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Interrelationships of Dall Sheep and Predators in the Central Alaska Range

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FEDERAL AID
FINAL RESEARCH REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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PROJECT TITLE: Interrelationships of Dall sheep and predators in the Central Alaska Range

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I PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Dall sheep in the Central Alaska Range (CAR) are valued by both hunters and nonconsumptive users, and proximity of the area to public roads and population centers facilitates access by humans. Although few data are available from the late 1980s, the sheep population in this area declined by an estimated 60% between 1984 and 1994 (Dale 1996). Much of this decline likely occurred during 1990–1994, because lamb production from 1991–1993 averaged only 11 lambs per 100 ewes. Hunter participation decreased annually and harvest of rams declined from a peak of 163 in 1989 to less than 50 in 1993 and remained low through 1997 (Dale 1999). Causes of the decline in sheep numbers are unknown, but severe winters, dry summers, and predation may have been involved. During 1995–1996, 47% of lambs in the CAR were killed by predators during their first year (Scotton 1997). However, little is known about reproduction and mortality of adult sheep and population levels of predators in the area, or if the documented levels of predation are within sustainable levels.

II REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Sheep populations have been surveyed at irregular intervals in many parts of Alaska for several decades, although precise estimates of population size are not available for most areas. Surveys during the 1990s indicated that sheep populations in much of the Alaska

and Brooks Ranges were below levels that occurred during the 1970s and 1980s (Whitten 1997). Spring or summer surveys to assess lamb production and survival were conducted annually from 1993–1997 in the CAR. Scotton (1997) found that coyote predation was an important source of mortality for lambs in the CAR. Previous authors (e.g., Murie 1944; Heimer and Stephenson 1982) suggested that wolf predation on adult sheep might be important to some sheep populations. Wolf numbers in the CAR were reduced by a control program during 1993 and 1994. Greatly varying opinions have been published regarding the effects of predator control on sheep populations. Heimer and Stephenson (1982) suggested sheep populations responded positively to predator reductions in the late 1970s, while Gasaway et al. (1983) and Hayes et al. (2003) concluded that sheep did not respond to predator reduction. Studies elsewhere have suggested that competition with resident wolves can restrict coyote distribution (Thurber et al. 1992) and that coyote populations fluctuate in response to changes in abundance of snowshoe hares (Todd et al. 1981; O'Donoghue et al. 1997). However, little is known about how changes in populations of predators and other prey species may affect sheep populations.

III APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Estimate annual pregnancy and birth rates for adult ewes.

Ewes were captured by helicopter net-gunning during March 1999–2002. Captured ewes were radiocollared and blood samples were obtained for pregnancy determination. Nineteen ewes were captured in 1999, 22 in 2000 (includes 13 recaptures), 23 in 2001 (includes 19 recaptures), and 19 in 2002 (all recaptures). No ewes died as a direct result of capture. The only serious injury caused by net-gunning was that 1 ewe suffered a fracture of the base of one horn, and seemed slightly disoriented after release. This ewe was killed by wolves approximately 1 week after release, and may have been more vulnerable to predation because of its injury. Pregnancy rates based on serum progesterone levels were 89, 91, 74, and 95% during 1999–2002, respectively (Appendix:Table 1). Surviving ewes were observed by aerial radiotracking several times per week during the lambing period to obtain minimum estimates of birth rates (some lambs may have died soon after birth and before they were observed). Minimum birth rates during 1999–2003 were 75, 76, 68, 55, and 44%, respectively (Appendix:Table 1). The reduction in observed birth rates during 2002 and 2003 likely was due to adverse weather conditions, which prevented tracking flights on several days during the peak of lambing and increased the likelihood that some lambs were never observed.

OBJECTIVE 2: Estimate lamb survival to yearling age class and determine causes of mortality.

Lambs were captured by hand after pursuit with a helicopter during mid May–early June when lambs were 1–2 days old. Captured lambs were radiocollared and monitored during June–April to estimate survival and mortality causes. Twenty-four lambs were captured in 1999, 23 in 2000, 23 in 2001, 24 in 2002, and 20 in 2003. No lambs were injured or died as a result of capture. Lambs were located by aerial radiotracking several times per week during late May and 1–2 times per month thereafter. Survival was

estimated using the Kaplan–Meier staggered-entry model of Pollock et al. (1989) using days as the intervals. If the date of a lamb's death was not known precisely, then the midpoint of the last date the lamb was known to be alive and the first date it was known to be dead was assigned as the date of death. First-year survival rates of lambs born in 1999–2002 were 0.12 (s = 0.06), 0.23 (0.08), 0.16 (0.08), and 0.36 (0.10), respectively (Appendix:Table 1). Lambs born during 2003 will be monitored as part of Federal Aid Project 6.14. Predation was the most common cause of death of lambs (90% of deaths for 1999–2002 cohorts). Coyotes and golden eagles were the main predators (40 and 30% of all mortality, respectively). In addition, 20% of deaths were ascribed to unknown predators; many of these cases showed signs of use by coyotes and one or more other predators. Wolves, wolverines, and possibly grizzly bears accounted for small numbers of deaths. Other sources of mortality included drowning, falls, and starvation (probably due to abandonment).

OBJECTIVE 3: Estimate annual survival and determine causes of mortality of adult ewes.

Radiocollared ewes (≥3 years old) were monitored approximately twice per month from March 1999 to June 2003 to estimate survival and causes of mortality. Survival was estimated using the Kaplan–Meier staggered-entry design of Pollock et al. (1989) using months as intervals. Annual survival rates were 0.76 (s = 0.08), 0.90 (0.06), 0.91 (0.06), and 0.86 (0.08) for years beginning 1 May 1999–2002, respectively (Appendix:Table 1). Mean annual survival for the 4 years was 0.86 (0.07). All 14 deaths observed during this period were caused by predators: 8 by wolves, 1 each by grizzly bears and wolverines, and 4 by unknown predators (3 were probably caused by wolves but wolverines or coyotes had also used the sites).

OBJECTIVE 4: Monitor movements of coyotes in relation to sheep distribution to determine proportion of coyotes that forage in sheep habitat.

From March 1998–June 2003, 19 coyotes were captured and radiocollared, then located approximately twice per month to determine home ranges, habitat use, movement patterns, and reproductive success. These included 15 resident adults (5 M:F pairs, plus 5 additional coyotes that replaced residents that died), 3 pups (2 M, 1 F; aged 10–13 months), and 1 dispersing 2-year-old male. All radiocollared coyotes were captured using Palmer CapChur™ darts; no serious injuries or deaths were caused by this method. During 1999, 2 other coyotes died as a result of excessive dart penetration during an experimental trial of a different brand of darts (PneuDart™). This type of dart was not used for any other captures. Mean annual home range size (minimum convex polygon models) was 43.4 km^2 for 3 adult pairs whose home ranges encompassed mountainous terrain occupied by sheep (elevations 700–2000 m) and 193 km^2 for 2 pairs whose home ranges were primarily in foothills, where sheep were absent (elevations mostly below 1000 m). Home ranges of the 3 pairs in the mountainous region were stable in size and location among years. Conversely, ranges of the foothills pairs were more variable in both size and orientation, and one of these ranges was abandoned due to death of the adult female and emigration of the male. During 2000, 4 of 5 coyote pairs denned and produced ≥1 pup each. Three of 5 pairs produced ≥1 pup during 2001, and no denning behavior or pups were observed during 2002 or 2003 (n = 3 and 4 resident pairs,

respectively). More detailed analyses of home range dynamics and movements of coyotes will be completed as part of a follow-up study (Federal Aid Project 6.14).

OBJECTIVE 5: Determine the extent to which resident coyotes prey on lambs vs. alternate prey.

Timing and locations of lamb mortalities due to coyote predation also were recorded. These data will be compared among years as part of Federal Aid Project 6.14. In addition, logistical support was provided to University of British Columbia graduate student Laura Prugh for a study of how coyote diets change in relation to changes in abundance of major prey species. Fieldwork was completed in July 2002 and data analysis is underway.

OBJECTIVE 6: Assess trends in sheep population and reproductive success over time.

The sheep population in the study area was surveyed annually during June 1998–2003 (Appendix:Fig 1). Surveys consisted of intensive searches conducted with R-22 helicopters. Sheep were counted and classified as lambs, yearlings, adult ewes, or adult rams (4 horn size classes). The population in units surveyed every year (survey units I–III) increased from 408–690 during 1994–1999, then declined steadily to 496 in 2002 (Appendix:Table 2). By 2003 the population had increased to 675, due mainly to high survival of lambs from the 2002 cohort (117 yearlings were counted in 2003 vs. 17 during 2002). Reproductive success indicated by lamb:ewe ratios in June (a function of birth rates and neonatal survival) was low during 2000–2001 (30–31 lambs:100 ewes), then increased during 2002–2003 (43–49 lambs:100 ewes). These data corroborate estimates of survival rates obtained from radiocollared lambs (Objective 2), which were low during 1999–2001, then increased during 2002.

OBJECTIVE 7: Determine nesting success of golden eagles.

In cooperation with the National Park Service, the central portion of the sheep study area was surveyed to determine nest occupancy by golden eagles in July 2000, and in April and June 2002 and 2003. In 2000, 7 pairs of eagles produced at least 1 fledgling each. Only 1 pair was observed occupying a nest in 2002, and this pair had abandoned the nest by mid-May without producing a fledgling. In 2003 a larger area was surveyed, and 8 nesting pairs were observed, 4 of which were within the original survey area.

OBJECTIVE 8: Analyze and publish results.

Further analyses of home ranges, habitat use, and movements of coyotes, locations and timing of lamb mortality, and preparation of manuscripts for publication will be completed under Federal Aid Project 6.14.

IV MANAGEMENT IMPLICATIONS

The Dall sheep population in the CAR declined between 1999–2002, despite a series of relatively mild winters. This suggests that the high mortality rates observed during this period were not sustainable. Predation was the most common cause of death for both lambs and adult ewes. However, predation on adult ewes was relatively low, and the primary predators of lambs were coyotes and golden eagles. Both of these predators rely

mostly on smaller prey, such as snowshoe hares (L Prugh, University of British Columbia, unpublished data; McIntyre and Adams 1999). Because snowshoe hares in northern regions exhibit dramatic population cycles, predation rates on alternate prey, such as lambs, might also be expected to change over time. During this study, the snowshoe hare population reached a peak during 1999–2001, then declined dramatically during 2002–2003 (L Prugh, University of British Columbia, unpublished data; ADF&G unpublished data). Although the number of known resident coyote pairs within the area occupied by sheep did not change substantially, these coyotes failed to produce pups during the 2 years after the hare decline. Similarly, no successful nesting by golden eagles was recorded in the area during 2002, and nest occupancy during 2003 was approximately half what was observed during 2000 (ADF&G and US National Park Service unpublished data). Thus, total numbers (adults plus offspring) of the main predators of lambs likely declined in response to the hare population decline. The net effect of these changes was that lamb survival approximately doubled during the second year after the hare population declined (0.36 during 2002 vs. a mean of 0.17 during 1999–2001).

Predation of lambs by both coyotes and eagles may be affected by weather conditions. For example, predation by coyotes in the CAR was high for several weeks after a heavy snowfall in January 2000. Conversely, predation by eagles during May 2003 was less than during the previous 4 years, possibly because stormy weather during the lambing period prevented eagles from hunting effectively during the period when lambs were most vulnerable. Weather also may influence timing and duration of the lambing period (Rachlow and Bowyer 1994), which may in turn affect lamb survival. In the CAR, an extended lambing season during May–June 2001 was associated with lower survival of lambs, compared to the previous year (Appendix:Table 1). Thus, potential effects of weather conditions must be considered when assessing the importance of predation on sheep.

Dall sheep in the Alaska Range are subject to predation by several species of predators, including wolves, wolverines, grizzly bears, coyotes, and golden eagles. All of these predators commonly prey on other species, and sheep are usually a relatively minor component of each predator’s diet. However, the cumulative effect of predation from many sources may significantly affect sheep populations. This is especially true if predator abundance increases in response to increases in some other prey, such as snowshoe hares. Results from this study suggest that, during the peak of the snowshoe hare cycle, predation of lambs by coyotes and eagles was sufficiently high so as to cause the sheep population to decline. However, predation rates were greatly reduced after the hare population declined, and likely will remain low until hares have again increased. In northern areas where populations of snowshoe hares undergo dramatic cycles in abundance, predator-caused mortality of alternate prey, such as Dall sheep lambs, may periodically exceed sustainable levels. Therefore, long-term persistence of sheep in these areas may depend on the ability of the sheep population to grow sufficiently during low and intermediate phases of the hare population cycle so as to accommodate periodic declines when hares and their predators are abundant. Managers should be aware that lamb mortality rates may differ greatly among years, but some of these changes can be predicted based on changes in snowshoe hare populations, especially in areas where

coyotes and golden eagles are present. This knowledge should help managers interpret results of periodic sheep population surveys and identify potential causes of population trends.

V SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN FOR LAST SEGMENT PERIOD ONLY

JOB 1: Estimate annual pregnancy and birth rates for adult ewes.

Ewes were not captured during FY03, thus, no blood samples were obtained for pregnancy determination. Eighteen radiocollared ewes were monitored during May and June 2003. Of these, 8 (44%) were seen with lambs during mid to late May. The observed lambing rate in 2003 was much lower than in the 4 previous years (75, 76, 68, and 55%, respectively; Appendix:Table 1). This may have been due to bad weather (clouds, fog, and snow showers) during much of the lambing period, which greatly reduced visibility and prevented observation flights on several days.

JOB 2: Estimate lamb survival to yearling age class and determine causes of mortality.

Fourteen lambs collared during May 2002 were monitored during July 2002–June 2003. Nine lambs survived the year, 1 was killed by coyotes, 2 were killed by coyotes or wolves, 1 was killed by an unknown predator, and 1 collar could not be recovered due to hazardous terrain. Annual survival, estimated with the Kaplan–Meier staggered entry method (Pollock et al. 1989), was 0.36 (s = 0.10; Appendix:Table 1). Twenty additional lambs were radiocollared during May 2003. Survival of these lambs will be assessed as part of Federal Aid Project 6.14. No injuries or deaths due to capture methods occurred during 2002 or 2003.

JOB 3: Estimate annual survival and determine causes of mortality of adult ewes.

Twenty previously-collared ewes were monitored during FY03. Two ewes died during the period, both killed by unknown predators. Annual survival, estimated with the Kaplan–Meier staggered entry method (Pollock et al. 1989), was 0.86 (s = 0.08; Appendix:Table 1).

JOB 4: Monitor movements of coyotes in relation to sheep distribution to determine proportion of coyotes that forage in sheep habitat.

Movements of 8 radiocollared coyotes were monitored during FY03. These comprised 4 resident adult pairs. One adult female was captured and radiocollared during November 2002, and seemed to be associated with a resident male whose previous mate had died. However, the new female died of undetermined causes during May 2003 and the male was found alone on all subsequent locations. One new adult male was captured during February 2003, and seemed to be paired with a collared female whose previous mate was killed by a trapper during January 2001. These coyotes shared a home range but were rarely found together after March 2003. Other collared coyotes also were found alone on most occasions, and no evidence of denning or pup production was observed in either 2002 or 2003. Data on home ranges and habitat use were collected and will be compared with sheep distributions to assess coyote foraging behavior. In addition, University of British Columbia graduate student Laura Prugh began analysis of coyote feces collected

during 1999–2002 and assessed populations of hares and small rodents as part of a cooperative study of coyote foraging behavior in the study area.

JOB 5: Determine the extent to which resident coyotes prey on lambs vs. alternate prey.

Locations of known or suspected coyote kills were recorded and the spatial and temporal distribution will be compared among years.

JOB 6: Assess trends in sheep population and reproductive success over time.

The sheep population was surveyed on 20 June 2003 using an R-22 helicopter. The population in survey units I–III increased from 496 in 2002 to 675 in 2003 (Appendix:Table 2, Fig 1). Within these units, 120 lambs and 117 yearlings were counted during 2003, a substantial increase in yearlings since 2002, when 108 lambs and 17 yearlings were counted. The ratio of lambs:ewes was 43:100.

JOB 7: Determine nesting success of golden eagles.

In cooperation with the National Park Service, the central portion of the study area was surveyed by helicopter during April and June 2003 to determine nest occupancy by golden eagles. Eight nesting pairs were observed, 4 of which were within the area surveyed during both 2000 and 2001.

JOB 8: Analyze and publish results.

Analysis of lamb and ewe survival rates, and home ranges and movements of coyotes has begun. Additional analyses and preparation of manuscripts for publication will occur during 2003–2005 as part of Federal Aid Project 6.14.

VI ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THE LAST SEGMENT PERIOD, IF NOT REPORTED PREVIOUSLY

State funds were provided to begin genetic analysis of coyote fecal samples obtained during this study. These data will be used to estimate annual coyote population size and to characterize individual diets of radiocollared coyotes as part of Laura Prugh's graduate studies.

VII PUBLICATIONS

Preparation of manuscripts for publication will occur during 2003–2005 as part of Federal Aid Project 6.14.

VIII RESEARCH EVALUATION AND RECOMMENDATIONS

These results indicate that predation can be a significant factor limiting Dall sheep populations in the CAR, and that predation rates are affected by changes in populations of other prey, especially snowshoe hares. Hare populations cycle over periods of approximately 10 years, and the current study recorded predation rates only during the peak and initial decline of the hare population. Further research is needed to determine how long predation rates remain low following a decline in hare abundance. Because

golden eagles are also a significant predator of lambs, and nesting success of eagles also varies with hare abundance, additional work should include an investigation of eagle nesting success and diets during the period when hares are scarce.

IX PROJECT COSTS FROM LAST SEGMENT PERIOD ONLY

FEDERAL AID SHARE $31,652 + STATE SHARE $10,551 = TOTAL $42,203

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XI APPENDIX

TABLE 1 Dall sheep pregnancy, birth, and survival rates in the central Alaska Range, 1999–2003

			Ewes		Lambs	
Year	Pregnancy (%)	Birth (%)	Survival	*s*	Survival	*s*
1999	89	75	0.76	0.08	0.12	0.06
2000	91	76	0.90	0.06	0.23	0.08
2001	74	68	0.91	0.06	0.16	0.08
2002	95	55	0.86	0.08	0.36	0.10
2003		44				

TABLE 2 Results of sheep composition surveys in the central Alaska Range (survey units I–III), 1984–2003

Year	Date	Ewes	Lambs	Yearlings[a]	Rams	Total	Lambs:Ewe	Rams:Ewe
1984	11–12 Jul	605	231		266	1102	0.38	0.44
1991	22–25 Jul	374	68		195	637	0.18	0.52
1994	4 Jun	211	72		125	408	0.34	0.59
1995	7 Jun	249	109	61	167	586	0.44	0.67
1996	9 Jun	267	137	95	158	657	0.51	0.59
1997	17 Jun	212	85	93	177	567	0.40	0.83
1998	17 Jun	287	117	69	192	665	0.41	0.67
1999	10–11 Jun	267	138	75	210	690	0.52	0.79
2000	24–25 Jun	279	84	67	185	615	0.30	0.66
2001	21–22 Jun	234	72	48	198	552	0.31	0.85
2002	20–22 Jun	219	108	17	152	496	0.49	0.69
2003	20 Jun	279	120	117	159	675	0.43	0.57

[a] The 1984, 1991, 1994 surveys used a Super Cub airplane, yearlings were classified with ewes. Surveys during 1995–2003 used a R-22 helicopter, yearlings were separated from ewes.

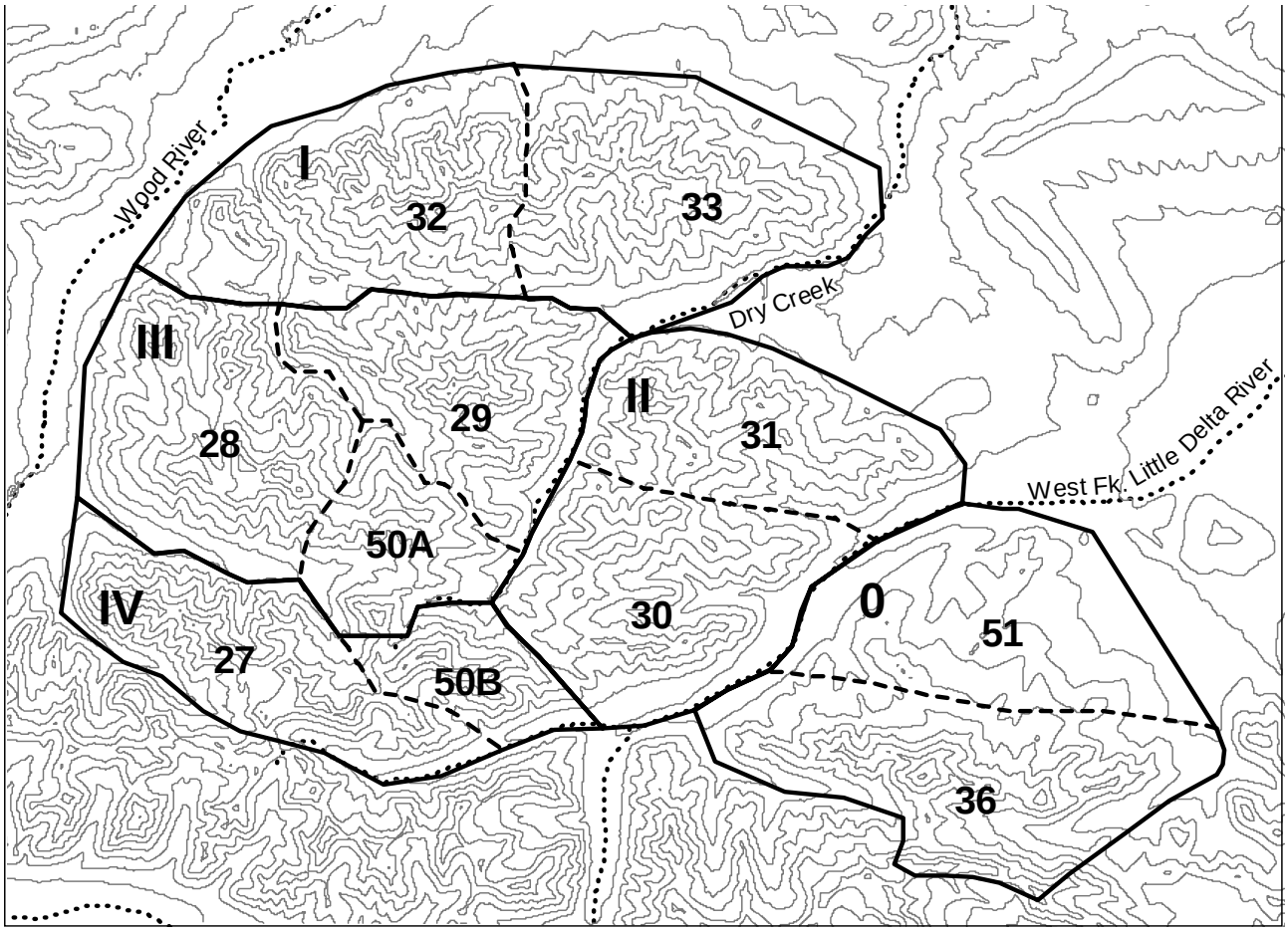

FIGURE 1 Area surveyed for Dall sheep during June 1998–2003. Dark lines and Roman numerals indicate units surveyed during previous years; dashed lines and Arabic numerals indicate subdivisions surveyed with little or no interruption; dotted lines indicate streams. Some portions of survey units 0 and IV were not surveyed during some years.

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