Wild Sheep Status and Management in Western North America: Summary of State, Province, and Territory Status Report Surveys

AUTUMN LARKINS, *Oregon Department of Fish and Wildlife, P.O. Box 8, 237 Highway 20 South, Hines, OR 97738, USA*

Abstract: I surveyed 21 western game and fish agencies in western North America to collect information wild sheep (*Ovis spp*.) population status and management. I utilized a new on-line data collection method called Survey Monkey. I received responses from 21 agencies (100% return rate). Information and data was interpreted as accurately as possible; and are summarized by state, province, or territory, wild sheep species or subspecies, and by issue. My objectives were to: 1) collect and synthesize long term demographic data for wild sheep in western North America; and 2) illustrate current issues affecting wild sheep management.

Key Words: California bighorn sheep, *Ovis canadensis californiana*, Dall's sheep, *Ovis dalli dalli*, Desert bighorn sheep, *Ovis canadensis nelsoni*, Rocky Mountain bighorn sheep, *Ovis canadensis canadensis*, Sierra Nevada bighorn sheep, *Ovis canadensis sierrae*, Stone sheep, *Ovis dalli stonei*.

Proceedings of the Northern Wild Sheep and Goat Council 17:8–28; 2010

Email: Autumn.N.Larkins@state.or.us

The Biennial Conference of the Northern Wild Sheep and Goat Council (NWSGC) is one forum wildlife biologists and mountain ungulate advocates can utilize to interact, and exchange data and ideas. The symposium typically includes a status report on wild sheep populations, and related management issues, provided by participating western game and fish agencies. My objectives with this report were to disseminate standardized, comprehensive information to participants on 1) wild sheep funding; 2) population status; 3) surveys conducted; 4) hunter numbers and harvest; 5) current research being conducted; 6) formats that allows possible determination of long term trends; and 7) explore current issues and concerns related to wild sheep management in western North America.

METHODS

Surveys were sent to 21 state, provincial and territorial game and fish agencies. Surveys were sent to lead biologists at each agency for each taxon of interest in that jurisdiction. Numerous attempts and liberal timelines were allowed to ensure as complete a summary as possible.

I utilized a new on-line data collection method called Survey Monkey. I purchased a professional account that allowed for an unlimited number of questions and unlimited responses. The Survey Monkey professional account provided the ability to download all data into spreadsheets and also utilize advanced reporting and charting tools. The design phase was enabled with skip logic to speed entry response time, and to modify settings and restrictions tailored to suit my specific survey needs. This electronic survey system theoretically saves data entry and analysis time for the compiler. The survey requested information on species-specific demographic information, funding, population status, survey and management

techniques, introductions and augmentations, hunter numbers and harvest, current research projects and published papers, habitat issues, and disease incidence or concerns. Responses were summarized and reported by taxon, topic, and state, province or territory where possible. Due to incomplete responses and non-reporting, few statistical analyses were conducted. However, in many cases trends in various population and hunter parameters may be apparent in the tabularized information.

RESULTS

I received responses from 21 of 21 surveys sent (100%). I did encounter some technical difficulties with the system: 19% of agencies surveyed had initial problems saving data, 14% were unable to complete the survey electronically and submitted hard copies, and 5% found the survey design to be incompatible with their specific data set. Sixty-two percent of the respondents had no issues with the system. Some additional issues that we experienced using Survey Monkey were 1) limited question design options; 2) difficulty in capturing detailed responses (no explanation option); 3) many questions had specific requirements (i.e., numerical answer only) which would "hook" the user and not allow the respondent to move forward to the next question. Some other comments that I received on the process were that participants would prefer to be able to review questions, gather information and enter data in stages, be allowed to go back and modify answers that had already been submitted, and users wanted the ability for multiple people to enter data for different sections of the survey. The numbers of state, provincial or territorial agencies reporting specific data varied considerably and was inconsistent throughout the survey. However, all complete and partial responses were included in this report. The potential shortcomings of the summary must be considered when reviewing the results as they were received from the responding agencies and interpreted by the compiler.

Funding

Every agency provided information on funding sources for each species of wild sheep that they manage (Figure 1). I combined results for all bighorn and thinhorn species for easier representation of the data. Out of the bighorn data, 50% indicated the use of auction and/or raffle money for funding, 27% utilized license and tag fees, 13% used general funds, 10% used federal funds, and 23% used other sources of funding. The thinhorn data indicated that 83% utilized general funds, and 17% used both federal funds and other sources of funding.

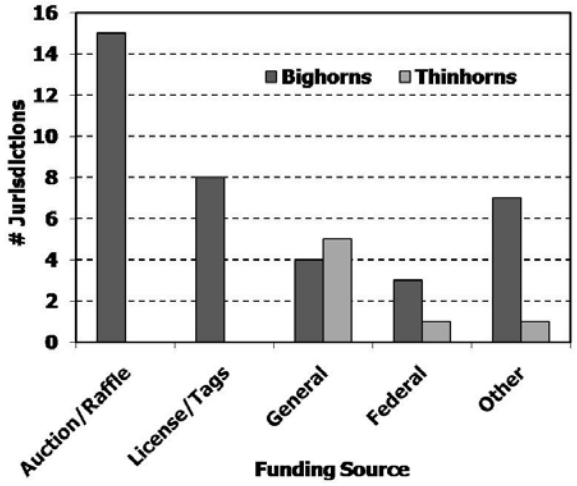

Figure 1. Funding sources reported by NWSGC agencies for bighorn and thinhorn sheep management.

Rocky Mountain Bighorn Sheep.— Fifteen out of 21 (71%) agencies reported on Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*). Of those agencies providing data, only 60% provided data for 1970, 73% provided data for 1980, 86% provided data for 1990, and 100% provided data for years 2000 and 2010 (Table 1). These gaps in the data must be noted when looking at the overall population estimates. Two agencies (North Dakota and South

Table 1. Wild Sheep population estimates reported by western states, provinces, and territories in North America 1970 – 2010.

Species	Jurisdiction	1970	1980	1990	2000	2010
Rocky Mountain Bighorn Sheep	Alberta	6,500	6,500	6,900	6,300	6,400
	Arizona		50	200	700	1,000
	British Columbia				2,000	2,300
	Colorado	2,200		5,500	7,500	6,900
	Idaho	2,000	2,090	3,850	1,710	2,000
	Montana	1,500	4,600		5,820	6,370
	Nebraska			60	100	250
	Nevada		50	140	210	300
	New Mexico	275	740	595	650	840
	North Dakota	100	150	250	150	350
	Oregon			500	800	750
	South Dakota	200	200	300	425	500
	Utah	50	100	300	900	1,900
	Washington		70	300	210	229
	Wyoming	2,577	4,220	7,069	6,495	6,200
	Totals	15,402	18,770	25,964	33,970	36,289
California Bighorn Sheep	British Columbia				2,400	3,000
	Idaho	90	350	1,240	1,350	1,250
	Nevada	20	50	480	1,400	1,900
	Oregon			1,700	3,000	3,400
	Utah				100	425
	Washington	300	550	600	795	900
	Totals	410	950	4,020	9,045	10,875
Desert Bighorn Sheep	Arizona	4,000	4,500	5,000	5,000	4,500
	California	3,700		3,465	4,143	
	Colorado			275	460	480
	Mexico					3,800
	Nevada	2,500	2,900	3,800	4,900	7,400
	New Mexico	170	70	130	195	550
	Texas	70	100	150	450	1,500
	Utah	400	600	1,500	2,500	2,800
	Totals	10,840	8,170	14,320	17,648	21,030
Sierra Nevada Bighorn Sheep	California	250	300	200	120	400
Dall's Sheep	Alaska	35,000 – 50,000	73,650	73,250	50,000 – 64,000	
	British Columbia				400 – 600	400 – 600
	Northwest Territories				14,000 – 26,000	14,000 – 26,000
	Totals	35,000 – 50,000	73,650	73,250	64,400 – 90,600	14,400 – 26,600
Stone Sheep	British Columbia				8600-12500	9600-13400

Dakota) indicated increases in Rocky Mountain bighorn sheep populations in the last 40 years. Eight agencies (53%) reported stable populations, one agency (Nebraska) reported stable to slightly declining populations, two agencies (Idaho and Oregon) indicated declining populations, and one agency (New Mexico) reported variable population trends depending on herd.

California Bighorn Sheep.— Six out of 21 (29%) agencies reported on California bighorn sheep (*Ovis canadensis californiana*). Of those agencies providing data only 50% provided data for both 1970 and 1980, 67% provided data for 1990, and 100% provided data for years 2000 and 2010 (Table 1). Two agencies (Nevada and Washington) indicated increasing California bighorn sheep populations. Two agencies (British Columbia and Utah) reported stable to slightly increasing populations. Idaho reported a stable population. Oregon reported variable population trends depending on the herd.

Desert Bighorn Sheep.— Eight out of 21 (38%) agencies reported on desert bighorn sheep (*Ovis canadensis nelsoni*). Of those agencies providing data only 75% provided data for 1970, 63% provided data for 1980, and 88% provided data for the remaining three time periods 1990, 2000, 2010 (Table 1). Six agencies indicated increasing desert bighorn sheep populations. Arizona reported a stable to slightly increasing population, and Utah reported their population as stable.

Sierra Nevada Bighorn Sheep.— Only the state of California has this subspecies. They provided population estimates for all forty years and indicated that the population of Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*) is increasing (Table 1).

Dall's Sheep.— Four agencies out of 21 (19%) reported on Dall's sheep (*Ovis dalli dalli*). Of those agencies providing data only 25% provided data for 1970, 1980, and 1990, 75% provided data for 2000, and 50% provided data for 2010 (Table 1). Unlike the bighorn sheep data, many of the thinhorn sheep agencies reported populations as a range with lower and upper bounds. Three out of the four agencies reported stable Dall's sheep populations, while Alaska reported a variable population trend.

Stone Sheep.— Two agencies out of 21 (9.5%) reported on Stone sheep (*Ovis dalli stonei*). Only British Columbia offered population estimates and only they provided the data for 2000 and 2010 (Table 1). Both British Columbia and Yukon declared that their Stone sheep populations are considered stable.

All twenty one agencies listed what they felt were the one to three main causes of population change by subspecies in their respective state, province or territory over the last forty years (Table 2). A wide variety of causes were given but several were repeated numerous times. Disease events were identified by 13 (62%) agencies as a negative effect, and translocations were listed by 13 (62%) agencies as a positive effect on sheep populations. Predation, primarily by mountain lions, was reported by 10 (47.6%) agencies as the third largest detriment to wild sheep populations. Proactive herd management and habitat improvements were listed by 9 (43%) agencies. Climate change ranked as the next highest cause of change in 8 (38%) agency reports. Vegetative succession, noxious weeds, cattle grazing, and overall habitat fragmentation were each listed by 7 (33%) agencies. Land use (increased access and/or abuse) was identified by 6 (29%) agencies.

Some reasons for population change specific to each subspecies were also identified. Changes to winter feeding programs in Washington and increased road

Table 2. Main causes of wild sheep population changes reported by western states, provinces, or territories over the last forty years.

Species/Subspecies	Jurisdiction	Causes of Population Change
Rocky Mountain Bighorn Sheep	Alberta	1) Vegetative succesSon affecting wintering habitat. 2) ATV/OHV abuses in habitat. 3) Predation (mountain lions).
	Arizona	1) First immigrated from population in New Mexico. 2) Focused on managing populations. 3) Increased translocation and enhancement activities.
	British Columbia	1) Pressure from access, land use, development. 2) Die-off in 1980s in East Kootenay. 3) Subsequent habitat management and proactive herd management.
	Colorado	1) Multiple transplants to reestablish new populations. 2) Stabilization during last 10 years a result of decreased transplant activity coupled with disease outbreaks causing poor lamb recruitment in several herds and all age die-offs in a few herds.
	Idaho	1) Disease: periodic all-age die-offs believed due to contact with domestic sheep, and long-term chronic effects on subsequent lamb recruitment. 2) Habitat change: noxious weed and tree encroachment on critical habitat. 3) Transplants within the Hells Canyon National Recreation Area and the Lost River Range.
	Montana	1) Populations have been increased and expanded through transplant efforts. 2) Since 1984, Montana has had 18 dieoffs of varying magnitudes, some due to documented contact with domestic sheep. 3) Roadkill has been significant in several populations.
	Nebraska	1) Reintroductions to increase. 2) Private Land Acceptance to increase. 3) Disease outbreaks (Pasteurella pneumonia).
	Nevada	1) Introductions. 2) Disease events. 3) Mountain lion predation.
	New Mexico	1) Establishing new populations via translocation--from 4 herds to 9 herds. 2) Declines induced by pnuemonia dieoffs resulting from domestic sheep contact (n=4). 3) Recent declines in alpine herds due to unknown causes, probably linked to winter severity.
	North Dakota	1) All-age-class die-off occured in the southern metapopulation. 2) Introductions. 3) Reintroduced O. c. canadensis from MT's Breaks in 2006 and 2007.
	Oregon	1) Disease events. 2) Mountain lion predation.
	South Dakota	1) Introductions and supplemental transplants. 2) Habitat improvements (controlled burning or wildfires).
	Utah	1) Transplants. 2) Disease issues.

Table 2. Continued.

Species/Subspecies	Species/Subspecies	Species/Subspecies
Rocky Mountain Bighorn Sheep	Washington	1) Disease events. 2) Stopped winter feeding.
	Wyoming	1) Disease events. 2) Shut down in-state BHS transplant actions from 1995-2009. 3) Chronic drought during 2000-2008 impacted herbaceous forage production on many winter ranges.
California Bighorn Sheep	British Columbia	1) Land use, access, development, recovery efforts for Okanagan sheep after die-off in 1999/2000. 2) Herd specific health issues associated with winter range conditions (overgrazing by cattle, forest encroachment, predation).
	Idaho	1) Reintroductions in historic unoccupied habitat. 2) Natural range expansion. 3) Law enforcement.
	Nevada	1) Introductions. 2) Vast areas of moderate to good forage conditions that have allowed for expansion and population increases. 3) Periodic disease event/dieoffs.
	Oregon	1) Drought and associated habitat issues. 2) Predation. 3) Possibly some latent respiratory disease issues in some herds.
	Utah	1) Transplants. 2) Our nursery herd for CA sheep on Antelope Island State Park has recently dropped in population and may have some disease issues.
	Washington	1) Declines due to disease outbreaks (pneumonia). 2) Increases due to transplants to suitable vacant habitat.
Desert Bighorn Sheep	Arizona	1) Drought. 2) Increased mountain lion predation. 3) Habitat fragmentation, primarily roads.
	California	1) Reduced connectivity from habitat fragmentation. 2) Disease risk posed by domestic livestock. 3) Habitat loss through climate change.
	Colorado	1) Reintroduction of the subspecies to Colorado beginning in 1979. 2) Mountain lion predation. 3) Disease events.
	Mexico	1) Populations are increasing due to the economic value. 2) This has led to active management programs and aggressive transplants. 3) This has also led to greater protection of both the animals themselves and their habitats as their value has been increasingly appreciated by landowners.
	Nevada	1) Reintroductions and augmentations. 2) Water developments. 3) Precipitation patterns.
	New Mexico	1) Predator control (mountain lion) since 2001. 2) Translocations primarily from a captive breeding facility since 1979.

Table 2. Continued.

Species/Subspecies	Species/Subspecies	Species/Subspecies
	Texas	1) Aggressive restoration efforts (transplants). 2) Management (habitat management, protection, prevention of domestic sheep within bighorn habitat, management of exotic species and predator control). 3) Improved cooperation between landowners, conservation organizations and TPWD.
	Utah	1) Growth due to transplants. 2) Low reproduction. 3) Potential disease/predation on some units.
Sierra Nevada Bighorn Sheep	California	1) Disease from domestic sheep 2) Predation by mountain lions is directly responsible for the greatest share of mortality and had spiked during the last 2 years. This predation is not compensatory but rather is additive and has limited population growth in some herds. 3) Demographic, genetic, and environmental stochasticity continue to pose a threat while the population is small.
Dall Sheep	Alaska	1) Extensive statewide predator control in the 1940s and 1950s likely contributed the growth of sheep populations throughout the 1960s. 2) Severe winters played a large role in population declines in some areas in the late 1960s and early 1970s, as well as the 1990s. Partly in response to the Mt. Pinatubo eruption (1991) and subsequent cool, short summer in 1992.
	British Columbia	1) None - very remote area, little issues - rock and ice!
	NW Territories	1) Not applicable.
	Yukon	1) Large-scale climatic fluctuations (Pacific Decadal Oscillation). 2) Harvest.
Stone Sheep	British Columbia	1) Predation and alternative prey issues. 2) Fire - range improvements. 3) Increased access with technological advances - jetboats! industrial exploration - seismic activity etc.
	Yukon	1) Large-scale climatic fluctuations (Pacific Decadal Oscillation). 2) Harvest.

kills in Montana have affected Rocky Mountain bighorn sheep populations. Increased law enforcement in Idaho and natural range expansion in Idaho and Nevada has affected California bighorn sheep populations. Demographic, genetic, and environmental stochasticity continued to pose a threat to the Sierra Nevada bighorn sheep subspecies. Extensive predator control in Alaska has likely contributed to the growth of Dall's thin horn sheep populations.

Distributional changes

Rocky Mountain Bighorn Sheep.— Eight of 15 (53%) agencies have relocated animals and expanded the distribution or have established new populations in previously unoccupied habitat (Table 3). Two agencies (Arizona and Wyoming) have experienced increased distribution through natural immigration. North Dakota reported having a major paradigm shift in 2000 when NDGF, working with federal agencies, began managing fewer bighorns in more areas rather than more bighorns in fewer

areas (i.e., increase distribution but with lower population densities).

California Bighorn Sheep.— Four of 6 (67%) agencies responded to the distribution change question for California bighorns. Of those, Utah and Washington reported that introductions and transplants were major causes of increases in distribution. Idaho populations experienced some natural range expansions. British Colombia reported little to no change in distribution.

Desert Bighorn Sheep.— Eight of 8 (100%) agencies responded to the distribution change question for desert bighorns. Colorado and Utah have both experienced increased distribution due to transplants and reintroductions. Arizona and California reported increases as well, but still have fewer occupied ranges than historically documented. Nevada's distribution has increased due to reintroduction and an aggressive water development program, although some available habitat is limited due to domestic sheep grazing and trailing Texas bighorns currently exceed population levels and distribution ranges of the 1800s and continue to expand, whereas New Mexico has remained essentially unchanged since the mid 1980s.

Sierra Nevada Bighorn Sheep.— In the 1970s, distribution of Sierra Nevada bighorn sheep had declined to only 2 known herds in California. Following a series of successful translocations, the number of occupied herd units increased to 7 by the 1990s. Currently, there are 8 herd units with self-sustaining female populations and small numbers of females (<4) have been documented in an additional 3 herd units during the past year. The federal recovery plan for this endangered subspecies requires that 12 of 16 recognized herd units be occupied for recovery.

Table 3. Reported causes of wild sheep distribution changes in the last forty years.

Species/ Subspecies	State/ Province	Little/No Change	Intro. & Trans.	Other
Rocky Mtn Bighorn Sheep	AB	X		
	AZ		X	
	BC	X		
	CO		X	
	ID		X	
	MT	X		
	NE		X	
	NV	X		
	NM			X
	ND			X
	OR	X		
	SD		X	
	WA		X	
	WY		X	
California Bighorn Sheep	BC	X		
	ID			X
	UT		X	
	WA		X	
Sierra Nevada Bighorn Sheep	CA		X	
Desert Bighorn Sheep	AZ		X	
	CA		X	
	CO		X	
	MX		X	
	NV		X	
	NM	X		
	TX		X	
	UT		X	
Dall Sheep	AK	X		
	BC	X		
	NWT	X		
	YK	X		
Stone Sheep	BC	X		
	YK	X		

Dall's Sheep & Stone Sheep.— The distribution of Dall's and Stone sheep for all reporting agencies (6) has for the most part not changed in the past forty years.

In summary it appears that bighorn sheep distribution generally is expanding in most western states and provinces, whereas thinhorn distribution has remained relatively stable over time (Table 3).

Introductions and Augmentations

Rocky Mountain Bighorn Sheep.— Ten of 15 (67%) agencies reported relocating or augmenting Rocky Mountain

bighorn sheep within the last 5 years. Alberta, Idaho, Oregon, South Dakota, and Washington have not performed any translocations since 2005. Due to the variety of reporting styles (i.e. some agencies gave specific numbers and locations, but some did not) the tabular representation of the data has been generalized (Table 4). In central Arizona the

Table 4. Introductions and augmentations of wild sheep over the last 5 years (2005-2010).

	Rocky Mountain Bighorn			California Bighorn			Sierra Nevada Bighorn			Desert Bighorn			Dall Sheep			Stone Sheep		
Jurisdiction	None	Internal	Internal & External	None	Internal	Internal & External	None	Internal	Internal & External	None	Internal	Internal & External	None	Internal	Internal & External	None	Internal	Internal & External
Alaska													X					
Alberta	X																	
Arizona			X								X							
British Columbia		X			X								X			X		
California								X			X							
Colorado			X							X								
Idaho	X			X														
Montana			X															
Mexico											X							
Nebraska			X															
Nevada		X			X							X						
New Mexico			X								X							
North Dakota			X															
NW Territories													X					
Oregon	X					X												
South Dakota	X																	
Texas										X								
Utah		X			X							X						
Washington	X					X												
Wyoming			X															
Yukon													X			X		

primary translocation efforts have been from the main herd near Clifton-Morenci into the West Clear Creek drainage near Camp Verde. British Columbia relocations occurred in the East Kootenay from the Golden herd to south and from the Radium herd to south. During the last 5 years Colorado has conducted 8 translocations, and moved a total of 112 bighorn. Three involved small numbers of animals (<10) for supplemental or experimental purposes; two were reintroductions to historic habitat; one was a range extension into an area recently burned by wildfire; one was for a research project; and one was an out-of-state translocation. Montana reported moving 497 Rocky Mountain bighorn sheep since 2006, 187 within Montana and 310 to various other states. Nebraska received 2 translocations from Montana to western Nebraska in the last 5 years. Nevada moved 30 ewes and lambs to augment a herd and mix sheep from Alberta with sheep from the Wind River Range, Wyoming. New Mexico

relocated 29 sheep to Arizona in 2005. During 2006-2007 two new herds were established in the Rio Grande Gorge, the first with translocations of 23 and 25 individuals, the other in 2007-2008 with translocations of 34 and 27 individuals. New Mexico's augmentations include 5 sheep moved to Turkey Creek in 2005 and an additional 25 sheep to the same location in 2006. North Dakota translocated 20 bighorns from Montana in 2006 and 2007. North Dakota has also conducted four in-state translocations that were all augmentations (n = 28). Utah translocated 249 sheep during eight separate efforts over the last 5 years, 2 of which failed due to disease outbreaks. Wyoming received 62 sheep from Montana during2006 and 2007, and performed an in-state relocation (12 sheep) in 2010.

California Bighorn Sheep.— Five of 6 (83%) agencies reported relocating or augmenting California bighorn sheep within the last 5 years; only Idaho has not performed any since 2005. British Columbia has translocated sheep from the Kamloops area herds to Fraser River herds and West and East Okanagan valley herds, and from Keremeos to the East Okanagan valley herd. Nevada performed augmentations occurring in 2006, 2007, and 2010 involving 3 release sites and 58 California bighorn sheep, primarily ewes and lambs. Oregon has conducted from 1- 4 transplants annually for the last five years. Most in-state transplants have been to augment existing populations, but several new herds have been started as well. Oregon has also provided wild sheep to several other states recently, including Wyoming in 2009. Utah's recent translocations have involved taking sheep from Antelope Island State Park and starting new populations on the Newfoundland and the Stansbury mountains. Within the last 5-years Washington started a new California bighorn sheep population near Chelan, which occurred over two years with sheep from Nevada and Oregon.

Desert Bighorn Sheep.— Six of 8 (75%) agencies reported relocating or augmenting desert bighorn sheep within the last 5 years; only Colorado and Texas have not done so since 2005. Arizona established a new population in the Mineral Mountains near Superior, and near Hell's Half Acre near Wikieup. Arizona also supplemented populations in the Harcuvar Mountains. During 2006, 13 adult females were translocated from the Old Dad Mountains to augment the Eagle Crags on the China Lake Naval Weapons Center in California. Nevada has transplanted 384 desert bighorn sheep into 10 different mountain ranges and has given the state of Utah 40 desert bighorn sheep. New Mexico has transplanted 122 sheep to the following locations: Little Hatchets (28), San Andres (30) in 2005, Big Hatchets (36) in 2006, and 18 to the Caballomountains; 5 to the Ladrones, and 5 to the Peloncillos in 2009. Utah's recent translocations have focused on moving sheep to empty canyons within the Kaiparowits Plateau and the San Juan Dirty Devil area.

Sierra Nevada Bighorn Sheep.— During 2005, 5 adult females were translocated from the Wheeler Ridge herd to augment the Mt. Baxter herd unit. Within 2 years, only 1 of those females remained in that herd. During 2009, 6 females were translocated to augment the Mt. Warren herd unit; 3 were removed from Wheeler Ridge and 3 from Mt. Langley. All 6 females were pregnant when moved and successfully gave birth in their new range. By the end of summer 2009, at least 5 of the lambs born to the translocated females survived.

Dall's Sheep & Stone Sheep.— No translocations or augmentations of Dall's or

Stone sheep have been conducted in the last 5 years by any of the reporting agencies.

Survey Techniques

I asked biologists to describe the field methods that they are using to collect survey data (population estimates and sex and age ratios) for each species. Additionally I asked them to indicate seasonal timing of surveys, frequency of surveys, and whether or not they considered the estimates to be statistically valid. Agencies reported using a variety of methods to survey sheep populations (Figures 2 and 3). Survey data are usually used in models to estimate sheep populations. I did not ask specifically what types of population models agencies used.

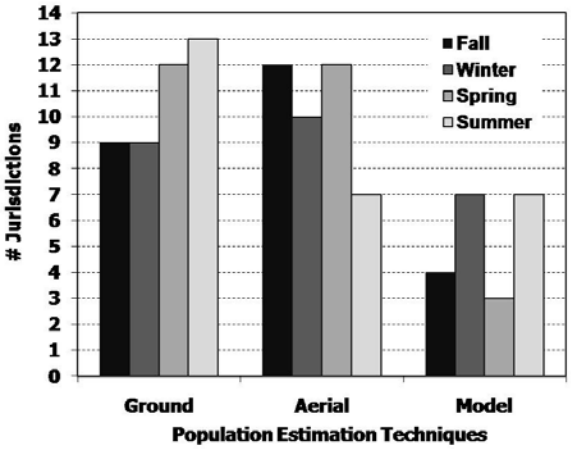

Figure 2. Bighorn and thinhorn sheep population estimation survey methods categorized temporally.

Of those agencies providing data for the fall survey time period, 43% used ground surveys, but only one agency reported these results as statistically valid. Twenty-nine percent calculated ratios from ground-based surveys, but none were being considered statistically valid. Fifty-seven percent of the agencies performed aerial population estimates during the fall, with 25% of those categorized as statistically valid. Forty-three percent obtained sex and age ratio estimates from the air in the fall, with 22% statistically valid. Only 19% agencies utilized population models from their fall surveys.

Of those agencies providing data for winter, 43% performed population estimates and 22% of those were considered statistically valid. Nineteen percent surveyed for ratio estimates on the ground, but none were considered statistically valid. Forty-eight percent of the agencies performed aerial population estimates during the fall, and only 30% of those were categorized as statistically valid. Thirty-three percent obtained sex and age ratio estimates from the air in the fall, and 57% were statistically valid. Thirty-three percent of the agencies utilized population models from their winter surveys.

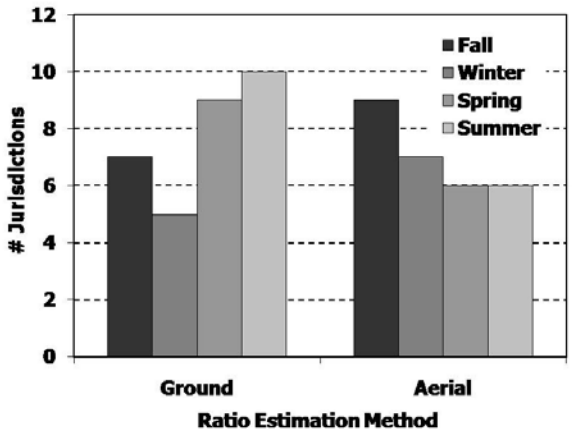

Figure 3. Bighorn and thinhorn sheep sex and age ratio estimation survey methods categorized temporally.

Of those agencies providing data for spring surveys, 52% surveyed for population estimates on the ground and 36% of those were considered statistically valid. Forty-three percent surveyed for ratio estimates on the ground, and 33% were considered statistically valid. Fifty-seven percent of the agencies performed aerial population estimates during the spring, and 50% of those were categorized as statistically valid. Twenty-nine percent obtained sex and age ratios from the air in the spring, but none were considered to be statistically valid.

Only 14% of the agencies utilized population models from their spring surveys.

Of those agencies providing data for the summer survey time period, 67% surveyed for population estimates on the ground and 21% of those were considered to be statistically valid. Forty-eight percent surveyed for ratio estimates on the ground, and 20% were considered to be statistically valid. Thirty-three percent of the agencies performed aerial population estimates during the spring, and 14% of those were categorized as statistically valid. Twenty-nine percent obtained sex and age ratios from the air in the spring, but none were considered to be statistically valid. Twenty-nine percent of the reporting agencies utilized population models from their summer surveys.

Almost all agencies conduct their surveys annually, but a few are performed every 2-5 years depending on herd ranges; several other agencies vary survey frequency depending on funding.

Harvest

The next series of questions in the survey asked agencies to report on their historic and current harvest trends for both males (Table 5) and females (Table 6), number of hunters and hunter success rates (Table 7), as well as type of hunts, weapon restrictions and season restrictions for each specific subspecies of sheep (Table 8).

Rocky Mountain Bighorn Sheep.— Fourteen out of 15 (93%) agencies reported their hunter numbers and harvest success rates; only Utah did not report. There were 16,754 hunters reported over the last 39 years for both sexes, and 3,477 males harvested, with Wyoming and Alberta reporting the highest numbers. There were 725 females harvested since 1970, with Montana reporting the most.

California Bighorn Sheep.— Six out of 6 (100%) agencies reported their hunter numbers and harvest success rates. There were 515 hunters reported for both sexes of California bighorns since 1970. The agencies reported 599 harvested males and 19 harvested females, with British Columbia harvesting the highest numbers overall.

Desert Bighorn Sheep.— Six out of 7 (86%) agencies reported their hunter numbers and harvest success rates. There were 1096 hunters reported since 1970. The agencies that provided data reported 923 males harvested, with Nevada reporting the highest numbers. There are no seasons for female desert bighorn sheep.

Sierra Nevada Bighorn Sheep.— There is no harvest for this taxon.

Dall's Sheep.— Three out of 4 (75%) agencies reported hunter numbers and harvest success rates. There were 11,633 hunters reported since 1970 excluding Yukon. The total harvest was 5097 males and 137 females over the last 39 years, with Alaska reporting the highest harvest rates for both sexes, but British Columbia and Yukon did not provide data on female harvest.

Stone Sheep.— Very little data were provided for Stone sheep. British Columbia reported 830 males harvested since 1980. There is no season for female Stone sheep. Hunter numbers and harvest rates were not provided by the agencies that manage for Stone sheep.

Hunt Type and Weapon Restrictions

Agencies were asked what type of hunts and weapon restrictions they allow for each species, with the option to choose all that apply (Table 8). The hunt type options provided were general season, limited entry/draw, harvest quota, and auction/raffle. The weapon choices were rifle, handgun, muzzleloader, archery and other. Lastly, the season restrictions that were available to select were male harvest only, female harvest only, non gender specific harvest, minimum age requirement, or minimum horn curl or length requirement (Figure 4). The data represented in this

Table 5. Reported ram harvest in North America, 1970-2009. States or provinces not reporting information for a species are not included.

Species/ Subspecies	Jurisdiction	1970	1980	1990	2000	2009
Rocky Mtn. Bighorn Sheep	Alberta	111	228	233	185	157
	Arizona			6	10	11
	British Columbia			60	22	51
	Colorado	15	76	115	137	125
	Idaho	63	28	73	28	34
	Montana	72	111	79	118	152
	Nebraska			3	10	2
	Nevada			2	4	11
	New Mexico	10	7	11	12	19
	North Dakota			7	4	5
	Oregon		5	6	9	11
	South Dakota	6	5	2	6	5
	Utah				9	
	Washington			3		3
	Wyoming	96	182	241	184	196
	Totals	373	642	841	738	782
California Bighorn Sheep	British Columbia			92	34	45
	Idaho	1	4	19	24	21
	Nevada			3	39	47
	Oregon	7	14	46	47	78
	Utah					4
	Washington	10	10	12	16	26
	Totals	18	28	172	160	221
Desert Bighorn Sheep	Arizona	39	39	60	89	75
	California			6	10	
	Colorado			4	7	6
	Nevada	18	66	91	113	172
	New Mexico	5			2	2
	Texas			1	6	16
	Utah	4	10	12	33	37
	Totals	66	115	174	260	308
Dall's Sheep	Alaska		684	1,366	726	788
	British Columbia			11		7
	Northwest Territories				200	200
	Yukon		255	368	243	249
	Totals		939	1,745	1,169	1,244
Stone Sheep	British Columbia			245	278	307

Table 6. Reported ewe harvest in North America, 1970-2009. States or provinces not reporting information for a species are not included.

Species/Subspecies	Jurisdiction	1970	1980	1990	2000	2009
Rocky Mtn. Bighorn Sheep	Alberta	29	44	31	35	45
	British Columbia			44	1	
	Colorado		3	18	56	25
	Montana	19	68	117	32	158
	Totals	48	115	210	124	228
California Bighorn	British Columbia			9	1	1
Dall Sheep	Alaska		11	40	63	3
	NW Territories				10	10
	Totals	0	11	40	73	13

Table 7. Reported number of hunters and (harvest success rates) for wild sheep in North America, 1970-2009. States or provinces not reporting information for a species are not included.

		# Hunters					Success Rate (%)				
Species/ SubSpecies	Jurisdiction	1970	1980	1990	2000	2009	1970	1980	1990	2000	2009
Rcky. Mtn.	Alberta	1,202	2,561	2,402	2,123	2,377	9	9	9	9	7
Bighorn	Arizona			6	10	11			100	100	100
Sheep	Colorado	98	305	340	332	255	15	26	39	58	57
	Idaho		102	181	62	64		28	40	45	53
	Montana	506	648	624	321	375	14	17	29	38	41
	Nebraska			3	10	2			100	100	100
	Nevada			2	4	11			100	100	100
	New Mexico	18	10	12	12	19	56	70	90	100	100
	North Dakota			8	4	5			88	100	100
	Oregon		5	6	9	11		100	100	100	100
	South Dakota	6	5	2	6	5	100	100	100	100	100
	Utah				9	24				100	100
	Washington			3		3			NA		100
	Wyoming	408	347	374	255	251	24	52	64	72	78
California	Idaho	5	10	22	43	22	20	40	86	56	95
Bighorn	Nevada			3	43	48			100	91	98
Sheep	Oregon	7	14	46	47	86	100	100	100	100	82
	Utah					4					100
	Washington	22	28	10	16	39	45	29	70	100	100
Desert	Arizona	79	50	70	94	77	49	78	86	95	97
Bighorn	California			6	10				100	100	
Sheep	Colorado			4	7	6			100	100	100
	Nevada		86	134	132	193		77	68	86	89
	New Mexico	5			2	2	100			100	100
	Texas			1	5	15			100	100	100
	Utah	10	19	15	33	41	40	53	80	100	90
Dall Sheep	Alaska		1,898	3,448	3,010	2,455		36	40	26	32
	British Columbia			39	35	36			26	0	19
	NW Territories			220	231	261			77	82	74

Table 8. Wild sheep hunt types and weapon restrictions reported by western states, provinces, and territories in North America, 1970-2009. States or provinces not reporting information for a species are not included.

Species	Weapon	General Season	Limited Entry	Harvest Quota	Auction/Raffle
Rcky. Mtn. Bighorn	Rifle	Alberta	Alberta	British Columbia	Alberta
		Arizona	British Columbia	Montana	British Columbia
		British Columbia	Colorado	New Mexico	Colorado
		Montana	Idaho		Idaho
		North Dakota	Montana		Montana
			Nebraska		Nebraska
			Nevada		New Mexico
			New Mexico		North Dakota
			North Dakota		Oregon
			Oregon		Utah
			South Dakota		Wyoming
			Utah		
			Wyoming		
	Handgun	Arizona	Colorado	Nevada	Colorado
		North Dakota	Idaho		New Mexico
			Nevada		North Dakota
			New Mexico		Oregon
			North Dakota		Wyoming
			Oregon		
			Wyoming		
	Muzzleloader	Arizona	Colorado	Nevada	Colorado
		North Dakota	Idaho		Nebraska
			Nebraska		New Mexico
			Nevada		North Dakota
			New Mexico		Oregon
			North Dakota		Wyoming
			Oregon		
			Wyoming		
	Archery	Arizona	Alberta	British Columbia	Colorado
		British Columbia	British Columbia	Nevada	Nebraska
		North Dakota	Colorado		New Mexico
			Idaho		North Dakota
			Montana		Oregon
			Nebraska		Wyoming
			Nevada		
			New Mexico		
			North Dakota		
			Oregon		
			Wyoming		
	Other		Arizona		Arizona
			Washington		Washington

Table 8. Continued.

Species	Weapon	General Season	Limited Entry	Harvest Quota	Auction/Raffle
California Bighorn	Rifle	British Columbia	British Columbia	British Columbia	British Columbia
			Idaho	Nevada	Idaho
			Nevada		Nevada
			Oregon		Oregon
			Utah		Utah
			Washington		
	Handgun		Nevada	Nevada	Oregon
			Oregon		
	Muzzleloader		Nevada	Nevada	Oregon
			Oregon		
	Archery	British Columbia	British Columbia	British Columbia	Oregon
			Nevada	Nevada	
			Oregon		
	Other		Washington		Washington
Desert Bighorn	Rifle		California	Nevada	California
			Colorado		Mexico
			Nevada		Nevada
			New Mexico		New Mexico
			Texas		Texas
			Utah		Utah
	Handgun		Colorado	Nevada	New Mexico
			Nevada		Texas
			New Mexico		
			Texas		
	Muzzleloader		Colorado	Nevada	Mexico
			Nevada		New Mexico
			New Mexico		Texas
			Texas		
	Archery		Colorado	Nevada	Mexico
			Nevada		New Mexico
			New Mexico		Texas
			Texas		
	Other	Arizona	Arizona		Arizona
			New Mexico		New Mexico
Dall Sheep	Rifle	NW Territories	British Columbia	British Columbia	Yukon
		Yukon	Yukon	Yukon	
	Archery	NW Territories	British Columbia	British Columbia	
			Yukon		
	Other	Alaska	Alaska		
Stone Sheep	Rifle	British Columbia	British Columbia	British Columbia	
		Yukon	Yukon	Yukon	
	Archery	British Columbia	British Columbia	British Columbia	

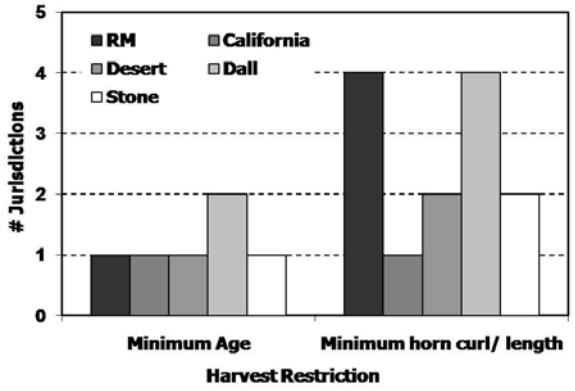

Figure 4. Harvest restrictions for bighorn and thinhorn sheep.

document both in text and in the tables is based on the details provided by each agency, and there may be some discrepancies as a result of vague responses.

Rocky Mountain Bighorn Sheep.— There was 100% compliance for these series of questions. Hunt types varied by weapon restrictions. Some agencies did not specify weapon restrictions among hunt types, but simply stated any legal weapon was allowed, and the use of a lesser weapon was allowed. In New Mexico crossbows were allowed for disabled hunters. Within the general season category 27% of agencies allowed rifles, 13% allowed handguns and muzzleloaders, and 20% allowed archery as the type of weapon. Within the limited entry hunt category, 87% of agencies allowed rifles, 47% allowed handguns, 53% allowed muzzleloaders, 73% allowed archery, and 13% indicated any weapon. Within the harvest quota category 20% allowed rifles, only Nevada allowed handguns and muzzleloaders, and 13% allowed archery as weapon type. For auction hunts 73% allowed rifles, 33% allowed handguns, 40% allowed muzzleloaders and archery, and 13% indicated any weapon of choice.

Season restrictions for Rocky Mountain bighorns resulted in 87% male only harvest, 33% female only harvest, 20% non gender-specific harvest; 7% (only British Columbia) required a minimum age requirement, and 27% had a minimum horn curl/length requirement.

California Bighorn Sheep.— All agencies managing for California bighorns responded to these questions. Only British Columbia holds a general season, and the weapon restrictions allow for rifle or archery only. Within the limited entry category, 83% of agencies allowed rifles, 33% allowed handguns and muzzleloaders, 50% allowed archery, and 33% indicated any weapon choice. For the harvest quota category 33% allowed rifles, only Nevada allowed handguns and muzzleloaders, and 33% allowed archery. For auction hunt types 83% allowed rifles, but only Oregon allowed handguns, muzzleloaders, or archery. Washington indicated that any type of weapon could be used.

Season restrictions for California bighorns resulted in 100% male only harvest and for 33% female only harvest. Only British Columbia required minimum age or minimum horn size restrictions.

Desert Bighorn Sheep.— The responses indicate that only Arizona has a general season for desert sheep and they allowed for any weapon type. Within the limited entry category, 63% of agencies allowed rifles and handguns, 50% allowed muzzleloaders and archery, and 25% indicated any weapon (including crossbows for disabled hunters in New Mexico). Only Nevada had a harvest quota hunt type, and they allowed for any legal weapon.. For the auction category, 63% allowed rifles, 38% allowed handguns, muzzleloaders, and archery, and 25% allowed any weapon type.

Season restrictions for desert bighorn sheep were fairly straight forward since there is no harvest of females. Only California and Colorado have minimum horn size restrictions.

Dall's Sheep.— Within the general season category 50% of the agencies allowed rifles, and 25% allowed archery. Alaska has no weapon restrictions aside from a few small-scale archery hunts. Within the limited entry category, 50% allowed rifles and archery. For harvest quota hunt types, 50% allowed rifles but only British Columbia allowed archery. Only Yukon reported an auction hunt type. There were no data reported specifically for handguns or muzzleloader weapon restrictions by any of the agencies managing Dall's sheep.

Season restrictions for Dall's sheep resulted in male-only harvests. Alaska also has a female harvest only, and non gender-specific hunts. Only Alaska requires a minimum age, but all four agencies (100%) have a minimum horn size requirement

Stone Sheep.— Both agencies, British Columbia and Yukon, allowed rifles for general season, limited entry, and harvest quota hunt types. Only British Columbia allowed archery for these same hunt types. There was no auction hunt type for Stone sheep. There was no information given specifically for handgun or muzzleloader weapon restrictions by either of the agencies managing Stone sheep.

Season restrictions for both agencies involved male harvest only, and both have minimum horn size requirements. Only British Columbia has a minimum age requirement. There is no harvest on female Stone sheep.

Current Research Projects

NWSGC agencies reported involvement in 40 sheep studies (Table 9). Seventeen of the 40 involve Rocky Mountain bighorns; only Nevada and New Mexico do not have any formal research for Rocky Mountain bighorn sheep. There are 3 studies currently being conducted on California bighorn sheep. Idaho, Nevada and Utah currently have no projects. California has eight research studies ongoing for Sierra Nevada bighorns. There are seven Desert bighorn sheep studies being conducted from just 3 agencies. California, Colorado, New Mexico, Texas, and Utah did not report any current projects. Only Alaska is performing research studies on Dall's sheep at this time. They currently have four ongoing projects. British Columbia reported the lone research project for Stone sheep. The project descriptions varied considerably and included vehicle collisions, movement studies, genetics, disease and parasites, habitat use, home range, mortality, predator-prey selection, landscape restoration, population viability, resource selection functions, and survey techniques.

DISCUSSION

I attempted to summarize sheep status reports received from 21 western states, provinces and territories in preparation for the 2010 Northern Wild Sheep and Goat Council Conference. I summarized data on funding, population status, distribution changes, introductions and augmentations, survey techniques, harvest and hunter numbers, hunt types, weapon and season restrictions, and current research projects. Rigorous statistical analysis was not possible due to deficient data sets and variability in responses. In spite of these deficiencies, I believe this information in this format will be useful to wild sheep managers.

As a result of my efforts to compile and summarize these data I offer a few observations. First, while the new on-line data collection survey method utilized this year did save some analysis time for the compiler, it did not allow for specific answers to some questions. Users complained that not every question can fall into a black vs. white category. Hopefully with increased options within the design phase of this software, Survey Monkey or

other programs like it, will become more user friendly. Secondly, there is far too much variability of issues between the subspecies of wild sheep to be lumped together. After summarizing these data, I believe that the survey might benefit from taxon-specific surveys. This approach will minimize non-applicable questions and ensure all facets affecting each species are fully captured. Finally, it is extremely important to emphasize that this paper discusses the results "as reported" by the agencies. Due to the obvious restrictions of the survey technique and lack of full detail, the results represented here were completely open to my interpretation. Every attempt was made to clarify and fact check details that were unclear, but these results undoubtedly contain inaccuracies. I urge the reader to contact the individual agencies to clarify or confirm any questions brought forth by this summary.

Table 9. Current sheep research projects reported by western states, provinces, and territories in North America.

Species	Jurisdiction	Project Description
Rocky Mountain Bighorn Sheep	Alberta	Ram Mountain with Marco Festa-Bianchet, University of Sherbrooke Sheep River with Katreen Ruckhstal, University of Calgary
	Arizona	Primarily looking at roads and movements. Wakeling, B. F., Najar, H. S., and O'Dell, J. C. Mortality of bighorn sheep along U.S. Highway 191 in Arizona. Arizona Game and Fish Department, Game Branch 5000 West Carefree Highway, Phoenix, AZ 85086, USA. Arizona Game and Fish Department, Region I 2878 East White Mountain Boulevard, Pinetop, AZ 85935, USA.
	British Columbia	Elk Valley study - underway, genetics with various labs.
	Colorado	George, J. L., D. J. Martin, P. M. Lukacs, and M. W. Miller. 2008. Epidemic Pasteurellosis in a bighorn sheep population coinciding with the appearance of a domestic sheep. Journal of Wildlife Diseases. Vol 44, No. 2. Pages 388-403. Wolfe, L. L., B. Diamond, T. R. Spraker, M. A. Sirochman, D. P. Walsh, C. M. Machin, D. J. Bade, and M. W. Miller. 2010. A bighorn sheep die-off in southern Colorado involving a Pasteurellaceae strain that may have originated from sympatric cattle. Journal of Wildlife Diseases (revised draft in review, April 2010).
	Idaho	The Department is continuing long-term research on bighorn sheep distribution, movements, and effects of disease as part of the tri-state (Idaho, Oregon, Washington) Hells Canyon Bighorn Sheep Restoration Project, begun in 1997. Many publications. The Department is also working with the Nez Perce Tribe and other groups on the multi-year Salmon River Bighorn Sheep Restoration project, begun in 2007.
	Montana	Not a research project but Montana has just completed the "Montana Bighorn Sheep Conservation Strategy", primary author/editor/compiler: Tom Carlsen. It was posted on our website 4/23/10.
	Nebraska	Evaluation of the Use of the Escape Terrain and Buffer Model to Depict Northwestern Nebraska's Bighorn Sheep Habitat. Rana A. Tucker, Department of Applied Sciences, Chadron State College, 1000 Main Street, Chadron, NE 69337 U.S.A. Teresa J. Zimmerman, Department of Applied Sciences, Chadron State College, 1000 Main Street, Chadron, NE 69337 U.S.A.

Table 9. Continued.

Species	Jurisdiction	Project Description
	North Dakota	Wiedmann is currently writing a comprehensive management plan. Data will include historic population levels, population goals on a herd-by-herd basis, identification of suitable habitat for further introductions, and GIS home range and mortality analysis. Will be published by NDGF.
	Oregon	All Rocky Mountain bighorn research conducted through the Hells Canyon Initiative since 1998.
	South Dakota	Currently a research project looking at mountain lion prey selection within bighorn sheep habitat and cause specific mortality for bighorn ewes and lambs was started in 2009.
	Utah	Placed 12 GPS collars on ewes and rams in the Hoop Lake and Flaming Gorge areas to look at sheep movements, and in particular sheep movements into the high country of the Uinta Mountains and potential overlap with active domestic sheep allotments (in conjunction with Uintah-Wasatch-Cache National Forest).
	Washington	Hells Canyon Initiative; Frances Cassier; Idaho Fish and Game; published. Role and ecology of Mycoplasma ovipneumoniae in respiratory disease in bighorn sheep; Tom Besser; Washington State University; Dissertation and 3 peer-reviewed publications expected in 2012.
	Wyoming	Devil's Canyon BHS Supplemental Transplant and Resource Selection Analysis, 2004-2008 (July 2009) Tom Easterly, WGFD and Dr. Matt Kaufmann & Aly Courtemanch, WY COOP Unit Distribution and Habitat Selection Patterns of Mountain Sheep in the Laramie Range (June 2009) Hall Sawyer & Ryan Neilson, WEST, Inc., and Martin Hicks, WGFD Clarks Fork BHS Study Final Report (June 2009) Doug McWhirter, WGFD Resource selection, movement, recruitment and impact of backcountry recreation on BHS in the Teton Range, NW Wyoming (in progress) Dr. Matt Kaufmann & Aly Courtemanch, WY COOP Unit Non-invasive evaluation of the genetic status and parasite loads of Teton Range BHS, NW Wyoming (in progress) Sarah Dewey, Grand Teton Nat'l Park, and Dr. Gordon Luikart & Marty Kardos, Univ. of MT
California Bighorn Sheep	British Columbia	Thompson River University student looking at range use and stats of Kamloops herd Recovery of Okanagan herds and reintroductions in those genetics and horn stats with Marco and Dave Coltman
	Oregon	Recently completed research evaluating genetic implication of Oregon's bighorn reintroduction programs using a Ph.D. student (Olson et al. in this proceedings) through Purdue University.
	Washington	Landscape restoration and spatial response of bighorn sheep in the Sinlahekin Wildlife Management Area; Dr. Mark E. Swanson and Dr. Lisa A. Shipley; Washington State University; Thesis and publication expected 2011.
Sierra Nevada Bighorn sheep	California	Current research is focused upon evaluating population viability, disease risk, and effects of natural and prescribed fire. Projects are in collaboration with graduate students at the University of Montana and Yale University. Eight abstracts will be submitted separately.

Table 9. Continued.

Species	Species	Species
Desert Bighorn Sheep	Arizona	Primarily effects of roads, although we are investigating many aspects of the Kofa desert bighorn sheep population and may initiate increased genetic studies. Some ongoing studies on disease and water use.
	Mexico	Mexico's biologists are doing a better job of documenting the work being done in their country. As the number of projects and programs increase, the reports and publications of the results increase as well. Many of these reports are being published in the Desert Bighorn Council Transactions.
	Nevada	Collaborating with USGS and Dr. Kathy Longshore on monitoring population isolation and any remnant movement and movement corridors of desert bighorn sheep impacted by Las Vegas and surrounding infrastructure. She is also looking at strengthening inference and accuracy of the River Mountain (unhunted herd between Las Vegas and Lake Mead) population estimate through intensive marking. A new study is beginning on the Desert National Wildlife Refuge and Nevada Test Site to look at population dynamics of desert bighorn sheep and mountain lions. This is also being directed by Dr. Longhsore with several secondary contributors. Unknown plans for publications, though I am sure the Desert Bighorn Council will likely be the primary outlet of information. Also a small project is underway led by Dr. David Thain, DVM with University of Nevada, Reno, Cooperative Extension on forage quality and desert bighorn sheep health and body condition. Only limited knowledge of that study.
Dall Sheep	Alaska	Arthur, S., and T. Craig. Demographics and spatial ecology of Dall's sheep in the central Brooks Range. ADF&G collaboration with BLM. Schmidt, J., and K. Rattenbury. Using distance sampling to estimate Dall's sheep abundance in Gates of the Arctic National Park and Preserve. NPS. Lohuis, T. Dall sheep population dynamics in the Chugach Mountains. Alaska Department of Fish & Game. Project is ongoing. Lohuis, T. Dall's sheep population dynamics in the Kenai Mountains. Alaska Department of Fish & Game. Project is ongoing. Roffler, G.H., S.L. Talbot, G.K. Sage, K. Pilgrim, L.G. Adams, M.K. Schwartz, R. Schwanke, and G. Luikart. Evaluating the genetic structure of Dall's sheep populations in Wrangell St. Elias National Park and Preserve. Collaboration with Alaska Department of Fish & Game. Project is ongoing.
Stone Sheep	British Columbia	Genetics with Dave Coltman, horn stuff with Marco, Sulpur 8 Mile with Pam Hengeveld etc.