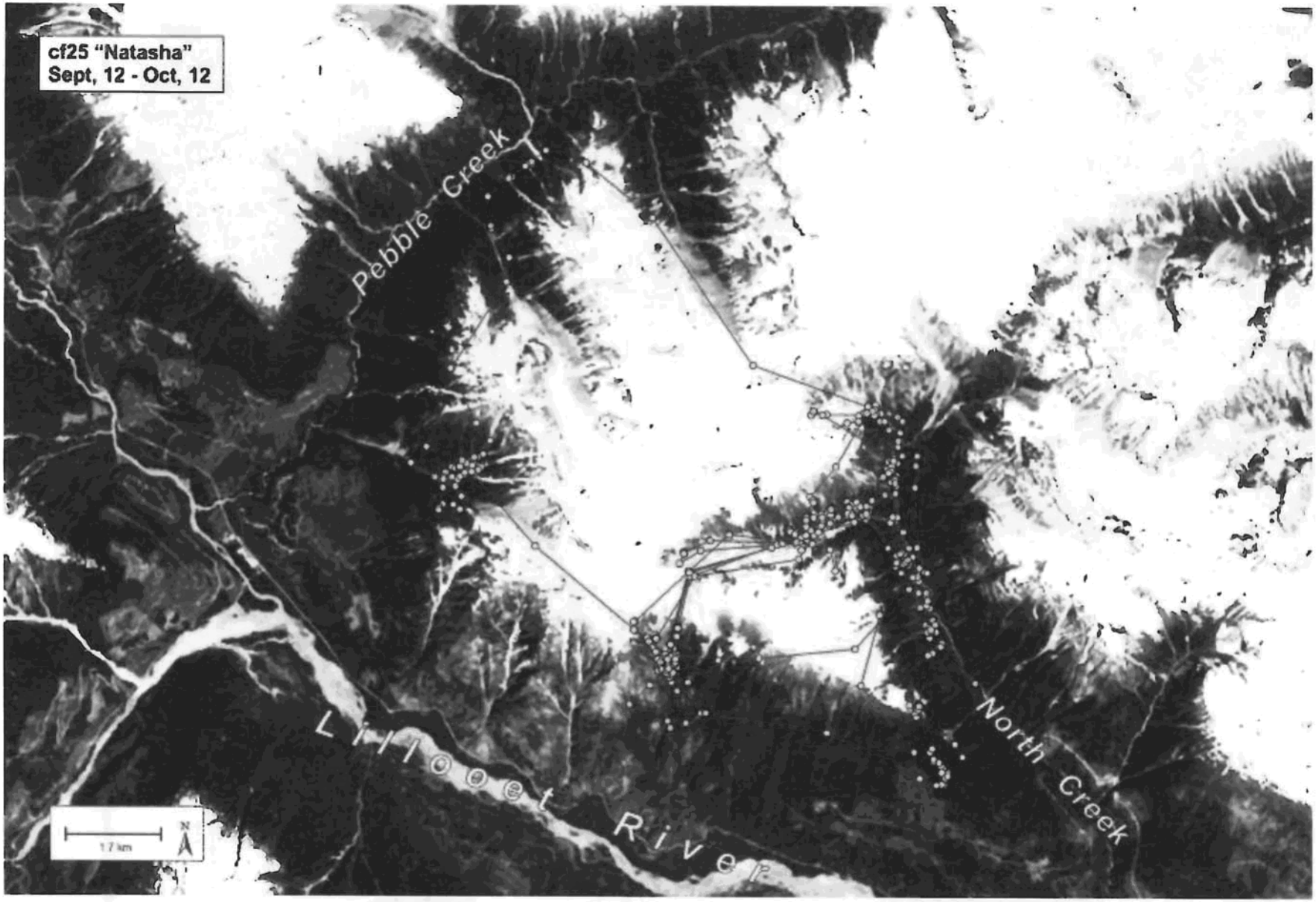

Figure 49. Known movement by grizzly bear CF25 ("Natasha") during 2012 and since previous data download.

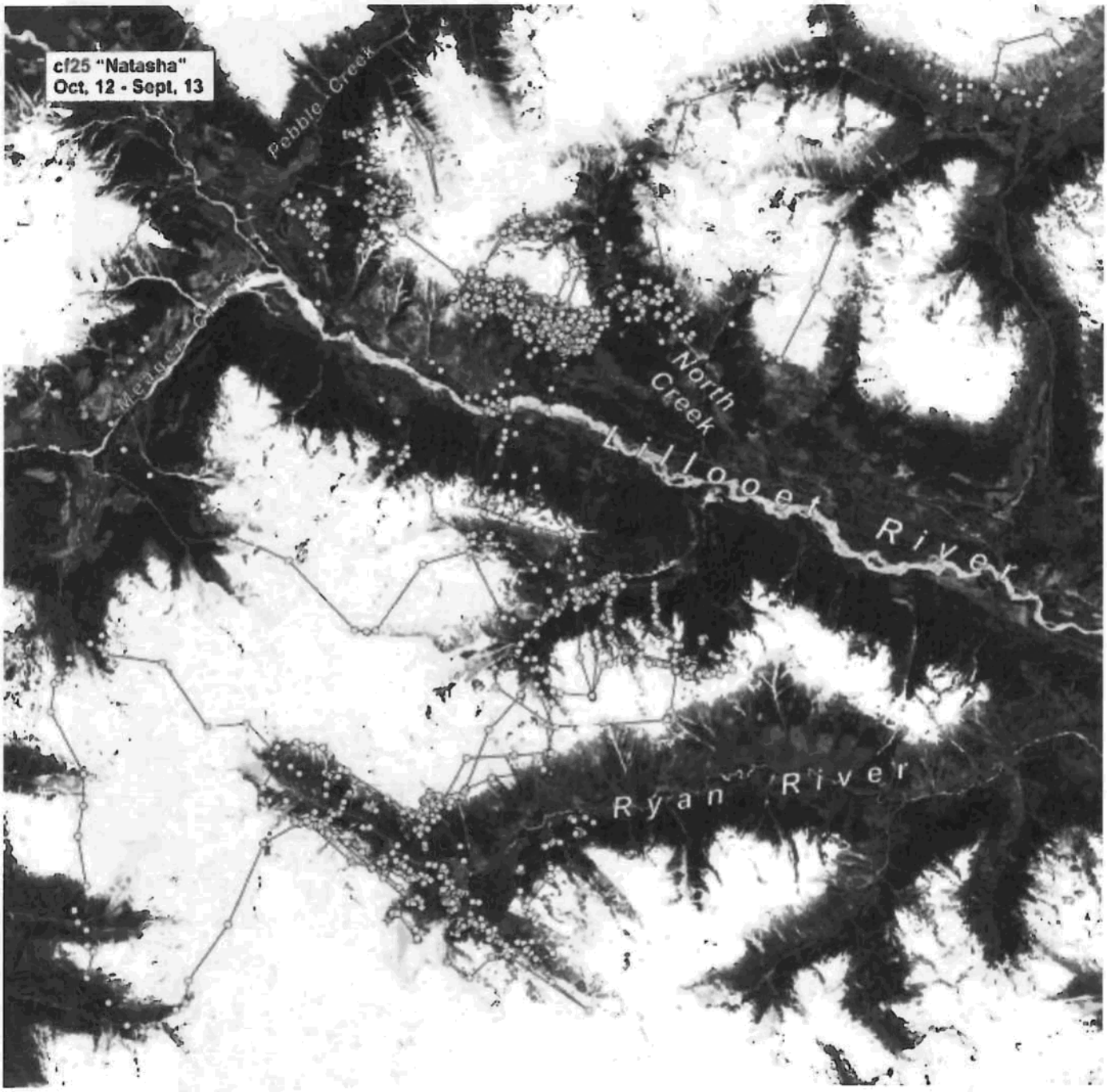

Figure 50. Known movement by grizzly bear CF25 ("Natasha") during 2013 and since previous data download.

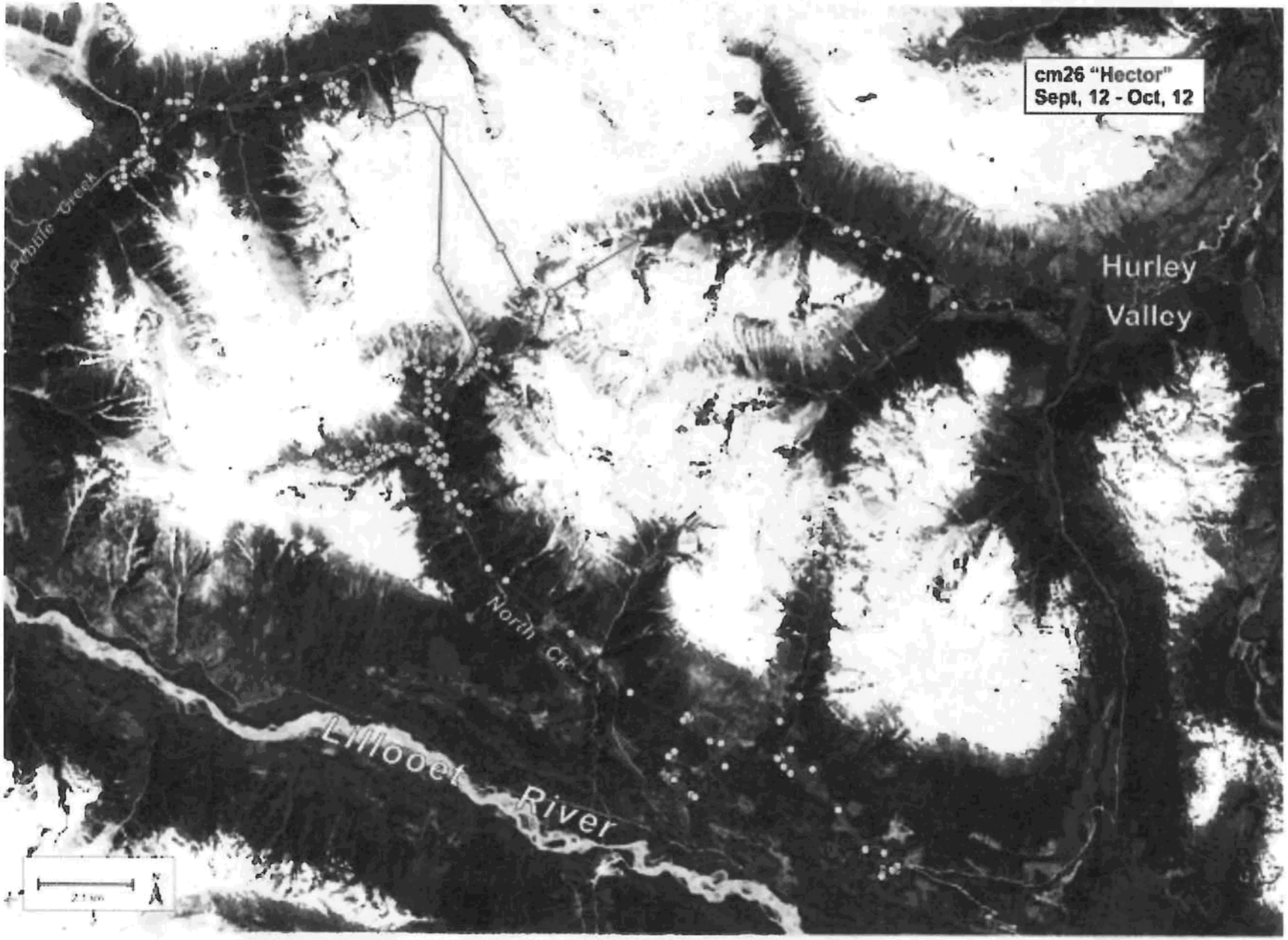

Figure 51. Known movement by grizzly bear CM26 ("Hector") during 2012 and since previous data download.

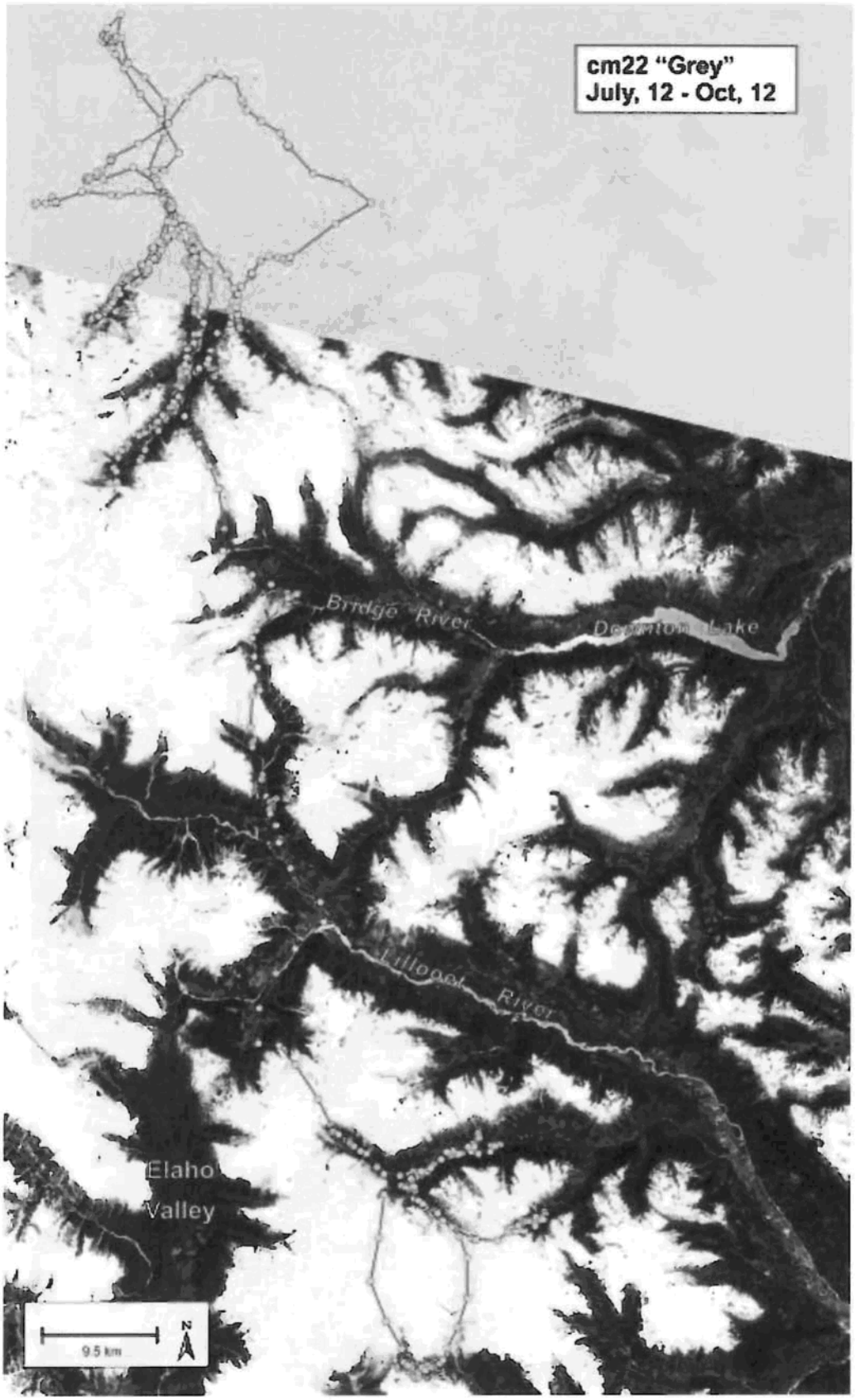

Figure 52. Known movement by grizzly bear CM22 ("Grey") during 2012 and since previous data download.

Figure 53. Known movement by grizzly bear CM22 ("Grey") during 2013 and since previous data download.

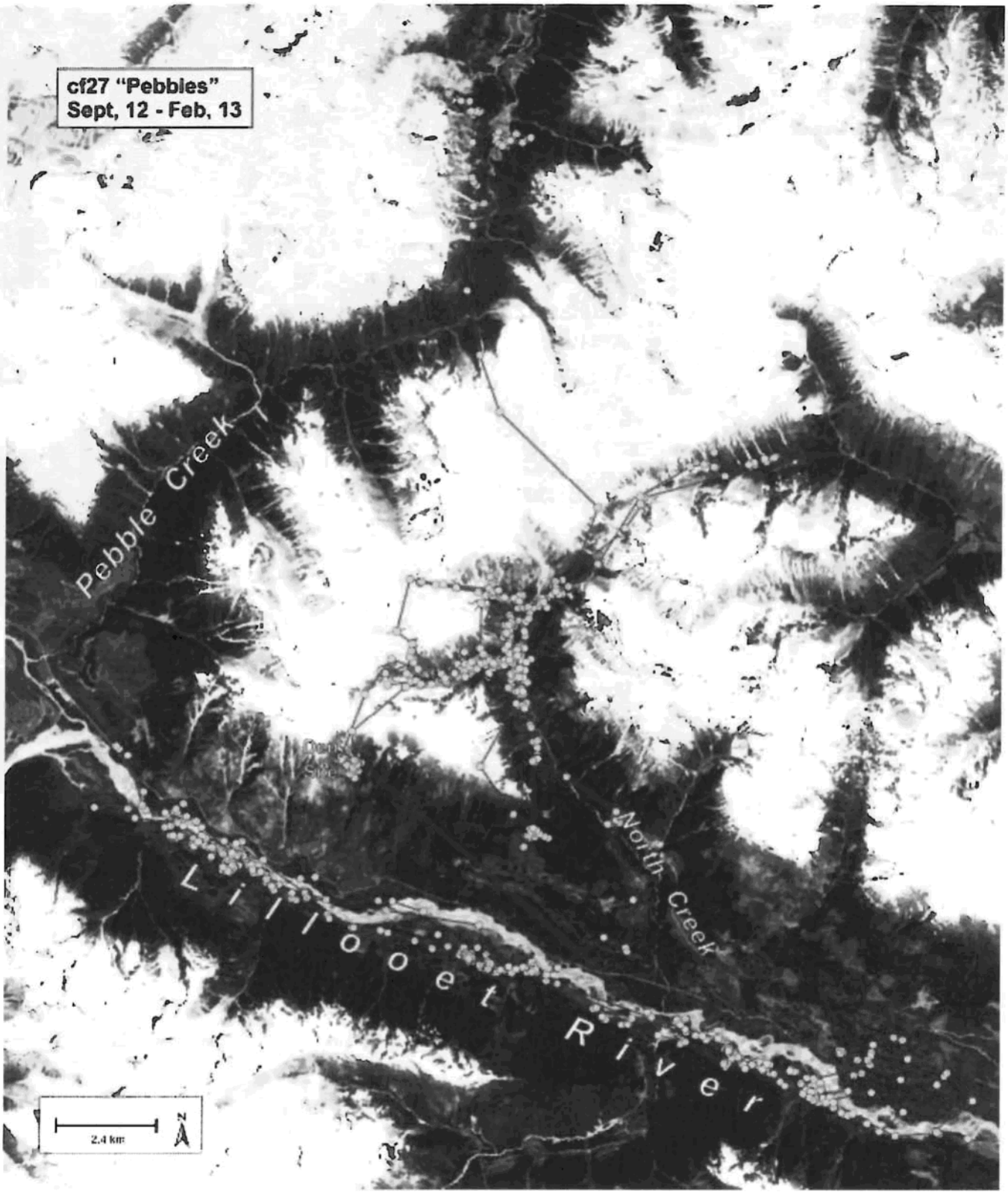

Figure 54. Known movement by grizzly bear CF22 ("Pebbles") during 2012 and since previous data download.

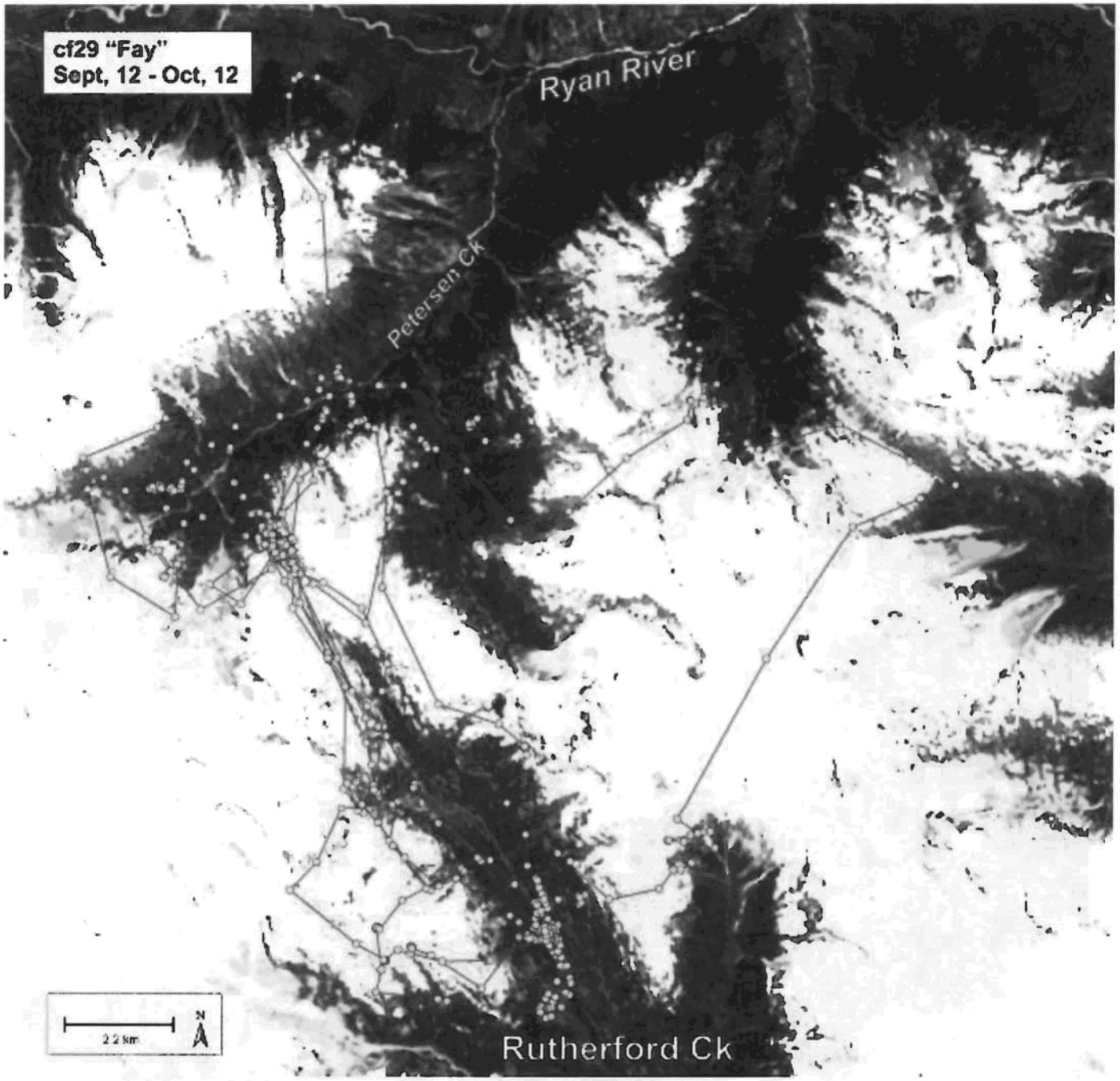

Figure 55. Known movement by grizzly bear CF29 ("Fay") during 2012 and since previous data download.

Figure 56. Known movement by grizzly bear CF20 ("Harriet") during 2012 & 2013.

LITERATURE CITED

Apps, C. D., and B. N. McLellan. 2008. Grizzly bear habitat selection and suitability across multiple scales in the Flathead and lower Elk drainages, British Columbia. Aspen Wildlife Research, and Ministry of Forests and Range, Revelstoke, British Columbia.

Apps, C. D., B. N. McLellan, J. G. Woods, and M. F. Proctor. 2004. Estimating grizzly bear distribution and abundance relative to habitat and human influence. Journal of Wildlife Management 68:138-152.

Apps, C., D. Paetkau, S. Rochetta, B. McLellan, A. Hamilton, and B. Bateman. 2014. Grizzly bear population abundance, distribution, and connectivity across British Columbia's southern Coast Ranges. Version 2.0. Aspen Wildlife Research and Ministry of Environment, Victoria, British Columbia.

Boyce, M. S., P. R. Vernier, S. E. Nielsen, and F. K. A. Schmiegelow. 2002. Evaluating resource selection functions. Ecological Modelling 157:281-300.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information theoretic approach. Springer-Verlag, New York, New York, USA.

CCAC (Canadian Council on Animal Care). 2003. Guidelines on the care and use of wildlife. Canadian Council on Animal Care, Ottawa, ON. http://www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/GDLINES/Guidelis.htm

Hamilton, A. N., D. C. Heard, and M. A. Austin. 2004. British Columbia grizzly bear (*Ursus arctos*) population estimate 2004. British Columbia Ministry of Water Land, and Air Protection, Biodiversity Branch. Victoria.

Kareiva, P., and U. Wennergren. 1995. Connecting landscape patterns to ecosystem and population processes. Nature 373:299-302.

McLellan, B. N. 1998. Maintaining viability of brown bears along the southern fringe of their distribution. Ursus 10:607-611.

Ritchie, M. E. 1997. Populations in a landscape context: sources, sinks, and metapopulations. Pages 160-184 in J. A. Bissonette, editor. Wildlife and landscape ecology: effects of pattern and scale. Springer, New York, New York, USA.

Woodbury, M. R., ed. 1996. The chemical immobilization of wildlife. Canadian Association of Zoo and Wildlife Veterinarians, Winnipeg, Manitoba, Canada.

APPENDIX 1. Capture/collaring details & status of study animals within the Sea to Sky Planning Area & environs.

Study Animal	CF01	CF02	CM03	CF04	CF05	CM06	CF07	CM08
Name	Ashley	Callie	Kahn	Daphne	Chloe	Mercury	Rhea	Keith
Capture/Recapture Date	03/08/2007	11/08/2007	11/08/2007	22/06/2008	23/06/2008	25/06/2008	07/07/2008	02/10/2008
Recapture?	no	no	no	no	no	no	no	no
Capture Method	Snare	Snare	Snare	Snare	Snare	Snare	Snare	heli-darting
Capture Location	Deserted Pass	Upper Callaghan	Deserted Pass	upper Peterson	Rutherford	Rutherford	upper Ashlu	upper Ashlu
Coordinates	456159E, 5547926N	481849E, 5562360N	455204E, 5550528N	488653E, 5582958N	496673E, 5576836N	496673E, 5576836N	456460E, 5547336N	456996E, 5547468N
Ear Tag Left	none	none	none		301 Red	325 Red	321 Red	322 Red
Ear Tag Right	none	none	none	313 Red				
Sex	female	female	male	female	female	male	female	male
Age Class	adult	adult	adult	adult	adult	adult	adult	adult
Est. Age	6 - 7	12	14-15	4	6	6	17	20
Related bears at site?	no	no	no	no	no	no	no	no
Lactating?	no	no	n/a	no	no	n/a	no	n/a
Wt at Capture (lbs)	est 220	240	est 500+/- 100	145	210	310	390	--
Zool. Length (cm)		188	200	163	166	183	190	206
Collar (Lotek GPS)	4400M	4400M	4400M	4400M	4400M	4400M	4400M	4400M
Collar ID	1344	1451	1343	1349	1348	1452	1345	1342
Collar Frequency	150.439	150.681	150.281	150.980	150.879	150.740	150.539	150.340
Date of Last Download	Sep-07	Oct-07	Sep-07	Oct-08	n/a	Oct-08	Oct-08	Oct-08
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	0.68	0.87	0.65	0.89	--	0.86	0.79	0.87
Status	uncollared	uncollared	uncollared	uncollared	uncertain	uncollared	uncollared	uncollared
Dead?	unknown	unknown	unknown	unknown	unknown	unknown	no	unknown
Mortality Cause	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Last Live Location	18/09/2007	06/10/2007	05/09/2007	23/10/2008	12/10/2008	14/06/2009	23/10/2008	18/06/2009
Collar Retrieved?	yes	yes	yes	Yes	no	Yes	no	yes
Match to DNA Sampling	F53	F93	M58	F88	F22	M176	F55	M56

Study Animal	CF02	CM09	CF10	CF11	CF01	CF12	CF13	CM14
Name	Callie	Bruno	Power	Phantom	Ashley	Phoebe	Juno	Atlas
Capture/Recapture Date	11/06/2010	12/06/2010	11/06/2010	24/07/2010	24/07/2010	27/07/2010	27/07/2010	27/07/2010
Recapture?	yes	no	no	no	yes	no	no	no
Capture Method	heli-darting	heli-darting	heli-darting	Snare	Heli-darting	snare	snare	snare
Capture Location	Brandy wine	Ryan	Rutherford	Clowhom Pass	Upper Ashlu	back Petersen	upper Ryan	Rutherford
Coordinates	485392E, 5545931N	TBA	501322E, 5570170N	463025E, 5526819N	457449E, 5545950N	490452E, 5582591N	473936E, 5588891N	496294E, 5576187N
Ear Tag Left			335 Red	345 Red		348 Red		
Ear Tag Right	332 Red	309 Red			306 Red		331 Red	305 Red
Sex	female	male	female	female	female	female	female	male
Age Class	adult	adult	adult	adult	adult	adult	adult	adult
Est. Age		20	18	9	14	10	15	17
Related bears at site?	2 COY	no	breeding male	3 COY	2-3 yr cubs snared	2 2-yr cubs	at least 1 cub	no
Lactating?	n/a	n/a	no	yes	n/a	yes	yes	n/a
Wt at Capture (lbs)	245	478	245	215	348	200	250	450 (est)
Zool. Length (cm)	174	193	170	168	184	164	175	186
Collar (Lotek GPS)	4400M	4400M	4400M	4400M	4400M	4400M	4400M	4400M
Collar ID	1347	1960	1346	1451	1344	1452	1343	919
Collar Frequency	150.778	150.959	150.640	150.681	150.439	150.740	150.281	151.649
Date of Last Download	Oct-11	Nov-10	Oct-11	Jun-11	Jun-11	Jun-11	May-11	Oct-11
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	0.91	0.93	0.90	0.81	0.84	0.87	0.88	0.55
Status	uncollared	uncollared	uncollared	uncollared	uncollared	uncollared	uncollared	uncollared
Dead?	no	unknown	unknown	unknown	unknown	unknown	yes	no
Mortality Cause	n/a	n/a	n/a	n/a	n/a	n/a	avalanche	n/a
Last Live Location	27/11/2011	27/11/2010	06/07/2012	21/11/2011	17/10/2010	26/06/2011	22/05/2011	09/11/2011
Collar Retrieved?	yes	yes	yes	yes	no	yes	yes	yes
Match to DNA Sampling	F93	M262	F89	F25	F53	F327	F13	M30

Study Animal	CF15	CF12	CM16	CM17	CF02	CM18	CM19	CF20
Name	Hope	Phoebe	Titus	Huck	Callie	Boulder	Silt	Harriet
Capture/Recapture Date	02/08/2011	04/08/2011	04/08/2011	22/09/2011	04/07/2012	19/07/2012	20/07/2012	20/07/2012
Recapture?	no	no	no	no	yes	no	no	no
Capture Method	snare	snare	snare	snare	helicopter	snare	snare	snare
Capture Location	Headqrters Pass	back Petersen	back Petersen	Tenquille Ck	Callaghan	Pebble Ck	Upper Lillooet	Hurley
Coordinates	503396E, 5603056N	490452E, 5582591N	490452E, 5582591N	511415E, 5596443N	484470E, 5548153N	479424E, 5616777N	457087E, 5617870N	TBD
Ear Tag Left	351 Red	348 Red					601 blue	602 blue
Ear Tag Right			358 Red	359 Red				
Sex	female	female	male	male	female	male	male	female
Age Class	adult	adult	adult	adult	adult	adult	adult	adult
Est. Age	12	9	8	720 (??)		41974	12	19
Related bears at site?	2 or maybe 3 yearlings	no, just CM16 Titus	no, just CF12 Phoebe	no	no	no	no	2 yearlings
Lactating?	n/a	n/a	n/a	n/a	no	n/a	n/a	no
Wt at Capture (lbs)	265	285	245	474	190	375	395	203
Zool. Length (cm)	179	169	176	206	170	188	197	170
Collar (Lotek GPS)	7000MU	7000MU	4400M	7000MU	7000MU	7000MU	IridiumTrack	7000MU
Collar ID	31751	31752	1342	31747	1348	1450	33016	523
Collar Frequency	150.838	150.818	150.340	150.939	150.879	150.589	150.380	149.298
Date of Last Download	Oct-11	Oct-11	Nov-11	Oct-12	Sept-13	Oct-12	n/a	Sept-13
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	0.96	0.97	0.91	0.92	TBD	TBD	TBD	TBD
Status	uncollared	uncollared	uncollared	uncollared	collared	collared	collar in recovery	collared
Dead?	no	no	no	no	no	no	no	no
Mortality Cause	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Last Live Location	02/08/2012	27/08/2012	17/06/2012	11/10/2012	13/09/2013	11/10/2012	11/08/2012	11/09/2013
Collar Retrieved?	yes	yes	yes	yes	no	no	no	no
Match to DNA Sampling	F139	F327	M249	M105	F93	M112	M256	F103

Study Animal	CM21	CM22	CM23	CF24	CF25	CM26	CF27	CM14
Name	Skid	Grey	Shaggy	Melanie	Natasha	Hector	Pebbles	Atlas
Capture/Recapture Date	24/07/2012	24/07/2012	24/07/2012	29/07/2012	15/09/2012	16/09/2012	16/09/2012	16/09/2012
Recapture?	no	no	no	no	no	no	no	yes
Capture Method	snare	snare	snare	helicopter	helicopter	helicopter	helicopter	helicopter
Capture Location	back Petersen	Petersen	back Ryan	back Meager	North Creek	Hurley	Pebble/McPa rlon Pass	Rutherford
Coordinates	484602E, 5582543N	488661E, 5582480N	TBD	455780E, 5599686N	481173E, 5608494N	494867E, 5612234N	482849E, 5622463N	494501E, 5569558N
Ear Tag Left		603 blue			357 red			
Ear Tag Right	604 blue		605 blue	606 blue				305 red
Sex	male	male	male	female	female	male	female	male
Age Class	subadult	adult	adult	adult	adult	adult	adult	adult
Est. Age	3 to 4	15		7	15	15		
Related bears at site?	no	no	no	no	no	no	2 yearling cubs	no
Lactating?	n/a	n/a	n/a	no	no	n/a	no	n/a
Wt at Capture (lbs)	193	398	293	350(est)	398	498	343	402
Zool. Length (cm)	161	196	188	179	175	198	178	186
Collar (Lotek GPS)	IridiumTrack	7000MU	7000MU	IridiumTrack	IridiumTrack	IridiumTrack	IridiumTrack	7000MU
Collar ID	33021	1960	1452	33018	33019	33015	33020	920
Collar Frequency	150.800	150.959	150.740	150.480	150.520	150.310	150.760	151.547
Date of Last Download	n/a	Sept-13		n/a	n/a	n/a	n/a	Sept-13
Fix Interval (hrs)	1:00	1:00	1:00	1:00	1:00	1:00	1:00	1:00
Fix Success Rate	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Status	collared	collared	collared	collared	collared	uncollared	uncollared	collared
Dead?	no	no	no	no	no	yes	no	no
Mortality Cause	n/a	n/a	n/a	n/a	n/a	shot	n/a	n/a
Last Live Location	21/06/2013	06/08/2013		01/11/2013	15/09/2013	28/10/2012	13/02/2013	23/07/2013
Collar Retrieved?	no	no	no	no	no	yes	yes	no
Match to DNA Sampling	M328	M14	M23	F143	F84	M101	F263	M30

Study Animal	CF28	CF29	CF30
Name	Peanut	Fay	Betty
Capture/Recapture Date	17/09/2012	18/09/2012	25/09/2013
Recapture?	no	no	no
Capture Method	helicopter	helicopter	helicopter
Capture Location		Ryan	Hope Ck
Coordinates	TBD	490467E, 5588752N	TBD
Ear Tag Left			
Ear Tag Right			304 red
Sex	female	female	Female
Age Class	subadult	adult	adult
Est. Age	3	14	8 to 10
Related bears at site?	sibling with her	no	no
Lactating?	no	no	
Wt at Capture (lbs)	203	318	
Zool. Length (cm)	160	164	169
Collar (Lotek GPS)	4400S	IridiumTrack	7000MU
Collar ID	1457	33017	1957
Collar Frequency	150.500	150.460	150.358
Date of Last Download		n/a	
Fix Interval (hrs)	1:00	1:00	1:00
Fix Success Rate	TBD	TBD	TBD
Status	collared	uncollared	collared
Dead?	no	no	no
Mortality Cause	n/a	n/a	n/a
Last Live Location		24/05/2013	
Collar Retrieved?	no	yes	no
Match to DNA Sampling	F382	F331	

APPENDIX 2.

HCTF PROGRAM-SPECIFIC REPORTING

Measures of Results

Over the study to date, we captured 30 (14M, 16F) study animals 35 times. These grizzly bears were captured by both helicopter-assisted ground-snaring as well as helicopter aerial darting. They were fit with either Lotek GPS7000MU collars or Lotek IridiumTrackM collars; both models were programmed for one-hour GPS fix attempts. As of fall 2013, twelve study animals (6M, 6F) were collared though one collar is non-functional and requires recovery. Three other collars were either slipped or released/rotted during the 2013 field season, and one other bear (CM26) died apparently due to being shot. These collars were recovered and the circumstances of the mortality were investigated. Through the summer and fall, periodic and opportunistic downloads were conducted on bears carrying UHF downloadable collars, and fixed-wing aircraft search and download flights were conducted in June and October. Data quality has been high, with GPS fix success ranging from 79 - 97%.

Although this study was still in a phase of data collection during 2013, there was significant work carried out with respect to communication and outreach. Much preliminary information has been transferred to the ecosystem management section and associated specialists of FLNRO through the annual summary report and associated data plots, coupled with informal interpretation. There has been much communication with FLNRO with respect to informing environmental assessment and proactive conservation measures. In addition to the annual report, graphics, powerpoint, and associated communication tools have and continue to be developed and updated.

Expected Benefits of the Study

Despite a wide range of land resource demands, there is little known of grizzly bear space-use and movement patterns or influential factors in the southern Coast Ranges. This information is important in evaluating, mitigating, and monitoring cumulative effects of existing and proposed resource development. Such knowledge can be especially valuable when also considered in the context of spatial predictions of population abundance, distribution and connectivity at the regional level. This study is appropriate for industry support, but partnership with HCTF is essential to such collaboration. As such, considerable value-added can be expected from HCTF funding. Without this study, assessment, mitigation and monitoring of cumulative effects will be based on assessments and/or subjective models with little to no empirical foundation. Such best-guess decision-making may compromise effective conservation to the goal of recovering and maintaining a healthy and viable regional grizzly bear population.

Extension/Public Information/Participation/Partners

Upon completion of analyses, project outputs will be disseminated in several ways including a website that will be launched to aid public extension subsequent to analyses, modeling and the derivation of associated planning tools.

Opportunities are being taken to communicate our research activities, preliminary results, and grizzly bear conservation issues to public, government, and industry groups. To this end, we have developed and are annually updating a poster describing grizzly bear research and conservation in the region. We have also developed a powerpoint presentation for delivery within appropriate venues. To date, the project has been featured and contributed to presentations that have included the Ministry of Environment (Region 4) annual general meeting, the WildLinks conferences with focus on Canada-US transboundary conservation of large carnivores between BC and the NW United States, as well as the International Bear Association 2011 conference in Ottawa. Beyond what can be provided through presentation, specifics of our work and preliminary results/outputs are detailed in our annual report. This includes text, tabular, and graphic (map) summaries of grizzly bear movements, behaviour, ecology, and associated landscape value. However, such data summaries do not reflect results and outputs based on appropriate analyses and interpretation, and raw data or associated plots are therefore not being released within the public realm. The annual summary report does, however, contain a caveat regarding interpretation of information intended to demonstrate progress. Finally, this research and its conservation utility has been discussed within occasional communications with local media coverage. Specifically, there was a major feature published in the Vancouver Sun that highlighted several aspects of this work, with input from project partners. HCTF is acknowledged in reports, posters, and presentations related to this work.

The study is a collaborative effort among Clayton Apps, Steve Rochetta (FLNRO) Bruce McLellan (FLNRO), and Tony Hamilton (MOE). Partnership funding this year has been through the provincial government and an industry contribution. Future partnerships may include industry and NGO groups, particularly in extension of outputs to conservation and recovery planning.

Photographic Record

Various aspects of field work (including capture) and both landscapes and site-specific habitat conditions within the study area have been documented using digital photo, video and remote cameras. Select photos are available to partners upon request.

South Coast Region
Grizzly Bear Inventory and Monitoring Plan – 2015-2020

Introduction

Grizzly bear information collection in SW British Columbia is entering a new phase in 2015: 1) a comprehensive summary of ten year's work on population abundance, distribution and connectivity is now complete and has been submitted for publication; 2) two major research projects are coming to a close (final reports are due in September 2015); and 3) an Environmental Impact Statement process has been initiated in the US North Cascades and BC has been called upon to participate in a decision about proceeding with Grizzly population restoration there.

On-going pressure for Grizzly bear recovery planning in SW BC is being exerted by the Coast to Cascades Grizzly Bear Coalition (C2C), who have the support of the St'at'imc First Nation, the Okanagan Nation Alliance, the Squamish First Nation and local community governments (e.g. in Whistler and Lillooet). C2C have repeatedly referenced a commitment in the Sea-to-Sky LRMP that calling for Grizzly recovery planning. Although government has recently decided not to proceed with recovery *planning*, Government's intention is very clear and has been communicated to C2C and their allies. The Natural Resource Sector is to use the Natural Resources Permitting Project's work on Cumulative Effects (CE) and Common Objectives to assist with delivering effective Grizzly conservation and management in SW BC.

The Grizzly bear CE team is nearing completion of their 1st Provincial Assessment of current conditions that is supported by the large body of Grizzly inventory, monitoring and research collected in SW BC since 2004. Although there is some indication of localized population expansion and reconnection, the BC North Cascades is functionally extirpated (only one male has been detected since 2010), the estimated 22 bears in the Stein Nahatlatch are the most highly related subpopulation of Grizzly bears in North America (having all been founded by a single breeding pair), and it is obvious that the Garibaldi Pitt does not have any resident adult females. Concurrently, the Squamish-Lillooet and South Chilcotin GBPUs continue to be subject to high levels of human influence, and many of the Grizzly and habitat indicators are well beyond the thresholds for population maintenance, let alone population recovery. Grizzly mortalities continue to exceed recruitment in numerous Landscape Units across the Regio, and a long list of Landscape Units remain unsuitable and ineffective for sustaining Grizzly bears because they are beyond objectives and thresholds for open road density, roadlessness, landscape-forage supply, stand level habitat protection, genetic and demographic linkage and human-caused mortality risk: all related to localized development, crop and livestock agriculture, communities, roads, highways, recreational facilities, front and back country recreation and expanding utility corridors.

The Sea to Sky LRMP called for the completion of a Regional Grizzly Inventory and Monitoring Plan, and that Plan's completion was also a required component of a successful Funding Contribution Agreement with Innergex signed in 2012. Additionally, one of the foundations of the Cumulative Effects Framework is that ongoing inventory and monitoring are essential components of its emphasis on adaptive management (Is mitigation being successful? Is recovery occurring? Is connectivity being maintained?)

The following report outlines the by GBPU priority objectives and strategies for regional Grizzly bear Inventory and monitoring from 2015 to 2020. A supporting bibliography of reports and publications is attached. Funding remains the biggest obstacle to successful plan implementation.

Monitoring and Inventory Objectives for the Garibaldi/Pitt GBPU

Objective 1: Understand GB population trend and demography by 2019

Strategy 1: Implement hair – snag/bait station DNA sampling within the Pitt, Indian,Stave, Sloquet,Tuwasus, Billygoat, Ure, Cheakamus and Mamquam drainages by 2015

Actions: a. Set up bait/hair snag stations and retrieve hair samples

a.1 – yearly trend analysis

a.2 – 5X5 DNA grids to complete mitigation effectiveness commitments for development issues

a.3 – understand population movements into formerly vacant adult female home ranges

b. Lab anaylsis of DNA

Strategy 2: Interpretation and write-up of DNA data describing population trend and demographics.

Actions: a. Yearly summary report

b. 5 year update report

Outcome: Summary report on current population trend and demography for the Garibaldi/Pitt GBPU. Input to Regional population and demography.

Objective 2: Attempt to understand spatial distribution of GB relation to influential factors

Strategy 1: GPS collar up to 10 grizzly bears within the Garibaldi/Pitt GBPU for 5 years by 2025

Actions: a. Use a combination of bait stations and helicopter collaring

b. Collar grizzly bears

c. download data

d. process and screen GPS point data

e. Map and summarize movement vectors, rates and space use

Strategy 2: Map and interpret relevant habitat data

Actions: a. Gather TEM data for the Garibaldi/Pitt GBPU

b. Map relevant environmental factors (human accessibility and activity)

Strategy 3: Correlate bear movement data to habitat and metrics of human activity

Actions: a. Analysis data and write update report

Outcome: Summary report

Costs:

Implementation of yearly on ground DNA trend analysis – staff time, vehicle costs, DNA analysis ($20K) materials including blood, camera's and batteries ($2K)

Implementation of 5X5 DNA effectiveness monitoring – varies depending on project area ($100K), funded largely by proponents.

Collaring – approx. $25K per collar (to buy, distribute, gather data and report) –up to 10 collars ($250K)

Monitoring and Inventory Objectives for the Stein/Nahatlatch GBPU

Objective 1: Understand GB population trend and demography by 2019

Strategy 1: Implement hair – snag/bait station DNA sampling within the Stein, Nahatlatch, Rogers, Gowan, Van Horlick, Boulder, Gott, Texas, Scuzzy, Spuzzum , Haylmore, drainages by 2015

Actions: a. Set up bait/hair snag stations and retrieve hair samples
a.1 – yearly trend analysis
a.2 – 5X5 DNA grids to complete mitigation effectiveness commitments for development issues
a.3 – understand population movements into formerly vacant adult female home ranges
b. Lab anaylsis of DNA

Strategy 2: Interpretation and write-up of DNA data describing population trend and demographics.

Actions: a. Yearly summary report
b. 5 year update report

Outcome: Summary report on current population trend and demography for the Stein/Nahatlatch GBPU. Input to Regional population and demography.

Objective 2: Attempt to understand spatial distribution of GB relation to influential factors

Strategy 1: GPS collar 10-20 grizzly bears within the Stein Nahatlatch GBPU for 5 years by 2017

Actions: a. Use a combination of bait stations and helicopter collaring
b. Collar grizzly bears
c. download data
d. process and screen GPS point data
e. Map and summarize movement vectors, rates and space use

Strategy 2: Map and interpret relevant habitat data

Actions: a. Gather TEM data for the Stein Nahatlatch GBPU
b. Map relevant environmental factors (human accessibility and activity)

Strategy 3: Correlate bear movement data to habitat and metrics of human activity

Actions: a. Analysis data and write update report

Outcome: Summary report

Costs:

Implementation of yearly on ground DNA trend analysis – staff time, vehicle costs, DNA analysis ($10K) materials including blood, camera's and batteries ($2K)
Implementation of 5X5 DNA effectiveness monitoring – varies depending on project area ($100K), funded largely by proponents.
Collaring – approx. $25K per collar (to buy, distribute, gather data and report) – 10 to 20 collars ($250-500K)

Monitoring and Inventory Objectives for the Squamish-Lillooet GBPU

Objective 1: Understand GB population trend and demography by 2019

Strategy 1: Implement hair – snag/bait station DNA sampling within the Squamish, Ashlu, Elaho, Roe, Brandywine, Callaghan, Soo, Rutherford, Ryan, drainages by 2015

Actions: a. Set up bait/hair snag stations and retrieve hair samples

a.1 – yearly trend analysis

a.2 – 5X5 DNA grids to complete mitigation effectiveness commitments for development issues

a.3 – understand population movements into formerly vacant adult female home ranges

b. Lab anaylsis of DNA

Strategy 2: Interpretation and write-up of DNA data describing population trend and demographics.

Actions: a. Yearly summary report

b. 5 year update report

Outcome: Summary report on current population trend and demography for the Squamish/Lillooet GBPU. Input to Regional population and demography.

Objective 2: Attempt to understand spatial distribution of GB relation to influential factors

Strategy 1: GPS collar 10-20 grizzly bears within the Squamish/Lillooet GBPU for 5 years by 2017

Actions: a. Use a combination of bait stations and helicopter collaring

b. Collar grizzly bears

c. download data

d. process and screen GPS point data

e. Map and summarize movement vectors, rates and space use

Strategy 2: Map and interpret relevant habitat data

Actions: a. Gather TEM data for the Squamish/Lillooet GBPU

b. Map relevant environmental factors (human accessibility and activity)

Strategy 3: Correlate bear movement data to habitat and metrics of human activity

Actions: a. Analysis data and write update report

Outcome: Summary report

Costs:

Implementation of yearly on ground DNA trend analysis – staff time, vehicle costs, DNA analysis ($10K) materials including blood, camera's and batteries ($2K)

Implementation of 5X5 DNA effectiveness monitoring – varies depending on project area ($100K), funded largely by proponents.

Collaring – approx. $25K per collar (to buy, distribute, gather data and report) – 10 to 20 collars ($250-500K)