2017/18 Rocky Mountain Trench Elk Inventory

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Executive summary

We conducted an aerial stratified random block survey in winter 2017/18 to inventory Rocky Mountain elk (*Cervus elaphus nelsoni*; hereafter elk) in the Rocky Mountain Trench (Invermere south to the US border; Management Units 4-02, 4-03, 4-04, 4-20, 4-21, 4-22, 4-24, 4-25, and 4-26). We divided the 3,351 km^2 study area into 172 blocks and stratified those blocks in a fixed-wing aircraft as either nil, low, medium, or high based on expected elk abundance. We then surveyed a randomly selected portion of each stratum in a helicopter: 29 (30%) of 97 low blocks, 21 (50%) of 42 medium blocks, and 20 (74%) of 27 high blocks. In total we surveyed 43% of the study area and our survey intensity was 2.4 min/km^2. We observed a total of 2,969 elk: 741 calves, 1,983 cows, 124 spike bulls, 91 raghorn bulls, 15 adult bulls, and 15 unclassified elk. The population estimate was 6,671 (90% CI = 5,764-7,578) for the entire study area. The estimated ratio of calves per 100 cows was 37.6 (90% CI = 30.7-44.5), and the estimated ratio of bulls per 100 cows was 13.9 (90% CI = 10.4-17.4). The population estimate was 5,907 (90% CI = 5,027-6,787) in the South Trench (MUs 4-02, 4-03, 4-04, 4-05, 4-20, 4-21, 4-22, and 4-24) and 767 (90% CI = 586-948) in the North Trench (MUs 4-25 and 4-26). Overall, the population declined by 53% since the last time it was surveyed in 2007/08 (population estimate = 14,115, 90% CI = 12,761-15,469; Phillips et al. 2008). Much of that decline is attributed to intensive cow harvest implemented to reduce conflicts on agricultural land between 2010 and 2012. The elk population is currently below the identified population target of 8469-11,292 elk (Ministry of Environment 2010). Causes of population declines are not well understood but poor calf recruitment from 2013 to 2017 appears to be a contributing factor.

Table of contents

List of tables

List of figures

Introduction

Rocky Mountain elk (*Cervus elaphus nelsoni*; hereafter elk) are highly valued by consumptive and non-consumptive users but expanding populations have created conflict with agricultural producers across western North America. In the East Kootenay, elk are managed to maximize hunting and viewing opportunities, while maintaining sustainable levels of grazing pressure on grasslands and minimizing crop depredation on private lands (Ministry of Environment 2010).

Elk are inventoried every ten years in the entire Rocky Mountain Trench (Invermere south to the US border) and every five years in the South Trench (Canal Flats south to the US border) to estimate population size and composition. The entire Rocky Mountain Trench was last inventoried in 2007/08 and the estimate was 14,115 (90% CI = 12,761-15,469l; Phillips et al. 2008), which was a 24% increase in elk populations since the last inventory in 2000. A management plan was developed in 2010 that established elk population targets by management zones, in consideration of declining range quality and increasing elk depredation on private lands. The management plan recommended a target 20-40% elk reduction across the East Kootenay Trench to maintain a population of 8,469-11,292 elk, which was expected to be a sustainable population relative to available forage.

Elk populations were reduced by implementing a low-elevation antlerless elk General Open Season (GOS) in the East Kootenay Trench from 2010-2012. The South Trench was then inventoried in 2012/13 and the population had declined by 37% since 2007/08, which triggered cancellation of the antlerless GOS in 2013. It is uncertain how populations responded since the reduction in antlerless harvest in the East Kootenay Trench so we completed an aerial survey in winter 2017/18 to update the population estimate and measure composition.

Study area

The Rocky Mountain Trench lies in southeastern British Columbia, stretching from Invermere south to the US border, and is divided into the North Trench and the South Trench. The North Trench occurs in Management Units (MUs) 4-25 and 4-26 (Invermere to Canal Flats), whereas the South Trench occurs in MUs 4-02, 4-03, 4-04, 4-20, 4-21, 4-22, and 4-24 (Canal Flats to the US border). The Rocky Mountain Trench is a wide valley bottom bounded by the Rocky Mountains to the east and the Purcell Mountains to the west. Our study area included most of the ungulate winter range within the Rocky Mountain Trench as well as the lower reaches of the Upper Kootenay River, Lussier River, Wildhorse River, St. Mary River, Bull River, and Wigwam River (Figure 1). The Rocky Mountain Trench is in the Dry Climatic Region and crosses several Biogeoclimatic Zones. Mule deer (*Odocoileus hemionus*), white-tailed deer *(O. virginianus*), moose (*Alces alces*), bighorn sheep (*Ovis canadensis*) and mountain goats

(*Oreamnos americanus*) occur within the Rocky Mountain Trench. Potential predators of elk include cougars (*Felis concolor*), grizzly bears (*Ursus arctos*), black bears (*U. americanus*), and wolves (*Canis lupus*).

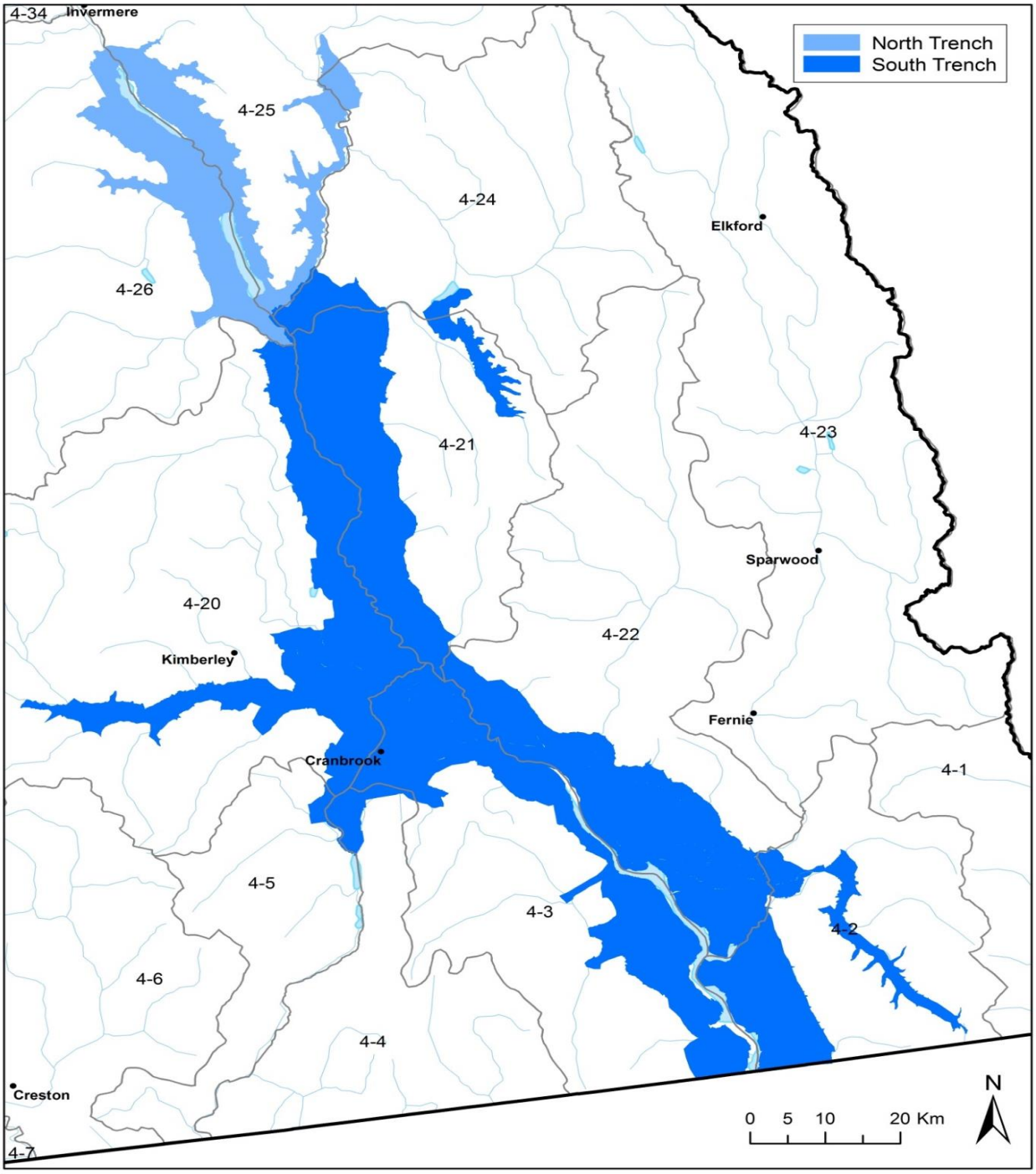

Figure 1. Study area for the 2017/18 Rocky Mountain Trench elk inventory.

Methods

We inventoried elk in the Rocky Mountain Trench using an aerial stratified random block survey design. The inventory was conducted from January 15th to Feb 5th, 2018 when elk were concentrated on winter ranges. We divided the 3,351 km^2 study area into 172 blocks (i.e., sample units) that could each be surveyed in approximately one hour (Unsworth et al. 1999). The extent of the study area was the same as the previous survey in 2007/08 (Phillips et al. 2008), but we modified the blocks slightly; we divided several large blocks (>35 km^2) and joined several small blocks (<5 km^2) to create more consistently-sized blocks. The average size of our blocks was 19.5 km^2 (SD = 7.3, range = 6.1-47.6).

We stratified all blocks based on the expected relative abundance of elk as either nil, low, medium, or high. We flew one or two transects over each block in a Cessna 206 plane to count the number of elk observed and the amount of sign present to rate each block; blocks with an expected number of elk of <5 were rated as nil, 5-25 as low, 35-85 as medium, and >85 as high. The navigator sat beside the pilot and tracked the plane's flight path using Avenza Maps on an iPad to ensure that we covered the highest quality habitat in each block. Two observers sat behind the pilot and navigator to look for elk and sign. We divided the study area into three sections and conducted stratification flights for each section during separate weeks; for each section we stratified those blocks and then immediately surveyed them during the days following to limit the number of elk moving into and out of adjacent blocks between the time of stratifying and surveying.

After stratifying the blocks, we randomly selected a proportion of blocks to survey; we initially selected approximately 25% of the low blocks, 50% of the medium blocks, and 75% of the high blocks. We did not survey blocks rated nil. Throughout the survey we periodically calculated the variance within each stratum (i.e., low, medium, and high) using Aerial Survey. If a particular stratum had high variance then we adjusted our block selection to survey a greater number of blocks within that stratum to reduce the sampling variance.

We used a Bell 206 Jet Ranger and Long Ranger helicopter to complete the survey. During most days there were two survey crews working concurrently in separate locations. Each crew consisted of the pilot, navigator, and two observers. The navigator sat beside and navigated the pilot using an iPad with Avenza Maps preloaded with maps showing block boundaries, roads, rivers, and elevational contours. The helicopter's flight path was tracked and saved. The two observers sat behind the pilot and navigator and recorded data, took waypoints with a GPS for all elk groups observed, and photographed selected groups. All members of the crew searched for and helped classify elk.

We flew transects 200-400 m apart, as dictated by topography and vegetative cover. We flew 20-50 m above treetops in forested areas and up to 130 m above ground in open areas. Flight speed ranged from 55-95 km/hr in most habitat types, but was up to 130 km/hr over agricultural fields and other open habitats. We followed elevational contours in steep terrain. We circled each group of elk to count and classify all individuals. When we encountered large groups of elk and groups in thick cover then the pilot used the helicopter to push the elk into an opening for easier classification.

Elk were classified according to criteria outlined in the Aerial-based Inventory Methods for Selected Ungulates (RISC 2002). We classified all elk as calf (<1 years old), cow, or bull. Bulls were further classified as spikes (1-2 points), raghorns (3-5 points with small, thin antlers) and adult bulls (large, heavy antlers with ≥5 points). We photographed large groups of elk with a digital camera to later verify our counts and classifications. We recorded the activity of the first elk observed in each group as bedded, standing, or moving, as well as the estimated percent snow cover and percent vegetative cover within a 10 m radius around the entire group (Unsworth et al. 1999). We recorded waypoints for all groups of elk using a handheld GPS unit. For other species we simply recorded the total number of animals observed in each block.

Data analysis

To estimate total population size we first estimated the population in each stratum and then added those estimates together using the program Aerial Survey 2000 Version 1.00. For each stratum, we generated population estimates by calculating the average number of elk observed per block surveyed. We then extrapolated those values to blocks that we did not survey. Next, we corrected for sightability bias (i.e., the number of elk that were present but missed during the survey) using the Hiller 12-e elk sightability model (with snow). This model applies a sightability correction factor for each group of elk observed by multiplying the number of elk observed in each group by the inverse of the probability that the group would have been missed. The probability of missing a group increases with smaller group sizes, thicker vegetative cover, and less snow cover. We then calculated the average sightability correction factor for each stratum and multiplied that factor by their uncorrected population estimates to obtain the sightability-corrected estimates for each stratum. We summed the sightability-corrected estimates of each stratum to obtain the total population estimate. We also estimated ratios of calves per 100 cows and bulls per 100 cows using the same procedure (i.e., summing stratum estimates). All data were uploaded to the Species Inventory Database.

Results

Survey conditions

High-elevation snowpack on Moyie Mountain (1,840 m asl) was close to the 42-year average during the survey (BC River Forecast Center). Low-elevation snowpack was approximately 28 cm at the Cranbrook airport (940 m asl) when the survey started (National Climate Archive). Snow cover was complete in all blocks except those in MUs 4-25 and 4-26, which had patchy coverage at low elevations. Survey temperatures ranged from -9˚C to 5˚C.

Stratification

We conducted the first stratification flight in the southern part of the study area (MUs 4-02, 4-03, 4-04 and southern part of 4-20) on January 13th, 3 days after a snowfall of 6 cm in Cranbrook. We conducted the second stratification flight in the central part of the study area (MUs 4-21, northern parts of 4-20, 4-22 and 4-24) on January 22nd, 4 days after a snowfall of 4 cm. We conducted the final stratification flight in the northern part of the study area (MUs 4-25 and 4-26) on January 30th. Total flight time for all stratification flights was 15.5 hours. We rated 6 (4%) blocks nil, 97 (56%) blocks low, 42 (24%) blocks medium, and 27 (16%) blocks high (Figure 2).

Survey intensity

Between January 16th and Feb 1st we surveyed 1,435 km^2 (43%) of the 3,352 km^2 study area with an intensity of 2.4 min/km^2. We surveyed 70 (41%) of the 172 blocks: 29 (30%) of 97 low blocks, 21 (50%) of 42 medium blocks, and 20 (74%) of 27 high blocks (Figure 2). Total survey time was 111.5 hours, and survey time per block ranged from approximately 15 minutes to 2 hours (mean = 48 minutes, SD = 19), depending on the size of the block.

Observations

We observed a total of 2,969 elk within 423 groups: 741 calves, 1,983 cows, 124 spikes, 91 raghorns, 15 adult bulls, and 15 unclassified (Figure 2). The average number of elk observed per block was 14.4 for low blocks (SD = 23.4, range = 0-116), 34.8 for medium blocks (SD = 25.8, range = 0-111), and 88.3 for high blocks (SD = 57.6, range = 32-253). Of the 423 groups observed, 174 (41%) were bedded, 232 (55%) were standing, and 17 (4%) were moving. The average vegetative cover was 30.5% (SD = 22.3, range = 0-95). Snow cover was complete for all groups except for 25 groups with 90-95%, and one group with 50%. We also observed 1,010 white-tailed deer, 383 mule deer, 14 moose, 47 bighorn sheep, 8 coyotes (*Canis latrans*), 3 wolves, 2 bobcats (*Lynx rufus*), and 2 cougars.

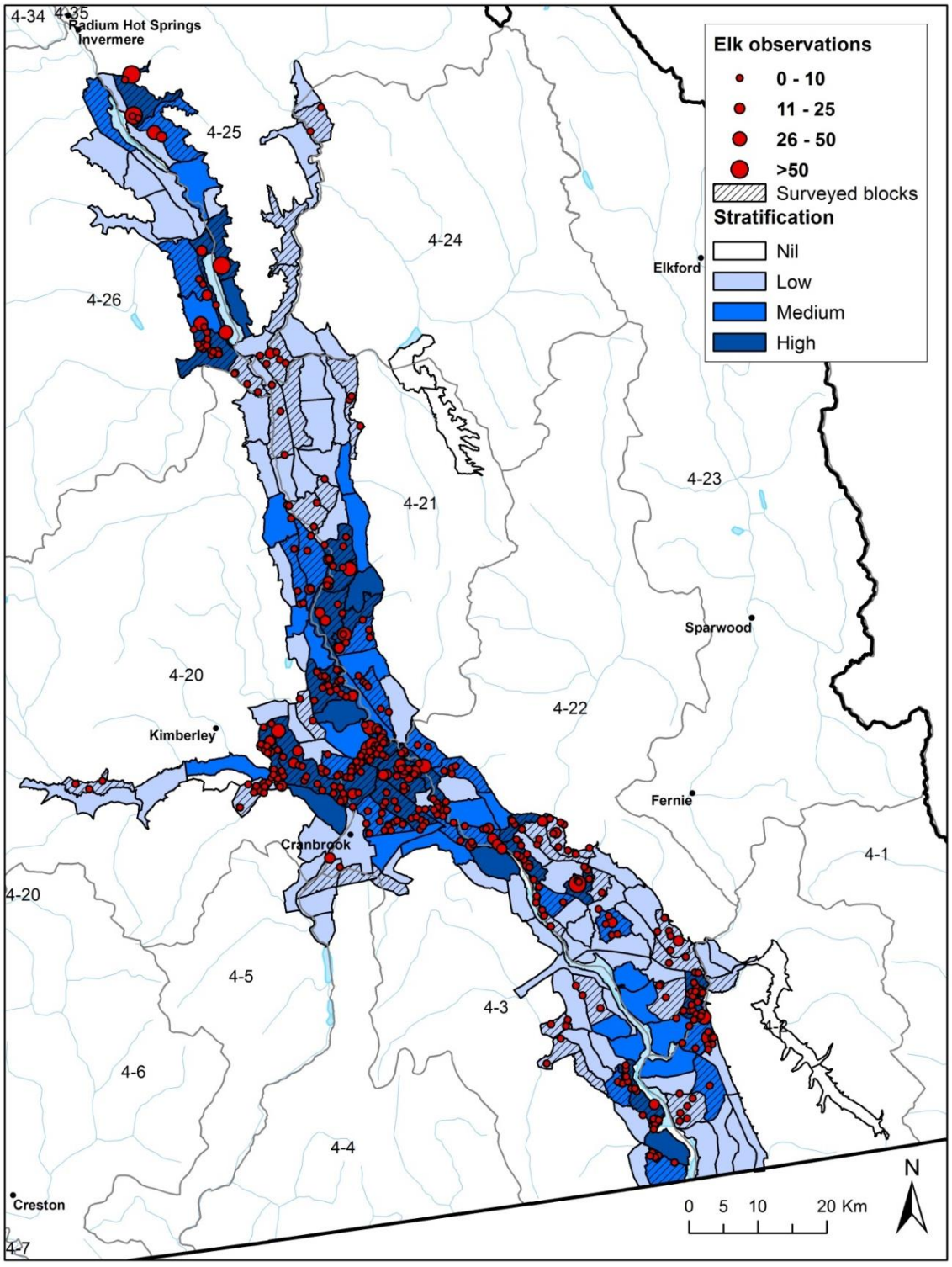

Figure 2. Elk observations (red circles) during the 2017/18 Rocky Mountain Trench elk inventory. Also shown is the stratification of all blocks: nil (*n* = 6), low (*n* = 97), medium (*n* = 42), and high (*n* = 27), and those that were surveyed (crosshatched; *n* = 70).

Population estimate

The total population estimate was 6,671 (90% CI = 5,764-7,578 Table 1); the population estimate of the South Trench was 5,907 (90% CI = 5,027-6,787), and the population estimate of the North Trench was 767 (90% CI = 586-948). The estimated density of elk was 1.1/km^2 in the low stratum, 2.4/km^2 in the medium stratum, 4.5/km^2 in the high stratum, and 2.1/km^2 across the entire study area. Sampling variance was highest in the low stratum (65% of total variance), followed by the medium stratum (24% of total variance) and the high stratum (11% of total variance).

Table 1. Observed and estimated number of elk in the Rocky Mountain Trench during the 2017/18 inventory.

	Observed	Estimated	90% CI
Calves	741	1,644	1,380-1,908
Cows	1,983	4,375	3,809-1,941
Spikes	124	291	213-369
Raghorns	91	268	154-382
Adult bulls	15	52	26-78
Unclassified	15	42	7-77
Total	2,969	6,671	5,764-7,578

Herd composition

The estimated ratio of calves per 100 cows was 37.6 (90% CI = 30.7-44.5) for the study area, and higher in the South Trench (38.9 calves:100 cows; 90% CI = 31.2-46.6) than the North Trench (28.6 calves:100 cows; 90% CI = 23.1-34.1). The estimated ratio of bulls per 100 cows was 13.9 (90% CI = 10.4-17.4), and similar between the South Trench (14.1 bulls:100 cows; 90% CI = 10.1-18.1) and North Trench (13.3 bulls:100 cows; 90% CI = 9.2-17.4) in the North Trench. Herd composition varied between MUs; calves per 100 cows ranged from 26.1-49.1, and bulls per 100 cows ranged from 9.4-20.7 (Table 2).

Table 2. Observed and estimated number of elk, and calf and bull ratios by MU during the 2017/18 Rocky Mountain Trench elk inventory. Observed and estimated values are for only the portions of each MU that were included in our study area (Figure 1), not the entire MU. Estimated values are not shown for MUs 4-4 and 4-24 because only a small portion of those MUs were surveyed, but those values are included in the total estimates. The total number of observed elk includes unclassified individuals.

	Observed				Estimated					
									Per 100 cows	
MU	Calves	Cows	Bulls	Total	Calves	Cows	Bulls	Total	Calves	Bulls
South Trench										
4-2	36	82	8	128	83	256	36	380	32.2	14.2
4-3	138	438	52	628	264	969	123	1,355	27.3	12.7
4-4	6	16	2	24	-	-	-	-	-	-
4-20	204	510	48	771	600	1,364	142	2,149	44.0	10.5
4-21	78	191	16	285	219	446	43	706	49.1	9.4
4-22	160	362	62	584	329	782	162	1,271	42.0	20.7
4-24	15	32	4	51	-	-	-	-	-	-
All	637	1,631	192	2,471	1,494	3,836	541	5,970	38.9	14.1
North Trench										
4-25	57	224	24	305	92	355	41	489	26.1	11.5
4-26	47	128	14	193	69	236	26	336	29.1	11.2
All	104	352	38	498	154	537	72	767	28.6	13.3

Harvest rates

In 2017/18 the estimated harvest rate for bulls and cows in the Rocky Mountain Trench was 34% and 1%, respectively. Since 2007/08, antlerless harvest rate has continued to drop while bull harvest rate has continued to increase (Table 3).

Table 3. Estimated antlerless and bull harvest rates in the Rocky Mountain Trench during the past three years that it was surveyed. Harvest rates were calculated by dividing the post-hunt, inventory population estimate by the pre-hunt population estimate (inventory estimate + total harvest). The pre-hunt population estimate is underestimated because it does not account for non-hunting mortality such as unlicensed harvest, vehicle and railway collisions, and predation. Harvest estimates were obtained from the annual provincial hunter survey (preliminary data for 2017/18).

		Antlerless estimates			Bull estimates		
Year	Area	Pre-hunt population	Harvest total	Harvest rate	Pre-hunt population	Harvest total	Harvest rate
2007/08	Rocky Mt Trench	11,676	699	6%	3,067	546	18%
2012/13	South Trench	6,637	404	6%	1,615	446	28%
2017/18	Rocky Mt Trench	6,075	56	1%	924	313	34%

Discussion

The population of elk in the Rocky Mountain Trench has fluctuated among survey years (Figure 3) and MUs (Figure 4) since inventories began in 1991/92. Herd composition has also fluctuated during that time (Table 4). The current 2017/18 population estimate (6,671, 90% CI = 5,764-7,578) is the lowest yet recorded and represents a 53% decline since the 2007/08 inventory (population estimate = 14,115, 90% CI = 12,761-15,469; Phillips et al. 2008). Much of the decline was due to increased cow harvest rates from 2010-2012 to reduce overgrazing on crown lands and conflicts on agricultural land. Populations have declined in every MU since the 2007/08 inventory except for MU 4-20 where the population increased slightly (Figure 4). The current 2017/18 population estimate for the South Trench (5,907, 90% CI = 5,027-6,787) represents a 21% decline since the last survey in 2012/13 (population estimate = 7,509, 90% CI = 6,829-8,189; Stent and Phillips 2013), despite closure of the antlerless elk GOS in 2013. The population of the South Trench is well below the target of 7180-9574 elk (Ministry of Environment 2010).

Elk distribution across their winter range was very different than past surveys. There was reduced use of historically high-density blocks (e.g., Skookumchuck Prairie, Wasa/ Wolf Creek and Pickering Hills), and use of Grasmere winter ranges also declined substantially since 2007/08, which could be attributed to the increase in wildlife exclusion fencing in this area. A herd of approximately 700 elk recently started wintering near Eureka, Montana and collar monitoring has shown that at least some of these animals summer in MU 4-02 and 4-22 (Montana Fish, Wildlife and Parks, unpublished data). Also of note, very few elk were observed in ecosystem restoration treatments south of Jaffray, which appeared to have little snow interception cover. We recommend a review of current ungulate winter range measures for elk and an assessment of habitat condition on historically well used winter ranges.

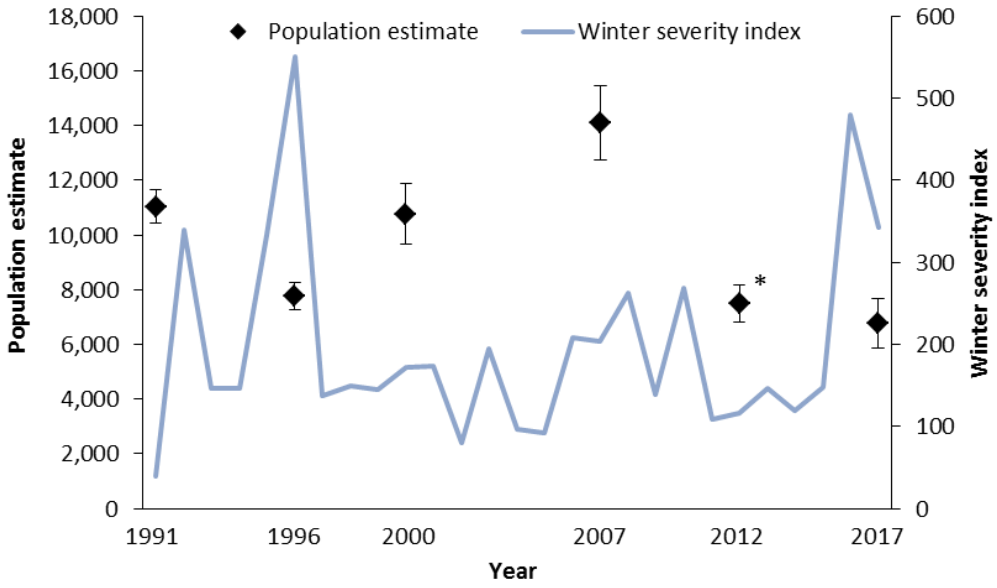

Figure 3. Population estimates of elk (left y-axis, black dots) and winter severity indices (right y-axis, blue line) in the Rocky Mountain Trench since it started being inventoried in 1991/92. Winter severity index is the standardized average monthly temperature multiplied by total snowfall, measured at the Cranbrook airport. Error bars for population estimates represent 90% confidence intervals. *The 2012 population estimate is for only the South Trench.

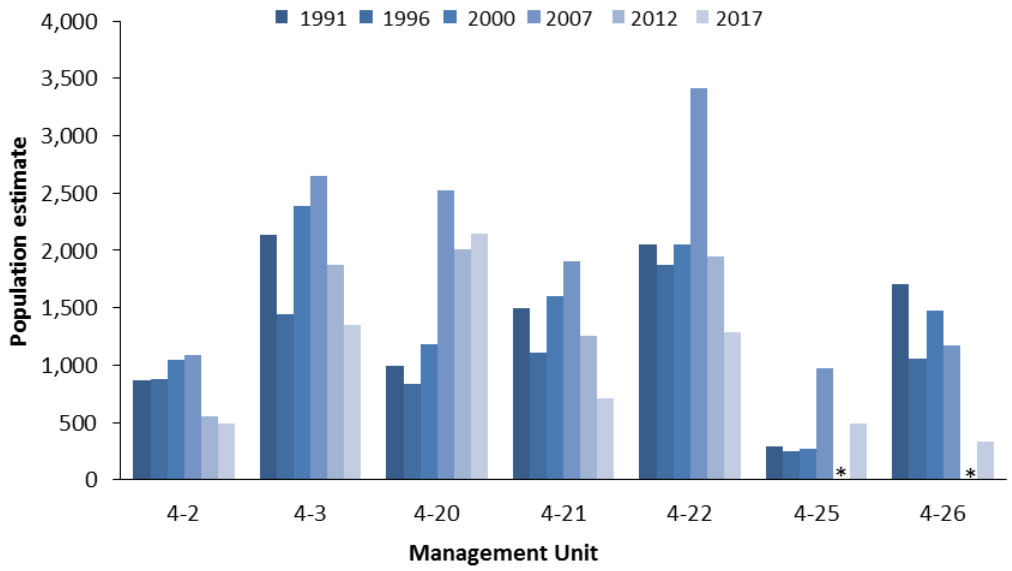

Figure 4. Population estimates of elk in each MU in the Rocky Mountain Trench during years that it was inventoried between 1991/92 and 2017/18. MUs 4-4 and 4-24 are not shown because only a small portion of those MUs were surveyed. *MUs 4-25 and 4-26 were not included in the 2012/13 inventory.

Table 4. Estimated population size and herd composition of elk in the Rocky Mountain Trench during years that it was inventoried between 1991/92 and 2017/18. *The 2012/13 estimates are for only the South Trench. Estimates were obtained from Simpson 1992, Hatter 1995 (1991/92), Halko and Hebert 1997 (1996/97), Halko and Hebert 2001 (2000/01), Phillips et al. 2008 (2007/08), and Stent and Phillips 2013 (2012/13).

				Bulls				Per 100 cows	
Year	Total	Calves	Cows	Spikes	Raghorns	Adults	All	Calves	Bulls
1991/02	11,038	1,918	7,269	1,047	705	100	1,852	26	25
1996/07	7,762	1,117	5,945	293	265	141	699	19	12
2000/01	10,733	2,488	7,039	699	230	279	1,208	35	17
2007/08	14,115	2,396	8,581	781	1,377	363	2,521	28	29
2012/13*	7,509	1,333	4,900	322	548	299	1,169	27	24
2017/18	6,671	1,644	4,375	291	268	52	611	38	14

We observed relatively high calf ratios (38 calves: 100 cows; Table 2) but true recruitment is likely much lower as calf mortality typically increases in the late winter and early spring. The East Kootenay experienced a period of low calf recruitment from 2013-2017 (10-20 calves: 100 cows), while cow survival rates were relatively high (0.82-0.90; FLNRORD unpublished data; Poole 2007). We expect that poor calf recruitment rather than cow mortality has suppressed population growth. Research has shown that predation of neonates (Eacker et al. 2016) and declining habitat quality have contributed to low recruitment rates observed in multiple elk populations (Lukacs et al. 2018). It is plausible that predation pressure has increased in the East Kootenay, given the recent increase in cougar populations and recolonization of wolves in the Region (FLNRORD unpublished data). Besides these factors, winter severity likely contributed to poor calf survival in 2016/17 (Figure 3).

Unlike the calf ratio, the ratio of bulls per 100 cows (14) was low (Table 4); the bull to cow ratio was the second lowest recorded and below the target of 20 bulls per 100 cows (Ministry of Environment 2010). The estimated number of adult bulls (*n* = 52) accounted for only 8% of the total number of estimated bulls (*n* = 618). The actual number of bulls is likely much greater since bulls commonly winter outside of our study area in surrounding high-elevation terrain. However, because the study area has been consistent the estimated bull numbers are meaningful for comparing trends, and the current bull estimate suggests that bull numbers have declined.

Harvest trends

Trends in harvest totals have corresponded closely with trends in population estimates for elk in the Rocky Mountain Trench (Figure 5). Since the last inventory of the Rocky Mountain Trench in 2007/08, bull harvest has fluctuated but has gradually decreased by 35%. Although bull harvest has declined, it is still higher than in the late 1990s despite having fewer elk, likely due to additional harvest in the spike bull season, which started in 2012. The GOS for 6-point or greater bulls is generally considered self-sustaining because harvest tends to decline as populations decline. However, additive bull harvest during the spike season could explain the declining bull ratio as 2016 and 2017 meat cutter records showed that substantial harvest occurred in the spike season (20-25% of total bull harvest; FLNRORD unpublished data). Antlerless harvest was highest during 2010-2012 when the GOS for antlerless elk was in place. Since then harvest has remained low as limited entry hunting (LEH) opportunities and a GOS on four private properties in MUs 4-20 and 4-22 have been the only seasons for cow elk. We suspect that vulnerability of elk has increased with increased access and a higher proportion of elk remaining in the East Kootenay Trench during the hunting season.

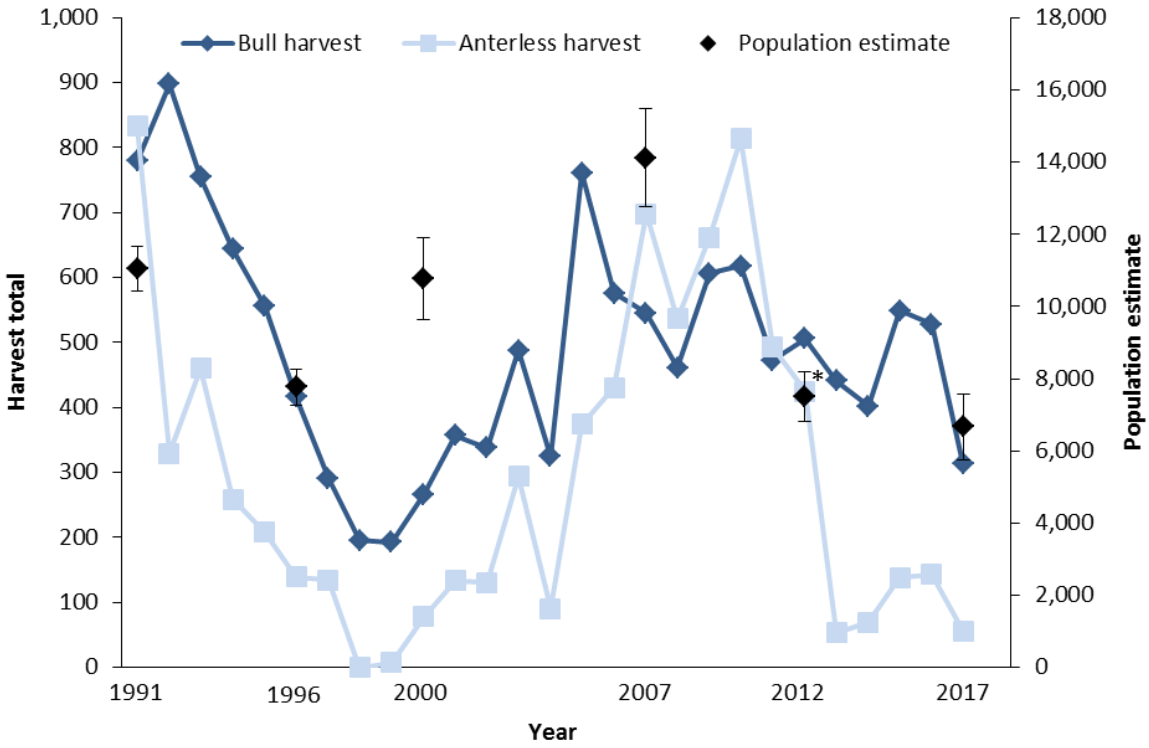

Figure 5. Estimated annual bull and antlerless elk harvest totals in the Rocky Mountain Trench and population estimates during years that it was inventoried during 1991-2017. Error bars for population estimates represent 90% confidence intervals. *The 2012 population estimate is for only the South Trench.

Comparison with past survey methods

The study area has differed slightly among previous inventories of the East Kootenay Trench, but all inventories had the objective of deriving a population estimate from Invermere south to the US border by delineating and surveying elk winter range. The Hiller 12-e elk sightability model was used in all inventories (Unsworth et al. 1991, 1999) and survey methodology was consistent among inventories. Survey intensity was lower in 2017/18 (2.4 min/ km^2) than previous surveys (4.2 min/ km^2 in 1991/92, 3.8 min/ km^2 in 1996/97, 3.9 min/ km^2 in 2000/01 and 2007/08, and 3.2 min/ km^2 in 2012/13). Lower survey intensity may be a reflection of the smaller number of elk observed in 2017/18 because we spent less time classifying animals than previous years.

Recommendations

We recommend reducing bull harvest in the East Kootenay Trench to meet the target ratio of 20 bulls per 100 cows. Additionally, factors potentially contributing to population declines should be assessed to identify future mitigation strategies. Population trends should continue to be monitored with surveys repeated in the South Trench in five years and the entire Rocky Mountain Trench in ten years. We also recommend revising the retention standards for elk winter range to ensure that sufficient canopy cover is retained at ecosystem restoration sites and assessing habitat quality on Skookumchuck Prairie, Pickering Hills, and Wolf Creek winter range. During future surveys we may consider hiring a single contract crew of observers to provide consistency and scheduling ease. We also recommend photographing all groups of >15 elk and all raghorn and adult bulls so that we can better verify counts and classifications.

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