Tara's copy

Estimating the Size of the East Kootenay Elk Population

by

Keith Simpson

Keystone Wildlife Research
12593 Ocean Cliff Drive,
White Rock, B.C. V4A 5Z6

Prepared for

BC Environment
Wildlife Branch
Cranbrook, B.C.

July 1993

Table of Contents

INTRODUCTION 1

ELK HARVEST DATA 1

POPULATION ESTIMATES 5

POPULATION MODEL 9

ESTIMATED POPULATIONS AND HARVESTS IN NORTHERN IDAHO 13

CONCLUSIONS 15

INTRODUCTION

Recent aerial surveys conducted in the Rocky Mountain Trench have yielded population estimates for elk which are substantially lower than the numbers estimated from hunter harvest data. The key area for comparison includes Management Units 401-403,420-424 and 426 which approximate the area covered by the recent aerial surveys. BC Environment requested that we examine the source data and methods of calculation for each estimate to determine the reasons for the discrepancy. We have also contacted managers in other jurisdictions to determine if similar problems exist elsewhere and potential reasons why.

ELK HARVEST DATA

For purposes of our analysis we have used harvest data collected from 1976 to 1992. Tooth ages needed to estimate the age distribution of bulls are available from 1980 onward. Prior to 1980 the majority of the harvest was bulls (Figure 1). From 1982 onward cows and calves have formed a significant portion of the harvest. Since 1980 the number of bulls taken has averaged about 1500 animals. The cow/calf contribution has fluctuated annually but about 1000-1500 females and young are also taken each year (Figure 1). The maximum recorded kill occurred in 1984 when over 4000 elk were taken in the Kootenay Region. The Management units in the southern Trench account for the majority of the harvest or about 1100 bulls and 90% of the cows and calves (Figure 2).

The estimated harvest is based on a 100% sample of hunters who buy elk tags each year. The response rate has averaged 76% and confidence limits for the regional estimate are less than $\pm$ 3%, with management unit estimates within 6-8% (John Thornton - personal communication). Telephone contact with non-respondents has shown there negligible bias introduced in the sample. In short, the harvest data is believed to accurately represent the number of elk taken each year regionally and by management unit.

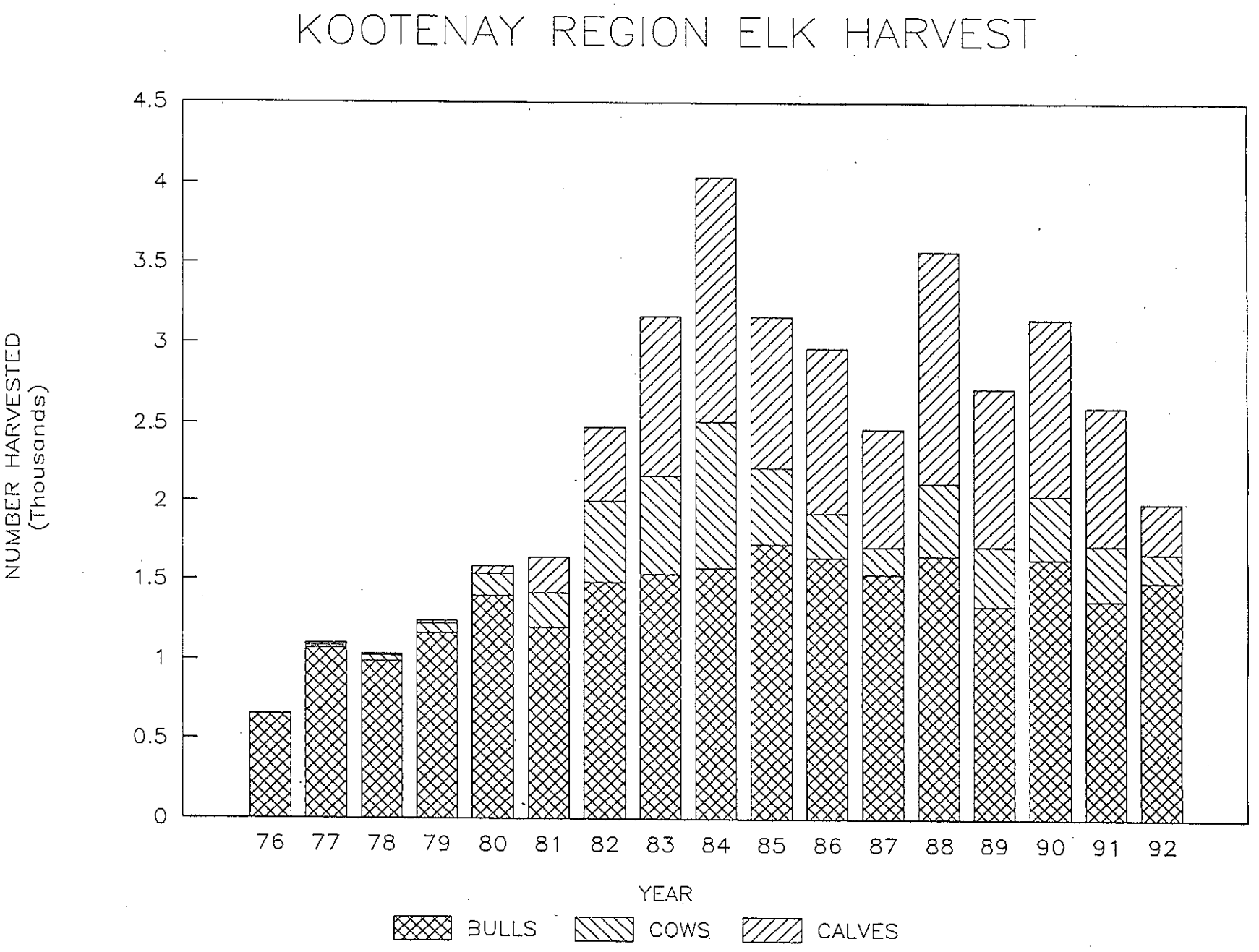
KOOTENAY REGION ELK HARVEST
NUMBER HARVESTED
(Thousands)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
YEAR
BULLS
COWS
CALVES

Figure 1

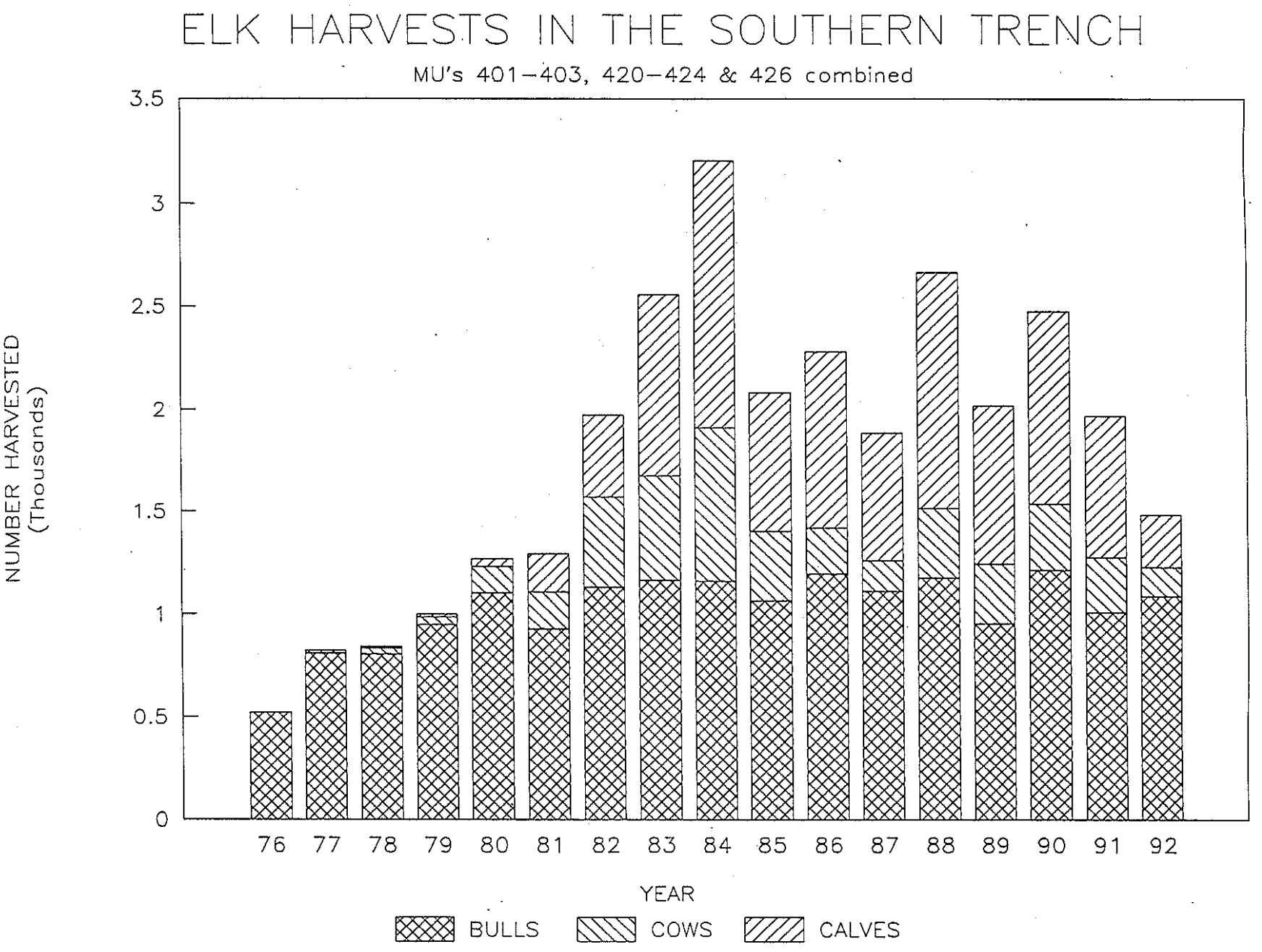
ELK HARVESTS IN THE SOUTHERN TRENCH
MU's 401–403, 420–424 & 426 combined
NUMBER HARVESTED
(Thousands)
3.5
3
2.5
2
1.5
1
0.5
0
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92
YEAR
BULLS
COWS
CALVES

Figure 2

Table 1. The proportion of bulls killed in each age class for the southern Rocky Mountain Trench based on tooth ages.

AGE	PROPORTION IN KILL 80-83	84-87	88-92
≤ 2	0.301	0.247	0.284
3	0.253	0.180	0.182
4	0.148	0.142	0.121
5	0.113	0.118	0.149
6	0.066	0.085	0.102
7	0.056	0.106	0.089
8	0.032	0.061	0.043
9+	0.031	0.061	0.031
N	681	1352	835

$X^2 = 91.8$, 16 df, $P<.001$

Age data is obtained from voluntary tooth returns. The age data is, therefore, not obtained from a random sample and several sources of error have been reported by Hovey (1993). Some of these include hunters sending in multiple teeth from the same animal or sending in teeth of animals taken in previous years. Suggested reasons for this include obtaining additional badges and checking the accuracy of the tooth aging system. Because the annual samples were small (150-200 teeth) and may not be representative, we combined the data for years which were similar. From 1980-1983, young bulls (< 3 yrs) formed a significantly larger portion of the harvest than after 1983 (55.4% vs 42.7-46.6%, Table 1). The reduction in numbers of young bulls followed shortly after the introduction of calf harvests (Figure 2). The age structures in Table 1 were used to back-calculate the numbers in each cohort and estimate the minimum number of males born each year from 1977 to 1987 in the southern Trench.

POPULATION ESTIMATES

Elk numbers for the entire Kootenay Region prior to the hunting season have been estimated between 23218 and 34,765 (Bill Warkentin - personal communication). The method used involves calculating the minimum number of bulls alive in a particular year by summing the number of bulls killed from each cohort over their expected life span. A one-year-old bull killed in 1979 would have been born in 1978. A two-year-old killed in 1980 would also have been alive in 1978. After tallying the harvests for several years up to 1991, the minimum number alive in years previous can be estimated. Knowing the number of bulls, the number in other sex/age classes can be estimated based on observed ratios. The overall ratio used by Warkentin was 38 bulls: 100 cows : 50 calves, which is an estimate of relative numbers prior to the hunting season.

We performed a similar calculation but did not try to estimate pre-season populations since all classification and population ratio data is obtained in winter after the hunting season. We estimated the number of male calves and spikes born each year from the cohort data. Bulls harvested in later years must have been alive as one-year-olds and two-year-olds and no spikes can be legally harvested so most would recruit to the adult (3^+ point) bull population in year 3. We assumed a 50/50 sex ratio in the calf population so an equal number of female calves was added to complete the estimates for male calves, female calves and spikes. We used the ratios for cows and antlered bulls from surveys completed in 1992 (Table 2). Those ratios may not be applicable to the population in 1980 but provide approximate guidelines needed to reconstruct the population (Table 3). In fact the proportion of calves may have been larger in 1980 prior to the initiation of cow/calf hunting since more calves may survive their first fall and be included in winter classification counts. Increasing the proportion allocated to calves would reduce the total population estimate. Based on this information we estimated that the total post-harvest Kootenay elk population should have been between 16,782 and 18,571 from 1981 to 1985 (Table 3).

Table 2. The minimum number of bulls born each year in the Kootenay region based on the harvest of antlered bulls from 1980 to 1991.

HARVEST YEAR	# BULLS	----- # BULLS BORN IN JUNE ------- 79	80	81	82	83	84	AGE	%
80	1395	40						1	2.9
81	1199	289	35					2	24.1
82	1483	282	357	43				3	19.0
83	1533	198	291	369	44			4	12.9
84	1572	193	203	299	379	46		5	12.3
85	1727	152	212	223	328	416	50	6	8.8
86	1640	154	144	202	212	312	395	7	9.4
87	1533	80	144	135	189	198	291	8	5.2
88	1653	89	86	155	145	203	213	9+	5.4
89	1332		72	69	125	117	164		
90	1631			88	85	153	144		
91	1369				74	71	129		
TOTAL	18067	1477	1545	1583	1581	1516	1386		
MEAN/YR	1506								

Table 3. The estimated elk population in the Kootenay region based on classification data from 1992 and estimated numbers of bull calves and spikes alive from harvest back-calculation.

POST HARVEST	% IN FEBRUARY	YEAR 81	82	83	84	85
ANT BULL	7.7	1379	1423	1433	1393	1295
SPIKE	8.5	1477	1545	1583	1581	1516
MALE CALF	8.5	1545	1583	1581	1516	1386
FEM CALF	8.5	1545	1583	1581	1516	1386
COW	66.6	11929	12305	12393	12049	11199
POST HARVEST POPULATION		17875	18439	18571	18055	16782

Identical calculations were completed for management units in the southern Trench where elk population estimates from aerial surveys were available. Back calculation was used to estimate the number of males born in each year from 1977 to 1987 (Table 4). The population estimate ranged from 12,443 in 1979, to 13,338 in 1982, declining to 8,949 in 1988 (Table 5). The lower estimates from 1986 onward result primarily since the cohort data is incomplete. The older bulls (6+) which usually contribute 26.5% of the harvest (Table 1) have not yet been included in the 1987 cohort estimate (Table 4). The estimates for 1979 to 1981 provide the best population estimates since few cows or calves were included in the harvest before that time and cohort data is complete since few elk born in those years will still be living.

These estimates are only slightly larger than those obtained from aerial surveys in the East Kootenay Trench and the Elk Valley in 1992 and 1993 when approximately 10,800 elk were estimated to be in those areas. Some of the difference (2-3000 animals) could be accounted in areas not covered by the aerial surveys which were included in the harvest estimates such as the upper Kootenay River and St. Mary's River.

Table 4. The minimum number of bulls born each year in the southern Rocky Mountain Trench (MU's 401-403, 420-424, 423 & 426) based on the harvest of antlered bulls from 1979 to 1992.

SOUTH TRENCH	YEAR	# BULLS SHOT	No. Born by Year 77	78	79	80	81	82	83	84	85	86	87
401-426	76	519											
401-426	77	805											
401-426	78	803											
401-426	79	944	284										
401-426	80	1099	278	331									
401-426	81	925	137	234	278								
401-426	82	1126	127	167	285	339							
401-426	83	1160	77	131	172	293	349						
401-426	84	1153	65	76	130	171	292	347					
401-426	85	1062	34	59	70	120	157	269	320				
401-426	86	1189	37	38	67	78	134	176	301	294			
401-426	87	1106		34	35	62	73	125	164	199	273		
401-426	88	1170			36	37	66	77	132	166	211	289	
401-426	89	950				29	30	53	63	112	135	171	235
401-426	90	1209					37	39	68	103	143	172	218
401-426	91	1004						31	32	106	85	118	143
401-426	92	1080							33	66	114	92	127
NO. MALES IN JUNE			1038	1070	1074	1130	1139	1117	1112	1046	961	842	722

Table 5. The estimated elk population in the southern Trench based on classification data from 1992 and estimated numbers of bull calves and spikes alive from harvest back-calculation.

POST HARVEST	% IN FEBRUARY	YEAR 79	80	81	82	83	84	85	86	87	88
ANTLERED BULL	7.7	960	972	1007	1029	1018	1009	968	896	799	690
SPIKE	8.5	1038	1070	1074	1130	1139	1117	1112	1046	961	842
MALE CALF	8.5	1070	1074	1130	1139	1117	1112	1046	961	842	722
FEMALE CALF	8.5	1070	1074	1130	1139	1117	1112	1046	961	842	722
COW	66.6	8303	8404	8708	8901	8809	8728	8369	7753	6908	5972
POST HARVEST POPULATION		12443	12593	13050	13338	13200	13078	12542	11618	10352	8949

Table 6. The annual harvest of elk in the southern Rocky Mountain Trench (MU's 401-403, 420-424, 423 & 426) from 1976 to 1992.

YR	BULLS	COWS	CALVES	TOTAL	HUNTERS	HUNTER DAYS
76	519	0	1	520	5170	34683
77	805	6	10	821	6103	41863
78	803	29	8	840	6609	46308
79	944	39	12	995	5850	38865
80	1099	125	39	1263	8461	65955
81	925	177	185	1287	8851	68373
82	1126	443	402	1971	9907	76254
83	1160	511	886	2557	9795	79920
84	1153	756	1296	3205	10349	82228
85	1062	340	681	2084	8984	84342
86	1189	228	862	2279	10604	85595
87	1106	147	629	1882	10140	86537
88	1170	345	1156	2671	10457	86077
89	950	288	780	2018	10571	92774
90	1209	326	939	2474	9415	76327
91	1004	265	696	1965	9698	75769
92	1080	139	259	1478	7143	55845
Totals (1983-92)	11,083	3,345	8,184	22,613	97,156	805,414
Means (1983-92)	1,108	334	818	2,261	9,716	80,541

POPULATION MODEL

In order to test the validity of the population estimates we examined the elk harvest in the southern Trench from 1976 to 1992 (Table 6). Approximately 1100 bulls have been killed each year and a variable number of cows (mean = 313) and calves (mean = 818). Adult branched antler bulls are the most difficult to survey and obtaining a minimum population estimate may best be done using back-calculation methods (Table 7). That exercise showed that the population in 1981 should have contained at least 3457 branched antler bulls and 1210 spike bulls. The cow/adult bull ratio was believed conservative since bulls are typically underestimated using aerial counts and the back-calculation confirmed that more bulls must have been alive in the population than indicated by the sex ratio. We inserted the estimate for branched antler bulls into the model and ignored the estimated cow/bull ratio.

Table 7. The minimum number of male elk alive in each age class in the southern Rocky Mountain Trench (MU's 401-403, 420-424, 423 & 426) from 1979 to 1992 based on harvests and cumulative pre-hunt populations. Age breakdown from Table 1.

AGE		YEAR 79	80	81	82	83	84	85	86	87	88	89	90	91	92
1.5	Prehunt	1206	1199	1210	1123	1100	1087	1030	978	906	782	657	491	310	24
	Harvest	45	53	44	54	56	15	14	15	14	26	21	27	22	24
2.5	Prehunt	1117	1160	1147	1165	1069	1044	1072	1016	962	891	756	636	465	288
	Harvest	239	278	234	285	293	266	245	275	255	312	254	323	268	288
3.5	Prehunt	780	878	882	913	881	775	778	827	741	707	579	502	313	197
	Harvest	239	278	234	285	293	208	191	214	199	213	173	220	183	197
4.5	Prehunt	495	542	600	648	628	587	568	586	613	542	494	406	282	131
	Harvest	140	163	137	167	172	164	151	169	157	142	115	146	121	131
5.5	Prehunt	303	356	379	463	482	456	423	417	418	455	401	379	260	161
	Harvest	107	124	105	127	131	136	125	140	131	174	142	180	150	161
6.5	Prehunt	188	196	232	274	336	351	320	298	276	287	281	259	199	110
	Harvest	62	73	61	74	77	98	90	101	94	119	97	123	102	110
7.5	Prehunt	117	126	124	171	200	260	253	230	197	182	168	184	136	96
	Harvest	53	62	52	63	65	122	113	126	117	104	85	108	89	96
8.5	Prehunt	64	64	65	72	107	135	137	140	104	80	78	83	77	46
	Harvest	30	35	30	36	37	70	65	73	67	50	41	52	43	46
9.5+	Prehunt	29	34	29	35	36	70	65	73	67	36	29	37	31	33
	Harvest	29	34	29	35	36	70	65	73	67	36	29	37	31	33
TOT. 2.5+ YEARS		3094	3357	3457	3741	3738	3678	3615	3586	3378	3181	2786	2488	1763	1062
TOT. SPIKES (1.5)		1206	1199	1210	1123	1100	1087	1030	978	906	782	657	491	310	24
TOT. HARVEST		944	1099	925	1126	1160	1153	1062	1189	1106	1170	950	1209	1004	1080

We assumed that the population estimate from 1981 best approximated the true population size and structure for cows and calves. We used those numbers as the seed population for an annually calculated population estimate (Table 8). Male/female calf sex ratios (53/47) and cow productivity (80%) were taken from Flook (1970). The initial population sex/age ratios follow those given on Table 5. The yearling cow component was separated from the adult cows since yearlings rarely raise calves. The methods of calculating successive estimates are noted below Table 8.

Although there are many assumptions associated with the hypothetical model, it does indicate that the harvests recorded from 1981 to 1992 could be sustained by a population of 13,000-14,000 elk. Realistic population parameters were used to generate estimates for each successive year and the population structure approximates that which has been observed. Some parameters, such as mortality rates, were adjusted to fit the existing data so caution should be exercised in interpreting such hypothetical data. One major conclusion is that the proportion of branched antler bulls in the population must be considerably larger than estimated from aerial surveys (15% vs 7.7%).

Table 8. A population model for elk in the southern Rocky Mountain Trench (MU's 401-403, 420-424, 423 & 426) from 1981 to 1992 based on minimum numbers born each year, observed calf/cow/spike sex/age ratios and numbers of antlered bulls from population buildback data (Table 8).

	81	82	83	84	85	86	87	88	89	90	91	92
FEBRUARY												
ANTL BULL		2532	2544	2499	2444	2456	2288	2195	2043	2127	1944	1965
SPIKE	1074	1138	1115	1099	1074	1020	1013	1018	1034	1026	1025	1020
YRLG COW	1074	991	944	923	877	871	875	888	882	881	877	878
COW	7634	7866	7784	7609	7227	7176	7215	7323	7270	7263	7224	7235
CALF	2260	2214	2182	2133	2026	2012	2023	2053	2038	2036	2025	2028
TOTAL POPn		14741	14569	14263	13649	13535	13414	13477	13267	13333	13095	13125
JUNE-AUG												
ANTL BULL	3457	3670	3659	3597	3518	3477	3301	3213	3077	3153	2969	2984
SPIKE	1198	1174	1156	1131	1074	1066	1072	1088	1080	1079	1073	1075
YRLG COW	1062	1041	1026	1003	952	946	951	965	958	957	952	953
ADULT COW	8708	8857	8728	8532	8104	8047	8091	8211	8152	8144	8101	8112
CALF	6966	7086	6983	6826	6484	6437	6473	6569	6522	6515	6481	6490
FALL HARVEST												
BULL	925	1126	1160	1153	1062	1189	1106	1170	950	1209	1004	1080
COW	177	443	511	756	340	228	147	345	288	326	265	139
CALF	185	402	886	1296	681	862	629	1156	780	939	696	259

February 1981 population estimate from Table 5 except antlered (2.5+) bulls from Table 7.

June-August population
Antlered Bull = sum of antlered bull + spikes in February
Spikes = February calves x .53
Yrlg Cow = February calves x .47
Adult Cow = February yrlg cow + adult cow
Calf = June-Aug adult cow x .80

Fall Harvest from Table 6.

February 1982 population
Antlered Bull = June-Aug antlered bull - fall bull harvest (assume no additional winter mortality)
Spike = June-Aug spike x .95 (5% natural mortality)
Yrlg Cow = June-Aug yrlg cow - apportioned yrlg cow harvest x .95 (5% natural mortality)
Adult Cow = June-Aug adult cow - apportioned adult cow harvest x .92 (8% natural mortality in oldest classes)
Calf = February adult cow + yrlg cow x .25 (observed cow/calf ratio)

Table 9. Elk population estimates and harvests in northern Idaho.

Unit	Year	Males	Females	Total	Popn	% Harv
4	86-90	420	186	641	4000	16
6	86-90	298	156	454	2600	17
7	86-90	228	116	344	1900	18
9	86-90	90	39	129	684	19

ESTIMATED POPULATIONS AND HARVESTS IN NORTHERN IDAHO

In Idaho, elk of all age and sex classes may be harvested during general open seasons. A large portion of the harvest is spike bulls (20%) while none may be harvested in B.C. In southern Idaho up to 90% of the bulls (spikes and branched) may be taken each year without affecting reproductive rates (Jim Hayden - personal communication). If the bull/cow ratio drops below 14/100, cows miss oestrus cycles and late calves become more common. Increasing the harvest of cows above 15% leads to a decline in the population. A main management objective is to maintain 20% of the bull harvest as mature (6 pt) animals and maintain a post-harvest ratio of 20 bulls / 100 cows. General open hunting seasons are usually set in October after the rut so that all bulls are available for breeding in September.

Population estimates have been made using the sightability model for four hunt units in northern Idaho. The average annual harvest of elk from those units and the estimated populations are shown in Table 9. Sixteen to 19% of the total population is harvested annually and about 10% of that total is males. The proportion of the total population harvested in each age sex class in northern Idaho (1982-1986) and the southern Trench in B.C. (1983-1992) are as follows:

	% harvest of Tot. popn Idaho		% harvest of Tot. popn B.C.
bulls	5.4		8.5
spikes	3.1		0
male calf	1.4		
female calf	1.3	all calves	6.3
cows	5.2		2.6
Totals	16.4		17.4

The total harvest in southern B.C. is similar to that in northern Idaho but the distribution among various sex/age classes has been altered by hunting regulations in B.C. which protect spike bulls and cows. General open hunting seasons are much longer in B.C. (40 days) than in Idaho (12-26 days) and hunting is permitted during the rut in B.C. Protection of spike bulls helps to ensure that possible overharvests to the male component of the population will not reduce the bull/cow ratio below the number required for breeding (20:100).

Table 10. Elk population estimates from aerial surveys and the estimated population based on harvest data and modelling (Table 8).

	Aerial Censuses					Harvest
	Trench 1992	Elk Valley 1992	Elk Valley 1993	Mean Elk Valley	Total South Trench	Model Estimate South Trench
Cows	5958	1049	1442	1245	7203	8112
Calves	1518	216	238	227	1745	2028
Spikes	760	49	295	172	932	1020
Bulls	691	102	67	84	775	1965
Totals	8,927	1,416	2,042	1,728	10,655	13,125

CONCLUSIONS

Based on the information available we have estimated the elk population in the southern Rocky Mountain Trench (MU's 401-403, 420-424, 423 & 426) to be approximately 13,000 animals (Table 8). Annual recruitment after natural mortality averages 2000 animals and this number has been balanced by hunter harvests which have averaged 2200 animals annually since 1983 (Table 6). The exploitation rates of the population appear similar to those in northern Idaho where comparable aerial census estimates are available.

The results suggest that the Idaho elk census model can accurately estimate the number of cows, calves and spike bulls in the population but that the number of branched antler bulls is underestimated by about 50%. The reasons for this include lower sightability of bulls due to their preference for habitats with greater cover and their occurrence in small groups. We believe that the model adequately compensates for those variables. Bulls are probably underestimated because they are widely distributed at very low densities and it is not economically feasible to survey large areas where few animals are present. Low density strata survey blocks are defined to include 15-20 animals. Areas where expected numbers are lower are generally rated nil and excluded from the survey area. The "missing" bull component is probably within those very low density habitats which have been generally excluded from the survey areas.

If the number of bulls estimated from aerial surveys is doubled to 1550 the total population estimate from aerial censuses (11,440) would be within 1,685 animals of the estimate generated from harvest statistics (13,125). The estimates would not be significantly different based on the confidence limits of the aerial survey data ($\pm$ 15%). Those animals could also be accounted in drainages which contribute to the harvest but were not included within the southern Trench aerial survey area.