WILD SHEEP MANAGEMENT WORKSHOP

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Friday April 9, 1999 was the final day of the 2ND North American Wild Sheep Conference. We asked conference attendees to participate in a day-long workshop designed to identify specific recommendations for wild sheep management; 60 sheep biologists, managers, researchers, students, and advocates participated. At the minimum, we wanted to develop an outline with specific, succinct recommendations, to help guide wild sheep management in North America for the next 25 years.

After introductory remarks and instructions, we provided each participant with a simple, matrix-format table (Table 1) listing Dall, Stone, California, Rocky Mountain and desert sheep on the X-axis, and wild sheep management challenges and issues discussed the previous 3 days on the Y-axis. Conference organizers prioritized the issues in this matrix; the first seven matched individual sessions at the conference. We asked people to identify and develop distilled, "bullet" recommendations for the intersecting cells, based on their personal wild sheep management experience and knowledge. For example, under the first intersecting cell of advocacy groups and Dall sheep, we wanted specific recommendations on what could be done by or with advocacy groups to benefit Dall sheep management. We asked participants to develop recommendations based on what they knew, rather than what they thought they knew. We asked participants to work individually for 90 minutes, developing their recommendations. We then reassembled participants in thinhorn, California, Rocky Mountain, and desert sheep subgroups. For two hours, subgroup participants briefly discussed and recorded their recommendations on flip charts, sorted by management challenge/issue. In this round-robin format, every participant had the opportunity to list their recommendations, without argument from their peers, until all recommendations were exhausted. Then, subgroups were assembled into a large-group format, and subgroup recorders individually described each recommendation, again sorted by management challenge/issue. Additional recommendations were then offered by the entire group and recorded. After all four subgroups had presented their recommendations, without argument from their peers, a short general discussion was held and the workshop was adjourned.

It is important to understand that conference and program co-chairs were not seeking a finished or polished product from this one-day workshop. Rather, we wanted to, at a minimum, develop an outline which could be expanded upon in our publication. Also, we did not expect, nor are we claiming, that this sorted list would include every legitimate recommendation for wild sheep management. We were not looking to "reinvent" but to "update" the wheel. The 1971 wild sheep meeting in Fort Collins, Colorado, the 1974 wild sheep conference in Missoula, Montana, the 1980 Desert Bighorn Council guidelines, and numerous other publications provide extremely useful templates for comparing and evaluating where we are with wild sheep management at present. We were not looking for unanimity in recommendations; in fact, we encourage skepticism and healthy debate on wild sheep management, with arguments grounded in science, data, and knowledge. We expect and encourage each reader to question the recommendations included here, and decide for themselves which are most appropriate.

Using workshop notes, a transcript from a court reporter/stenographer, comments on the matrix-table sheets submitted or subsequently mailed by individual workshop participants, and subgroup flip charts,

the following pages represent the "raw", bullet-like recommendations identified. These have been further edited for brevity, but content has not been altered. Following this section and drawing on these "raw" recommendations and available literature, a synthesized compilation of management recommendations for wild sheep in North America is included.

Table 1. Workshop matrix, 2ND North American Wild Sheep Conference, Reno, NV, April 9, 1999.

Management Challenge/Issue	Dall	Stone	California	Rocky Mountain	Desert
Advocacy Groups (political action, fund-raising, network of support)					
Habitat Fragmentation/Human Disturbance (urban sprawl, subdivisions, planning/zoning, land ownership/acquisitions/easements/ consolidation, highways, fences, dams, industrial activities, ORV use, military, recreational), human dimensions					
Habitat Management (buffer zones, mineral/salt licks, water development, prescribed and natural fire, noxious weeds, logging, reclamation, mapping techniques, GIS modeling)					
State/Federal Relationships (formal wilderness designation/restrictions on needed management activities, forest plans, resource management plans)					
Hunting/Harvest (subsistence, trophy, ewe harvest, hunter orientation, mandatory horn registration/plugging, waiting periods)					
Capture/Transplant (minimum transplant sizes, source herds, herd health histories, techniques, evaluation of long-term transplant success)					
Disease (documentation, diagnosis, cooperative response, treatment options)					
Predation (documentation, management options and strategies)					
Population Management (density-dependent effects)					
Livestock (cattle, sheep, feral horses and burros)					
Genetics/Taxonomy (DNA databases/confounded by transplants, forensics)					
"Inter-Connectedness"/Corridors/Migration Routes/Metapopulation approach					
Threatened & Endangered Status/Listing					
Law Enforcement (poaching, pickup heads, record book entries/fair chase, forensics)					
Exotics					
Native Ungulates					
Information and Education/"Watchable Wildlife" strategies					

Other					

Desert Bighorn Sheep

Advocacy Groups

- Expand vision toward long-term conservation of wild sheep.
- Educate groups about wild sheep habitat needs and reality of land-use planning and NEPA.
- Recognize contribution of and cultivate financial support from these groups.
- Contribute information and articles to advocacy group publications.
- Expand advocacy groups to include conservation groups, and increase their involvement as interested parties.
- Help groups with diverse objectives realize their commonality.
- Expand upon funding needs.
- Explain potential limitations of short-term research findings; obtain funding for longer-term research.
- Help groups better evaluate funding requests.
- Continue working with groups in retiring and/or purchasing domestic sheep grazing permits.

Habitat Fragmentation and Human Disturbance

- Recognize importance of inter-mountain corridors for conservation of metapopulations which travel across intervening desert valleys.
- Consider all lands used by desert bighorn sheep as important.
- Explain how population persistence declines as populations become more isolated.
- Unfragmented habitat in good condition which includes corridors must receive high management priority.
- Involve biologists in land exchanges, which must be evaluated for their impact on sheep habitat.
- Recognize that recreational use also fragments habitat.
- Restore movement corridors with vegetative treatments, especially where tamarisk has encroached.
- Restoration of movement corridors includes decreasing recreation, acquiring land through easements, restrictions on use by hikers, and decreasing vegetation to improve visibility through burning, chemical treatment, and logging.
- Evaluate human impacts to determine their adversity on desert sheep and their habitats.

Habitat Management

- Continue to use existing BLM guidelines for fencing in bighorn sheep habitats.
- Document and evaluate benefits of artificial water development.
- Restore natural waters rather than just concentrating on artificial water development.
- Support natural fire, restore natural fire frequency; implement prescribed burns to improve habitat.
- Develop a database to demonstrate how we're losing habitat by vegetative encroachment.
- Provide adequate protection, buffer zones, and seasonal restrictions for oil, gas, mining, and other extractive commodity practices near suitable mountain sheep habitat.

State/Federal Relationships

- Wilderness legislation should include a description of the minimum tools which can be used.

- Include stipulation to continue use of current management practices in wilderness and wilderness study areas (WSAs), as they become designated wilderness areas.
- Encourage better communication between state/federal agencies on wilderness management goals.
- Hold annual meetings involving upper management to discuss current issues and problems.
- Encourage more education and information sharing among resource specialists.
- In land-use plans, important, occupied bighorn habitat needs to be identified and assigned management priority, to establish a legal basis for actions to benefit bighorn sheep. This may include amending existing land-use plans to eliminate domestic sheep allotments as they become vacant.
- In land-use plans, recognize options to reallocate forage for wildlife as livestock grazing permits are retired or relinquished.
- Involve state agencies in the scoping process for land-use/ecosystem plans, and throughout process.
- Land management agencies should prohibit or closely manage packing with domestic goats in wild sheep habitat.
- Encourage more cooperative management between the U.S. and Mexico for shared bighorn herds.

Hunting and Harvest Strategies

- Encourage hunter orientation programs in states where desert bighorn sheep are hunted.
- Develop predictable, reliable information and survey methodology on which to allocate sheep permits, and develop consistency in those. Standardize between and within states.

Law Enforcement

- Reduce poaching by making the sale or barter of pickup sheep heads illegal.
- Discontinue pinning pickup heads, which makes them basically legal.
- Collect and store horn samples as part of the pinning requirement for legal heads.
- Develop a DNA or mineral database to assist law enforcement.
- During capture and transplant operations, pin or somehow mark transplanted rams, for future identification.
- Emphasize potential DNA analyses to identify populations for research and law enforcement.

Capture and Transplant

- Generally support the 1973 DBC guidelines, with one specific exception. Remove the recommendation to utilize enclosures following transplant.
- Historical sheep distribution information should be used in determining suitable transplant areas.
- Evaluate cause of initial sheep decline. Determine whether that cause has been effectively eliminated.
- Do not transplant new sheep into sites where prior transplants failed, without attempting to determine and rectify problems that occurred with the original transplant.
- Recognize different transplant objectives, including establishment of new populations, expanding the range of existing populations, or creation of migratory behavior.
- Evaluate predation potential before the transplant and the need to consider predator control. Transplant populations are especially vulnerable to predation.
- Examine disease potential and status of source herds, and consider what diseases may be carried with transplanted sheep.

- Minimize diseases that transplanted sheep carry, and consider possible disease effects on augmented herds.
- Do not transplant large numbers of animals from small herds, to minimize impact on source herd.
- Develop and establish updated protocol for capture and reestablishment of bighorn sheep herds.
- Use transplants to create linked male populations.
- Use transplants to expand distribution and habitat use of existing populations.
- Avoid establishing isolated populations which are likely going to struggle. Use transplants to create linked populations, create metapopulations, or expand existing metapopulations.
- Develop guidelines for the best possible management of bighorn sheep captive facilities.

Disease

- Support research regarding effects of llamas, domestic goats, and cattle on bighorn sheep.
- Assess health of source bighorn herds. When capturing animals, develop a database on the diseases herds have been exposed to, particularly if transplanted sheep will contact other wild sheep.
- Bighorn and domestic sheep must be separated, to minimize potential disease transmission.

Predation

- Evaluate transplants of sheep into densely occupied deer habitat, which often have abundant mountain lion populations.
- Conduct research on predation impacts on lamb production and survivorship.
- Support ability of managers to remove mountain lions where they are a documented problem, especially with struggling bighorn herds.
- Improve habitat visibility to reduce vulnerability of bighorns to predation.
- Design artificial water developments so that predation at water sources is reduced or eliminated.

Population Management

- Do not assume density-dependent responses in bighorn sheep populations. Responses of bighorn sheep to population reductions are complex, and dissimilar to other ungulates (e.g., white-tailed deer).

Livestock

- Discourage habitat degradation by cattle and minimize habitat overlap between cattle and bighorn sheep. Anticipate more overlap with yearling cattle than with cow-calf pairs.
- Prohibit recreational goat packing in bighorn habitat, since we don't know what disease implications there might be, and also because escapee goats can survive very well in bighorn habitat.
- Manage burros within established appropriate management level (AML) guidelines.
- At water sources, bighorn sheep need to be separated from domestic stock and other feral animals, because bighorns tend to be displaced or outcompeted.

Genetics and Taxonomy

- Support Captive Breeding Specialist Group (CBSG) workshops to obtain more information on impacts of inbreeding. Establish an adequate information base to manage inbreeding effects.

Endangered and Threatened Status

- When justified, designation as T&E status should be pursued. Once sheep are designated, federal land management agencies then have legal requirements (e.g., reduction in direct take, killing, harassment) they must follow. Use T&E status to help obtain needed funds. Indirect take requires consultation on any habitat loss or negative impacts.
- Investigate alternatives (e.g., conservation plan) to listing for declining populations.

Exotics

- Do not introduce exotic mammals and/or plants to bighorn sheep range.
- Attempt to eliminate existing exotic plants and/or mammals from bighorn sheep range.

- Reduce potential for colonization of exotic plants on bighorn range by requiring use of certified hay and controlling or eliminating off-road vehicles.

Education

- Watchable wildlife programs should not increase disturbance on bighorn sheep ranges. Biological input into these programs is needed. Programs should emphasize ethical viewing of wildlife, especially by photographers.
- Use Project Wild to disseminate information about bighorn sheep.

Rocky Mountain Bighorn Sheep

Advocacy Groups

- Expand the FNAWS network in states and provinces that don't currently have chapters/affiliates.
- Review the FNAWS grant-in-aid process and offer suggestions to improve that process.
- Improve coordination between the FNAWS network and states/provinces in the political arena.
- Seek increased funding for sheep management from the general public and non-consumptive NGOs.
- Expand outreach to include nonhunters. Recognize nonhunted populations as potential source herds.
- Be aware of expectations and conditions associated with funding (i.e., *quid pro quo*).
- Reinforce that advocacy groups are advisory while agencies retain responsibility and decisionmaking.
- Invite advocacy groups to meetings where they traditionally are not invited.
- Ensure that money from auctioned complimentary sheep licenses goes back into sheep management.
- Advocacy groups should get more involved in public and private land-use planning.
- Encourage and improve youth education in sheep projects.
- Advocacy groups should be strong proponents of hunter ethics.

Habitat Fragmentation and Human Disturbance

- Continue human disturbance studies and develop specific recommendations for specific herds.
- Use technology (e.g., Internet) to distribute herd-specific information on human disturbance studies.
- Integrate existing information between groups on how human disturbance is affecting bighorn sheep.
- Minimize human disturbance during critical times of year for bighorn sheep.

- Assess risk and map vulnerability (e.g., GIS) of herds on a five-year basis.
- Map cumulative effects of human disturbance and model future impacts, depending on land uses.
- Synthesize what is known about, and recommend further human disturbance research topics.
- Constrain time and location of recreational activities to enhance bighorn sheep habitat security.
- Work with metropolitan planners and local/state/private organizations to reduce human disturbance.
- Discourage habitat fragmentation and require mitigation of impacts.
- Work with public/private partners to expand/facilitate land exchanges, easements and acquisitions.
- Develop interpretive signs, brochures, pamphlets about ethical viewing of sheep.

Habitat Management

- Implement habitat improvements on a large scale.
- For pinyon/juniper burning, implement a 50-year-or-less fire frequency, and reseed with grass and forbs. For sagebrush-dominated habitats, that fire frequency should be 25 years or less.
- Synthesize and share knowledge about necessary fire frequency and fire management practices for different vegetative communities which comprise sheep habitat.
- Aggressively pursue or create options to improve habitat within wilderness areas.
- Include habitat management techniques in wilderness planning, implementation, and legislation.
- Seek consistency from land managers on what habitat management practices are allowed in wildlife management areas, wilderness areas, or wilderness study areas (WSAs).
- Recognize wild sheep as a primary wilderness component.
- Assess, evaluate, and monitor wildlife habitat treatments and manipulation.
- Aggressively pursue chemical, mechanical, and biological control of noxious weeds in sheep habitat.
- States and provinces need written goals or plans for sheep restoration and distribution.
- Produce current and historic maps of known or suspected bighorn sheep habitat.
- Standardize terminology for sheep seasonal habitats.
- Standardize mapping scales and integrate mapping techniques
- Analyze and evaluate habitats prior to transplants, to ensure suitability before moving sheep.

State/Federal Relationships

- Better coordinate state and federal planning for domestic sheep grazing in wild sheep habitat.
- Amend BLM and USFS land-use plans to recognize importance of wild sheep habitats. Describe specific management actions to achieve recognition of important wild sheep habitats.
- Modify existing MOU's to clearly establish state wildlife agency jurisdiction over wild sheep transplants, perhaps through the Western Association of Fish and Wildlife Agencies (WAFWA).
- Improve communication between states and National Park Service on bighorn sheep management.
- Develop bighorn sheep management plans where absent, particularly in the National Park Service.

Hunting and Harvest Strategies

- Coordinate with tribal managers on shared herds.
- Manage herd population size and density with ewe removal strategies.
- Articulate biological basis for why we hunt these sheep herds.
- Management should be adaptive and based on management experiments.
- Publish results from management experiments (e.g,. any-ram hunting), to build on that research.
- Standardize regulations between states.

Law Enforcement

- Standardize legality of pickup heads and associated regulations on pinning and sale of pickup heads.
- Support stiffer penalties and fines for illegal harvest of bighorn sheep, perhaps to felony level.
- Enforce existing regulations and laws on wildlife violations and human-related disturbances (e.g., ORVs, dogs, planes). Elevate poaching of bighorn sheep to felony status.
- Work with advocacy (e.g., FNAWS network) and wildlife law enforcement groups (e.g., North American Wildlife Enforcement Officers Association) to promote, fund, and expand existing law enforcement relative to wild sheep.
- Support efforts to restrict or eliminate game farming.

- Support efforts to restrict or eliminate trafficking of wildlife parts.
- Improve coordination with tribal law enforcement officials.

Capture and Transplant

- Optimize transplant stock between states and provinces.
- Improve communication on the need for, and availability of, different transplant stocks.
- Evaluate compatibility of transplant stocks to new habitats.
- Maintain database on transplant histories.
- Continue to use transplants to return sheep to historic ranges.
- Perform rigorous suitability evaluation of potential transplant areas.
- Evaluate success/failure of transplants, and publish that information.
- Transplant at least 30 sheep initially, then transplant additional animals via multiple releases, to increase the likelihood of a successful transplant.
- Formalize transplant guidelines in states and provinces.
- Perform disease testing on transplanted sheep, and include results in accessible transplant database.
- Establish minimum requirements and protocols for handling transplanted sheep.
- Where lacking, develop capture and transplant manuals.
- Determine individual mortalities two weeks post-transplant, to evaluate success of the transplant.
- Develop health and DNA histories for source herds, including linkage to prior transplants.
- Synthesize knowledge about appropriate interval between a die-off and reintroduction of sheep.
- Evaluate deer density and numbers, and the cougar situation, in potential transplant sites.
- Develop management strategies for metapopulations (i.e., sheep population size > 500).
- When transplanting sheep, radiocollar as many mature animals as possible to facilitate monitoring, while recognizing watchable wildlife viewing issues.
- No equipment should be used between herds unless properly sanitized, to decrease disease transmission.

Disease

- Develop and share detailed health assessments of source herds.
- Promptly remove wild sheep after known interaction with domestic sheep.
- Share data on bighorn sheep disease, perhaps through the Western Wildlife Health Cooperative.
- Work with livestock industry and interested publics on the concerns of using domestic sheep for vegetation management (i.e., weed control) in bighorn sheep habitats.
- Continue to acknowledge fatal pneumonia transmission from domestic to wild sheep.
- Summarize and share available knowledge on effectiveness of treatments for diseases.
- Assess risk of potential interaction with domestic sheep and reduce this risk where possible.
- Synthesize information on risk of disease transmission from other livestock and wildlife species.

Predation

- Encourage research that examines prey and predator populations simultaneously.
- Synthesize existing information on predation and its effect on bighorn sheep.
- Determine not only if predation is occurring, but if there is a population-level effect from predation.
- Recognize the complexity of predation.
- Monitor and evaluate effectiveness of predator control/management actions

Population Management

- Status and trend of sheep herds should be monitored by taxonomic units and bioregions, not just state and provincial political units.
- Develop population management plans for wild sheep herds.
- Stress importance of high quality habitat coupled with appropriate density of sheep (i.e., "more sheep is not always better").
- Acknowledge the potential for different limiting factors on males and females in the population.
- Monitor specific population parameters to determine status relative to carrying capacity, and make data-based management decisions.

Livestock

- Partitioning of forage resources should be based on best available knowledge, including temporal, spatial, and dietary overlap.
- Recognize bighorn sheep habitat needs when allocating forage.
- Increase enforcement of trespass livestock.
- Encourage federal land managers to manage feral horses to appropriate management levels (AMLs).
- Research and recommend fence designs compatible with wild sheep daily or seasonal movement.
- Eliminate or modify net wire fences in wild sheep habitat, to facilitate passage by bighorn lambs.

Genetics and Taxonomy

- Collect, analyze, store and share DNA information (e.g., blood, tissue, hair) on wild sheep.
- Develop and publicize an accessible database where this information is stored.

- Minimize loss of genetic diversity in our herds.
- Repopulate historic ranges with native subspecies when possible; if not, use closest ecotype available.
- Develop guidelines for mixing California and Rocky Mountain bighorn sheep via transplants.

- Determine and use most appropriate genetic stock for transplants.

Metapopulations
- Recognize importance of corridors between populations. Be aware of potential disease transmission.
- Develop metapopulation strategy for Rocky Mountain bighorn sheep that addresses genetic diversity and potential disease transmission.
- Maintain metapopulations and genetic linkage for Rocky Mountain bighorns.

Exotics
- Remove free ranging exotic ungulates. Seek effective and prompt responses for game farm escapees.

California Bighorn Sheep

Advocacy Groups
- Foster education, develop and improve communications and dialogue, provide information and data, and cooperate with those groups who seek information.
- Inform advocacy group about their opportunities for input into wild sheep management.
- Promote cooperation with other groups, including ranchers and forests products industry.

Habitat Fragmentation and Human Disturbance
- Produce a seamless habitat map at 1:250,000 scale, identifying historic, occupied, and potential habitats of all wild sheep species/subspecies. Focus on U.S./British Columbia/Alberta by 2005; Alaska/Yukon/NW Territories by 2010.
- Identify problems with urban sprawl, animal damage, and developed areas where wild sheep may become a nuisance.
- Include wild sheep goals in range management and forest plans, and planning and zoning documents, listing specific objectives for wild sheep management, at the earliest opportunity.
- Develop, retrieve, and share existing guidelines on forestry and roads in British Columbia.
- Recommend distance from roads to fences be at least one-half mile, so sheep harassed off a highway/road do not immediately encounter a fence barrier.
- Develop guidelines on ORVs, military overflights, air space use, recreation, to minimize disturbance.

Habitat Management
- Utilize adequate buffer zones for separation between domestic and wild sheep.
- Evaluate management practice of placing salt on bighorn ranges. Determine physiological demand for salt of California bighorns. Recognize the utility in treating some diseases and the potential for increased disease transmission (e.g., contagious ecthyma) with salt.
- Prescribed burning and fire management for California bighorns can be used to control juniper and conifer encroachment, but site-specific fire management planning should be done in advance.
- In general, fires should be avoided if they result in shrub loss in California bighorn habitat, but

prescribed fire may promote desirable forage, enhance visibility, or decrease noxious weeds.
- Leafy spurge and other noxious weeds in bighorn habitat should be controlled chemically, rather than by use of domestic sheep.
- Provide forest and mining industry guidelines to maintain and enhance bighorn sheep habitat.
- Standardize terminology used in bighorn sheep management (e.g., defining habitat effectiveness).

State/Federal Relationships
- Stress the importance for federal land management agencies to manage vegetation in designated wilderness and wilderness study areas (WSAs). Noxious weed control and prescribed burning to attain vegetation objectives for bighorn sheep are necessary.
- Stress the importance of being allowed to develop and maintain water sources in WSAs.
- Cooperatively identify time periods for sheep management activities in WSAs, to minimize overlap with heavy recreational use season(s).
- Cooperatively determine timing and frequency of helicopter use and landings in wilderness for sheep management practices.
- Recommend mitigation measures to address Department of Defense use of air space over WSAs and other seasonally important bighorn habitat.
- Identify and seek federal land agency approval for various habitat management activities in WSAs.

Hunting and Harvest Strategies
- Develop a biological framework for harvest recommendations. Identify alternative harvest strategies to attain the same management objective.
- Trap/transplant surplus sheep to fill potential habitats prior to implementing limited ewe harvest.
- Recognize that hunting is a valid and legitimate population control method for California bighorns.
- Explain the importance of biological data collection relative to status, trend, and impact of hunting.
- Discourage the unethical practice of using aircraft for scouting by hunters.
- Minimize survey/inventory flights to minimize disturbance and displacement of bighorn sheep.
- Support mandatory horn plugging/pinning of legally harvested rams. In states where private possession of pickup heads is legal, pickup heads should also be pinned.
- Require permit for private possession of sheep heads, but disallow sale, to reduce illegal commerce.
- Subsistence harvest by native peoples should be monitored and reported.
- All harvest for herds shared by state/provincial/tribal jurisdictions should be recorded and shared.
- For California bighorn sheep, limited entry hunting rather than over-the-counter, general license hunting is preferred. If limited entry licenses are set appropriately, minimum horn curl regulations are not necessary.

Law Enforcement
- Seek consistency between and among states, provinces, and tribes on legality of pickup sheep heads.
- Eliminate the potential for private ownership of native species of wild sheep.
- Oppose game farming, private ownership, sale, trade, or interstate transfer of wild sheep

except between government agencies and tribal governments.

Capture and Transplant

- Develop a standardized capture procedure.
- Develop and document herd health histories.
- Pretest source herds, especially for interstate or international transplants.
- Be extremely cautious about mixing stocks from different sources.
- Transplant of California bighorns outside traditional range should be allowed if they are the best adapted or most appropriate stock to fill available habitat if, and only if, separation from other wild sheep is assured.
- Standardize protocols for release sites, including a prerelease evaluation of each site.
- Identify preferable family group units when capturing stock for transplants.
- Use caution in transplanting sheep into marginal sites. Many states are nearing completion of transplants into their most preferred sites. To continue their program, they may be transplanting sheep into marginal sites. It may be better to leave those as buffer areas without sheep, or allow the core population to expand into those areas, rather than risk compromising the entire area with the possibility of introducing disease.

Predation

- States should establish protocols for predator management and maintain opportunities to utilize all tools necessary for predator management. Predator control or management may increase the success or decrease the risk of new transplant herds or herds in decline.

Population Management

- Urge formal application of a modified metapopulation model, defining a metapopulation as an area of distinct herds or subgroups where periodic interchange may occur, bounded by topographic or mechanical barriers that preclude all but rare movement across those barriers.
- Consider weather and climate as explicit variables, along with topographic, vegetative and nutritive factors in determining habitat suitability and herd performance.
- Improve the ability to monitor herd performance.
- Further delineate and seek to understand mortality and risk factors in population management.

Livestock

- Cattle grazing may be compatible with wild sheep, but managers should minimize the potential for direct contact and forage competition, wherever possible.
- Wild horses should be managed to appropriate levels, to minimize impacts to wild sheep (e.g., water holes, habitat destruction and/or modification, range condition).
- States and provinces should prevent interaction between mouflon sheep and California bighorn sheep. The presence of mouflon sheep precludes opportunities for establishing new bighorn herds.
- Managers should strive to encourage blood testing and serum banking of California bighorn sheep, to develop species-specific standards, as opposed to cattle standards now used for disease exposure.

Inter-Connectedness and Corridors

- Identify, map, secure, and/or recover corridors for dispersal and seasonal movement between distinct herds and segments of herd. Once corridors are identified, identify potential blockages to movement.
- Identify private lands critical to wild sheep conservation.

Genetics and Taxonomy

- Retain existing nomenclatures until evidence can be clearly established and independently validated that new taxonomy merits acceptance by all parties concerned.
- Recognize that species are more than their genetics. Maintain unique ecotypes.
- Identify how much genetic diversity exists. Discuss how much diversity is being lost because small populations are experiencing genetic drift, with some populations being extirpated or in decline.

Endangered and Threatened Species

- Threatened or endangered status for British Columbia-derived populations of California bighorn sheep is unnecessary.

Exotics

- Urge federal land management agencies to be more restrictive with mouflon sheep on public lands.

Records Book Listing

- Support records book listing for California bighorn sheep if entered heads are plugged/pinned and supported by a valid hunting license. No pickup heads should be allowed in records book listings.

Thinhorn Sheep

Advocacy Groups

- Enhance and maintain existing alliances.
- Initiate new, less traditional alliances, being particularly attentive to learning and teaching in developing and maintaining those relationships.

Habitat Fragmentation and Human Disturbance

- Enthusiastically participate in land management planning and review.
- Firmly educate involved publics concerning probable negative impacts to wild sheep.
- Monitor impacts and increase certainty of recommendations for future management of wild sheep.
- Anticipate problems and proactively plan for specific wild sheep management.
- Teach the public that sheep populations can support many managed uses, and that parks meet needs for special nonconsumptive uses.
- Recognize wild sheep habitat needs when analyzing land tenure adjustments and large-scale land exchanges.

Habitat Management

- Protect basically pristine thinhorn habitats from degradation. Habitat degradation of pristine habitats will be negative for thinhorn sheep.
- Managers should not rush to “improve” pristine habitats.

State/Provincial/Territorial/Federal Relationships (Intergovernmental Relationships)

- Work locally with other governmental agencies, advocating a return to or establishment of a functional management system.

Hunting and Harvest Strategies

- Harvest of only mature rams has minimal effect on thinhorn populations and can be sustained with minimum population monitoring or management action.
- Harvest of ewes or immature rams may adversely affect population size, productivity, and trend, and is not universally appropriate. It must be closely monitored where it occurs.

Law Enforcement

- Inform and educate the public on the rationale for existing regulations, in an effort to minimize violations because people understand and comprehend those regulations.
- Support law enforcement and aggressively support fines equal to the established market value of poached animals, when convictions have been obtained.

Capture and Transplant

- Capture only as necessary. Use the best data available to select the most appropriate capture method.
- Oppose transplants in thinhorn ranges.

Disease

- Aggressively pursue legislation and regulations assuring no domestic sheep, goats or cattle interact with thinhorn sheep.
- Establish baseline studies to examine the health and disease status across thinhorn sheep range.

Predation

- Retain predator control as a management option, apply it with great care, and make sure you identify why, how and what your thresholds are for application.
- Predation is seldom an important limiting factor in Dall sheep populations. In isolated cases where predation may be a problem, the biology of the situation should be carefully documented and demonstrated, and then appropriate action taken.

- Additional research and documentation on situations where predation can have an effect are needed. If predator control/management is undertaken, the program should be thoroughly documented and evaluated.
- Where consistent with applicable constitutional mandates and legal constraints, managers should support implementation of predator management to facilitate attainment of defined population size and human use objectives.

Population Management

- Thinhorn populations are not subject to density dependent effects. Rather, they are held below carrying capacity by other factors, such as weather.
- Managers should take no management action which may reduce population size without clear and consistent data indicating a density-dependent limitation exists.

Genetics and Taxonomy

- Examine the issue of the Fannin subrace of Stone and Dall sheep.
- Genetics is an academic rather than a management concern for thinhorns.
- Maintain pristine ecosystems and let natural systems operate.

Endangered and Threatened Species

- View thinhorn sheep as subspecies, not jurisdictional groups.
- Do not let thinhorn populations become endangered.

Exotics

- No introduction of exotics in thinhorn habitat.

Native Ungulates

- Manage total predator/prey systems, not single species management. To target management for one species often can be detrimental to other species. Management should be designed at the landscape scale.
- Maintain intact ecosystems.

MANAGEMENT OF WILD SHEEP IN NORTH AMERICA

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A workshop was convened at the 2ND North American Wild Sheep Conference to develop guidelines for managing wild sheep in North America. Participants included wild sheep biologists and managers from state, provincial, territorial, tribal, and federal agencies, universities, and research organizations, law-enforcement officers, and members of the public representing organizations that support conservation and management of wild sheep. Much of the experience and knowledge concerning the biology and management of wild sheep in North America was represented.

Working groups for desert bighorn, Rocky Mountain bighorn, California bighorn, and thinhorn sheep developed separate recommendations. These were discussed by the entire workshop and recorded for developing guidelines. Management topics were not wholly prioritized because the most critical management needs will vary among locations and times. Some literature citations have been added to increase utility of the guidelines. However, this is far from a complete review of the literature on wild sheep management. Previous useful literature reviews and management guidelines are found in: Bureau of Land Management (1995a), Trefethen (1975), Monson and Sumner (1980), Wilson et al. (1980), Van Dyke et al. (1983), Krausman et al. (1984), McCarty and Bailey (1994), Bureau of Land Management (1995b) and Valdez and Krausman (1999).
This list of guidelines is long and ambitious. It will tax the resources of many management agencies and organizations. However, it is the goal we must strive to achieve if we are to maintain the benefits of North American wild sheep for ourselves and future generations.

MANAGING WILD SHEEP ENVIRONMENTS

We may be certain that, if civilization continues its attrition of the remaining tracts of primitive country, all of our scientific knowledge and its specialized techniques may come to nothing. Not only the bighorn's existence, but much of his intrinsic value to man as well, depends upon the preservation of his habitat. It is more than likely that a hunter's memory of his stately ram is at least equaled by remembrances of mountain peaks, glittering lakes and green, untrampled meadows. (Smith 1954:104-105).

Habitat Loss and Fragmentation

1. Establish, restore, maintain and protect complete wild sheep ranges, including seasonal ranges and movement corridors for populations and metapopulations.

2. Protect all pristine wild sheep environments where they persist.

3. Provide buffer zones and seasonal activity restrictions to mitigate impacts of oil and gas developments, mining, other industrial activities, and tourism-related impacts upon wild sheep ranges. Promote zoning regulations to minimize subdivision expansion into important foothill and canyon wild sheep habitats.

Habitat Management and Acquisition

1. Where necessary, use easements, land exchanges and acquisitions to establish, restore and protect complete year-round ranges, including movement corridors, for wild sheep populations.

2. Habitat analysis should precede habitat management for wild sheep so that management is directed at limiting factors within sheep ranges, including movement corridors. Limiting factors may differ between ram ranges and ewe-juvenile ranges, and among years with differing weather. Access to a diversity of forage resources and foraging sites with different elevations, aspects and forage types will provide the most stable, year-round nutrition for wild sheep. Management efforts should include evaluation of the effectiveness of habitat manipulation in achieving stated goals for sheep populations and distributions.

3. In many areas, wild sheep habitats are being lost due to encroachment by trees and tall shrubs that restrict visibility (Risenhoover et al. 1988). Managers should be aggressive in developing site-specific prescriptions for treating deteriorated habitats with fire, chemical, or mechanical means (Greenwood et al. 1999, Smith et al. 1999). Repeated treatments of large areas may be necessary. Landscape-level habitat manipulation should be addressed, to avoid small, "patch" treatments that may artificially and adversely concentrate wild sheep. However, caution is advised where California bighorn use open shrub habitats, and pristine thinhorn sheep ranges probably do not require vegetation manipulation.
4. Within wild sheep ranges, reseed disturbed areas with native grasses, forbs and shrubs known to be valuable to local sheep populations.

5. Control introduction of exotic plants on wild sheep ranges by requiring use of certified hay. Educate off-road vehicle users about their potential to inadvertently transport exotic weeds on vehicle undercarriages. Seek to control established exotic plants with chemical, mechanical or biological methods.

6. Where bighorn sheep use natural or artificial waters, restrict access to those waters by livestock and feral burros. Artificial waters should be placed in secure habitats with escape terrain and good visibility. Remove visibility-obstructing vegetation surrounding water sources.

7. Follow Bureau of Land Management fencing guidelines (BLM Manual Handbook H-1741-1-Fencing, Release 1-1572, 12/6/89) on wild sheep ranges and in movement corridors. Remove or modify net wire fences, where possible, in sheep ranges.

8. Seek to place highway right-of-way fences as far from roads as possible, so as not to create a barrier that may keep animals on the roadway.

Human Disturbance

1. With public outreach and interagency coordination, including local governments where appropriate, develop site- and herd-specific regulations for eliminating or mitigating impacts of human disturbance on wild sheep. Where necessary, seasonally restrict recreational use of critical wild sheep habitats and movement corridors. Prohibit hiking with dogs in critical habitats. Agencies should enforce their regulations intended to control wildlife harassment.

2. Identify areas where wild sheep may become attracted to human developments or become a nuisance/hazard (e.g., roadside barrow ditches feeding on exotic grasses, golf courses). Develop habitats to attract sheep away from these areas.

Disease Threats and Management

1. Due to the frequent transfer of *Pasteurella* spp. bacteria, domestic sheep allotments in or near the ranges of wild sheep are a serious threat to the health of wild sheep (McCarty and Bailey 1994:15, Martin et al. 1996). These allotments should be eliminated or, if suitable, converted to cattle.

2. Domestic sheep should be kept at least 13.5 km (9 miles) from desert sheep ranges (Desert Bighorn Council, Tech. Staff 1990; BLM Instruction Memorandum No. 98-140). Greater isolation distances, up to 20 km (12.4 miles) (Singer et al. 2000) or more (Schommer and Woolever 2000) are necessary where there are no effective barriers to wild sheep movements. Movement patterns of wild sheep should be determined for any herd in the vicinity of an existing or proposed domestic sheep pasture. Where possible, maintain dense forest cover as a barrier between domestic and wild sheep. Continue education and outreach with the domestic sheep industry and small "farm flock" operators regarding risks to wild sheep associated with domestic sheep. Use an inter-agency approach, involving domestic sheep permittees and Woolgrower Associations, to analyze risks and potential for interaction and to develop site-specific solutions (Schommer and Woolever 2000).

3. Permanently remove any wild sheep that has interacted with domestic sheep.

4. Do not use domestic sheep or goats for exotic weed control in or near wild sheep range.

5. Remove any feral goats from wild sheep ranges. Discourage recreational pack goats. If used, ensure they are closely tended, are tethered or penned at night, and will not contact wild sheep. Pack goats should not have been in recent contact with domestic sheep. In areas where wild sheep are exceptionally tame and prone to approach humans and pack animals, prohibit recreational pack goats.
6. Prevent, and seek legislation to preclude, the introduction of any domestic sheep, goats or cattle into the pristine ranges of thinhorn sheep, or into the ranges of any bighorn sheep populations that may have persisted without previous contact by livestock.

7. Consider the risks of disease transmission in developing strategies for metapopulations. In some cases, the viabilities of two smaller metapopulations will have to be weighed against the risk of epizootic in a larger metapopulation.

8. Use all opportunities to obtain samples for assessing the health status of wild sheep herds. This is especially important prior to transplanting animals. Maintain a database of herd health and disease-exposure for each herd. All cases of sickness or natural death of wild sheep should be presented to a wildlife disease expert or veterinary diagnostic laboratory for accurate diagnosis. Each state, province, and territory should have a protocol for responding to reports of sick wild sheep, including where to obtain veterinary assistance, tests to be performed and subsequent population monitoring.
9. States, provinces, territories, and tribes should share data on disease exposures and health parameters of wild sheep, possibly through the Western Wildlife Health Cooperative.

10. Develop an internet site or other effective, timely communication for disseminating current knowledge of disease outbreaks and science-based management actions.

Competition from Livestock, Exotic and Native Ungulates

1. No exotic ungulates or domestic livestock should be allowed on pristine thinhorn sheep ranges. Exotic ungulates should be discouraged on all other wild sheep ranges.

2. Manage wild horses and burros on wild sheep ranges within established guidelines. Eliminate other exotic ungulates, especially mouflon sheep, where they have no legally mandated presence.

3. Where cattle graze wild sheep ranges, use management strategies to minimize overlap of range use, especially during critical seasons. Cow/calf pairs are preferred to yearlings, which are more prone to use steep terrain. Partition forage resources between cattle and wild sheep using the best available local knowledge, including food habits and spatial and temporal overlap for both ram and female groups of sheep. Allocate sufficient amounts and kinds of forages to wild sheep to maintain a viable herd of healthy animals.

4. Promptly remove trespass livestock from wild sheep ranges. Monitor allotments for conformance to agreed-upon stocking rates and seasons.

5. Wild sheep are generally subordinate to other ungulates at water sources. Where access to water is a limiting factor, provide separate watering access for sheep by fencing out livestock, horses and burros from at least a part of the water source. Otherwise, provide wild sheep waters in such steep terrain that other ungulates cannot access the sites and/or develop other water sources to draw competing ungulates away from waters developed specifically for wild sheep.

6. Oppose game ranching in which exotic ungulates may unintentionally become established on wild sheep ranges. Where game ranches exist, promptly remove any escaping animals. Require game ranches to provide bonds that will assure removal of escapees. Regular monitoring and maintenance of game ranch fences should be required and there should be penalties for inadequate fence maintenance.

7. Discourage vegetation change, from disturbance or succession, that will create or increase competition from other native ungulates on wild sheep ranges.

Predation

The impacts of predation upon wild sheep populations will depend mostly upon (1) the vulnerability of sheep to predation, as determined by the health of sheep and by habitat security factors (escape terrain proximal to foraging areas, and visibility); (2) predator abundance; and (3) the size of the wild sheep population as it determines whether predation rates are density- dependent, or inversely density-dependent (Solomon 1958). In a multiple-prey system, the predator/wild sheep ratio and the proportion of the sheep herd lost annually to predation may increase as the sheep population declines, even to extirpation. Predator-prey relations are often complex and highly dynamic, and therefore vary among times and places.

1. Predator control is a valid management option, especially for small or newly transplanted wild sheep herds. Predator management strategies should be flexible, adapting to local and temporal conditions, and should be implemented in ways that allow reliable evaluations of their effects upon wild sheep populations.

2. Many wild sheep habitats need management, particularly removal of tall, dense vegetation, to improve visibility and reduce vulnerability of sheep herds to predation. State and provincial

wildlife agencies should be more proactive in encouraging and facilitating habitat management, including wild sheep transplant or population augmentation sites.

3. Water sources in wild sheep ranges should be designed and located, or vegetation near waters should be treated, to decrease vulnerability of sheep to predation by providing escape terrain and good visibility.

4. New transplants of wild sheep are especially vulnerable to predation because there are relatively few sheep and they are placed in unfamiliar territory. Transplant sites should be selected to minimize vulnerability to predation. It is desirable to evaluate predator abundance in proposed transplant sites, and to consider if pre-transplant predator control should be implemented.

Wilderness Management

1. Improved state-federal communications on wilderness management is needed. Federal agencies should assign biologists, as well as recreation specialists, to coordinate with state agencies and wild sheep advocacy groups on wilderness issues. Domestic sheep in wilderness areas with potential or occupied bighorn sheep habitat should be eliminated.

2. If wild sheep are to contribute fully to wilderness values, wilderness management plans must recognize and provide for the natural processes expected in wild sheep populations. Where wild sheep occur in wilderness areas, their populations should be designated as primary wilderness components (Bailey and Woolever 1992). Wild sheep should be reintroduced into all suitable, vacant historic ranges within wilderness areas.

3. Some management intervention will often be necessary in order to maintain the wilderness values of wild sheep populations, especially in the preponderant small wilderness areas. These values include seasonal and metapopulation movements that are necessary for population viability and maintenance of genetic resources. Interventions such as ignition of prescribed fires, monitoring of populations, and the capture and movement of animals are justified to retain these values. Reducing conifer encroachment in prime bighorn range inside designated wilderness should be emphasized.

4. Clear policy guidance should be developed for management of habitats and wildlife populations in wilderness areas and wilderness study areas. Policies should be applied consistently among areas and periods.

5. Based on input from state wildlife management agencies, wilderness management plans should identify time windows when management activities for maintaining wild sheep values, including survey flights, will cause minimal impacts to other wilderness uses and wilderness values.

Research Needs

1. The effects of developing artificial water sources upon the distribution, productivity and survival of wild sheep requires further study. Experimental research, with treatment and control groups, is recommended. In hot climates, artificial waters should be tested periodically for the presence of dangerous *Clostridia* bacteria.

2. Studies of predator-wildsheep dynamics, includingsystems with multiple prey species, are needed. Wild sheep demographics, including lamb survival and recruitment, should be determined at various combinations of predator and prey population sizes. Experiments should be designed to manipulate predator or prey population sizes, and should include both favorable and unfavorable weather periods for wild sheep.

3. Experiments are needed to determine the minimum fence necessary to hold cattle while allowing safe passage for all sex-age classes of wild sheep.

4. Continue research on the infectious diseases and parasites of llamas, domestic goats and cattle, and their threats to wild sheep.

5. A standardized disease and nutrition sampling and testing protocol should be developed for wild sheep, possibly through the Western Wildlife Health Cooperative. Routine collection and sharing of blood and fecal samples may be used to establish baseline values of nutritional and health parameters for each subspecies and species of wild sheep. Baseline values may then be used to assess herd health, trend of ecological density, and success of habitat management.

6. Conduct experimental as well as observational research on the effects of human disturbance upon wild sheep. Demographic as well as behavioral and physiological impacts should be determined. There is a need for a review and synthesis of existing information on this topic.

7. Review and synthesize information on fire frequencies needed to maintain open wild sheep habitats in many ecosystems. Develop protocols for conducting prescribed fires in wild sheep habitats.

8. Review and synthesize information on effects of aircraft (fixed wing, helicopter and hang gliders) upon wild sheep behavior. Develop guidelines for management.

MANAGING WILD SHEEP POPULATIONS

"The objective of conservation of mountain sheep is to safeguard the future of the species. As a minimum it means the preservation of a diverse gene pool in interaction with a natural ecosystem….. A reserve system would contain representative populations, not only of each subspecies of mountain sheep, but also of different ecotypes within a subspecies….. Such a system would be the backbone of our efforts to conserve mountain sheep and insure the availability of animals and knowledge for present and future management needs." (Geist 1975:84).

Harvests and Population Reductions

1. Obtain reliable survey information as a basis for allocating wild sheep harvest permits. For large thinhorn populations, conservative harvests can be sustained with minimum population monitoring. Elsewhere, monitor population trend, abundance, recruitment and ram age structure, at least. Monitor forage conditions in critical habitats. Additional data on sex-age specific mortality rates will enhance understanding of herd dynamics and enhance population modeling efforts (McCarty and Miller 1998). Use long-term data to assess the role of weather in determining herd performance.

2. For large, productive wild sheep herds living in open, continuous habitat, conservative harvest of mature rams has little, if any, population effect (Geist 1975:92). If the number of ram licenses is limited and conservative, horn curl regulations are unnecessary.

3. Removal of ewes may be beneficial in herds that are near forage carrying capacity and are exhibiting symptoms of density-dependentdeclines in recruitment and animal quality. Symptoms of density-dependence may include lack of yearling breeding and reduced reproduction by 2-4 year old ewes, extended lactation, increased average age of adults, reduced horn annuli growth in rams over the first 3 years of life, and reduced body size of yearling ewes. Density-related changes in herd dynamics should be verified, not assumed. Many herds are controlled primarily by density independent factors, and carrying capacities may vary greatly among years, depending upon weather. If ewes are to be removed, translocation is preferred unless all suitable ranges have viable wild sheep herds. Impacts of ewe removals should be measured with pre- and post-treatment data, or with another experimental design including control and treated populations.

4. All harvests, including state, provincial, territorial, tribal or subsistence harvests, should be reported and recorded in a common database for each metapopulation.

5. Hunter orientation programs are encouraged. These may include identification of legal sheep, regulations and hunter ethics, care of meat and trophies, and biological rationales for harvest levels and methods.

6. Use public outreach to explain the rationales and the economic, cultural, recreational and biological bases for hunting of wild sheep. Do not promote a biological basis (herd management) where none exists (herds below forage carrying capacity; harvest of older rams only).

7. The California bighorn working group supported record-book listings for California bighorn, but only for registered and plugged trophies taken by fair chase, not for pickup heads.

Capture, Handling and Transplants

1. Wild sheep should be reestablished in all vacant historic ranges that still provide suitable habitat.

2. Transplants may be used to establish new herds, augment existing herds, expand existing ranges or create migratory behavior. Transplant strategies should be related to plans for metapopulations of wild sheep. Establishing isolated populations in habitats that do not have the potential to support at least 100 wild sheep is discouraged.

3. Potential transplant sites should be thoroughly evaluated. For historic ranges, consider the possible causes for extirpation and determine that these problems have been rectified. If evaluation indicates potential habitat problems, improve habitat prior to releasing sheep. Evaluate predator abundance, especially where there may be moderate to large deer and cougar populations. If determined appropriate, implement pre-transplant and temporary post-transplant predator control to assist in establishing new wild sheep populations. Eliminate or mitigate livestock or other large ungulate conflicts prior to release of wild sheep.

4. For each transplant, use the native subspecies where possible, otherwise the most nearly similar ecotype (i.e., similar food habits, similar habitat selection patterns, similar seasonal and daily movement patterns). Cooperation among states, provinces and tribes may be necessary to provide the most appropriate transplant stock.

5. Move at least 30 sheep for any initial transplant. Higher numbers, through multiple transplants, will likely enhance success. Translocation of family or social groups is preferred over the use of individuals captured separately, but genetic concerns from transplanting small numbers of potentially-related sheep should be recognized. Recognize that smaller transplants (N=~10 head) to supplement existing small bighorn herds are a viable management technique. Also, transplanted sheep may be released at multiple locations within a project area.

6. Do not remove large numbers of sheep from small source herds. Such removals may cause range contraction and inversely density-dependent predation rates.

7. Test source herds for diseases. Minimize potential for transferring diseases among wild sheep ranges. Do not transplant sheep from herds with recent histories of pneumonia. In multiple-source transplants and augmentations, aim to avoid mixing animals with dissimilar disease exposures. If necessary, test for incompatible diseases by exposing a few animals under controlled conditions. Sanitize all handling equipment between capture and transplant operations.

8. Obtain adequate samples for genetics analysis from each group of transplanted sheep.

9. Monitor transplanted sheep for at least a year, most intensively during the first 6 months. Use mortality sensing radio collars, and collar as many animals as possible, with exceptions where wildlife viewing is the primary management objective.

10. Each state, province, and territory should maintain a database of transplant histories, including genetics and disease information.

11. If propagation pens are used to maintain a source herd and provide transplant stock, maintain numbers of sheep with supplemental feed *ad libitum*, if food quantity or quality is suspected to be limiting. Maintain a 1:5 ram:ewe ratio, primarily by removing young rams. Isolate ewes during the lambing season. Periodically obtain samples to monitor genetic diversity of the captive population. Rotate breeding rams to maintain genetic diversity while recognizing potential disease concerns. Periodically supplement the female breeding stock with ewes from external sources. Remove competing ungulate species from the pen. Minimize predation losses with effective fences and predator control, as needed (New Mexico Dept. Game and Fish/Conservation Breeding Specialist Group, 1999:83).

12. Each state, province, and territory should have written protocols for capturing, handling and transplanting wild sheep. There should also be a standard protocol for evaluating animal health. Health and safety of wild sheep must be stressed in all capture and handling operations. Capture teams should include veterinarians. Guidelines of the Desert Bighorn Council Technical Staff (1982) are recommended with one exception: soft release of transplanted sheep, using a temporary enclosure, is not recommended.
13. Transplants are not needed in thinhorn sheep populations.

Taxonomy, Genetics, Ecotypic Variation

1. Although the existing taxonomy of wild sheep is questioned, it should be retained until thorough and extensive genetic analyses have been completed and withstood peer review.

2. States, provinces, and territories should cooperate to monitor the status and trends of wild sheep according to political units, taxonomic units, and bioregions (major ecotypes of wild sheep).

3. The wild sheep of North America have undoubtedly lost much of their original genetic diversity due to extirpations and population declines resulting in genetic drift. Genes interact with environments to determine the genetics of future populations and also the diverse anatomical, physiological and behavioral results of ontogenies. If the remaining genetic diversity of wild sheep is to be preserved, and if its full value is to be realized, wild sheep must persist in a diversity of environments. Therefore, the preservation of ecotypic diversity is equally important as the preservation of taxonomic diversity (Geist 1975:84).

4. In pristine North America, subspecies of wild sheep did not frequently occur as isolated populations. As more historic ranges of wild sheep are being repopulated, genetic exchange between subspecies is again expected. The Desert Bighorn Council and the Northern Wild Sheep and Goat Council should develop guidelines for managing clines between subspecies, and provide suggestions for recognizing categories of wild sheep in hunting-related record books.

5. Genetic studies are needed, not only to refine the taxonomy of wild sheep, but also to determine the genetic diversity that can be retained within subspecies. Biologists should collect, label and store samples for genetic analyses at almost every opportunity. A small number of central storage repositories for these samples is desirable. Samples should be available to qualified geneticists. Protection of samples for individual professional ambitions should not impede comprehensive analyses using a variety of methods.

Threatened and Endangered Classifications

1. Federal funding should be adequate for the recovery of listed subspecies. Prohibitions of the Endangered Species Act against direct take and against indirect take (i.e., habitat destruction) should be enforced.

2. Conservation strategies should be developed and implemented to avoid the necessity for listing imperiled subspecies or distinct populations of wild sheep. These strategies must contain clear commitments to conserve sheep and their habitats, if they are to reduce a need for protection under the Endangered Species Act.

3. Stocks of California bighorn sheep derived from British Columbia do not warrant listing as threatened or endangered at this time.

Management of Metapopulations

1. Metapopulation management plans should weigh the values of demographic support and genetic interchange against the risks of disease transmission among populations.

2. It is imperative to maintain corridors with appropriate habitat qualities (e.g., foraging areas, water sources, security) for unimpeded movement of wild sheep among populations within metapopulations. Likely corridors are areas with steep or broken terrain. Vegetation in these corridors should be managed to maintain visibility. Barriers caused by roads, especially interstate highways, and by canals, fences, and human occupations should be minimized and mitigated.

3. Agency rewards and incentives should not favor the funding and implementation of isolated management projects at the expense of developing and implementing comprehensive metapopulation plans (Bailey 1992).

Research Needs

1. Experimental research on the impacts of inbreeding in wild sheep is needed. There are opportunities for this research whenever a small wild sheep herd is augmented with a novel genetic stock. Pre- and post-transplant reproduction and survival may be compared. Or, if a novel genetic stock of only ewes is introduced, the reproductive successes of native inbred and translocated outbred ewes may be compared within the post-transplant period.

2. Historic records should be used to evaluate the effects of moving transplant stocks into novel vegetation types.

3. Determine the persistence of diseases following dieoffs and the appropriate quarantine period necessary before the affected herd or habitat may be restocked with wild sheep. Evaluate management activities that may reduce this quarantine period.

4. Much research is needed on the population dynamics of wild sheep in single- and multiple-prey predator-prey systems. Opportunities to manipulate the abundance of wild sheep, the abundance of alternative prey, or the abundance of predators should be used in management experiments.

5. The values and disease risks for wild sheep, particularly of contagious ecthyma, from providing baits or salt blocks, including antibiotic, anthelminthic (Miller et al. 2000) or trace-mineral blocks, should be determined.

6. The characteristics of "Fannin" thinhorn sheep should be investigated to clarify their taxonomic, genetic and ecotypic status.

7. Information on the interrelationships of mountain goats and wild sheep should be summarized and the need for further research evaluated.

ADAPTIVE MANAGEMENT

"It is a common pastime in many organizations to collect vast quantities of data on a routine basis . . . with the vague intentions of submitting them to analysis one day. The piles of useful stuff in the files get more comprehensive, and out of date, as the years go by. Pious intentions to analyze them some day are of little value. If data are not worth analysis at a suitable near date they are rarely worth collection. Data should be collected with a clear purpose in mind. Not only a clear purpose, but a clear idea as to the precise way in which they will be analyzed so as to yield the desired information." M.J. Moroney, source unknown.

1. Management of wild sheep and their habitats should be adaptive, building upon reliable knowledge that is generated by testing management hypotheses with rigorously designed management experiments (MacNab 1983). Designing these experiments is the responsibility of both management biologists and research biologists. To the extent practicable, experimental management should include designated controls, random assignment of treatments, replications, and a commitment to measuring and reporting results.

2. Confounding of multiple experiments on one wild sheep herd or habitat must be avoided if the effects of individual management practices are to be evaluated.

3. Results of management experiments should be analyzed and published in accessible journals, symposia or proceedings.

THE HUMAN ELEMENT IN WILD SHEEP MANAGEMENT

"Perhaps the greatest need of all is for an informed general public willing to accept the responsibility of seeing to it that good conservation practices and a continued program of research are carried out." (Buechner 1960).

Advocacy Groups

1. Wild sheep advocacy groups have important advisory and fund-raising roles. However, management agencies have ultimate decision-making responsibilities.

2. Advocacy groups should be expanded to include a broad range of both hunting and non-hunting publics and organizations.

3. Chapters of the Foundation for North American Wild Sheep, or organizations affiliated with the Foundation, should be established in all states and provinces that have wild sheep. Chapters are also encouraged in states and provinces that do not have wild sheep.

4. Professional biologists should encourage advocacy groups by maintaining regular communications, by providing clear biological rationales and critiques for management options, and by carefully considering and responding to the concerns and needs of advocacy groups.

5. Advocacy groups should be invited to participate in interagency management meetings, especially for land-use planning that impacts wild sheep habitat.

6. In dealing with advocacy groups, biologists should emphasize the commonality of goals among otherwise diverse groups. Attention should be focused upon the maintenance of complete wild sheep habitats and healthy, viable populations and metapopulations.

7. Professional wild sheep biologists should be used to assist in evaluating proposals for project funding by advocacy groups. Each funding organization should develop a comprehensive format to be used for submitting all proposals.

8. Advocacy groups should be strong proponents of hunter ethics.

Fund Raising

1. Continued private funding of many types of projects for wild sheep is needed. These include population management, improvement and acquisition of habitat, education, short- and long-term research, and law enforcement.

2. Funding of wild sheep management by a broad range of advocacy groups and by the general public is appropriate and needed. Hunters have accepted a disproportionate share of the costs of wild sheep management, while the benefits of wild sheep populations are realized by all.

3. Cooperative federal funding of wild sheep management is especially appropriate for unhunted populations on federal lands, such as National Parks. Relying primarily upon hunter/advocacy groups to fund this management is not appropriate.

4. Professional biologists should communicate regularly with advocacy groups, not just when funding of management projects is being requested.

5. When an advocacy group is funding a management or other wild sheep project, there should be a clear, written understanding of the project objectives, including the expectations of the funding organization. Funding recipients are obligated to report management efforts, research findings and management implications from funded projects to their funding organizations.

6. Funds from special sales or auctions of hunting licenses for wild sheep should be used solely for wild sheep enhancement and should not be diverted to other uses (Northern Wild Sheep and Goat Council 1988).

Political Action

1. Political activities for protecting wild sheep and their habitats should be coordinated among advocacy groups and across state, provincial, territorial, First Nation, Native Corporation/Organization, and international boundaries.

2. In order to reduce the threat of pneumonia epidemics in wild sheep, political (e.g., legislative) support from advocacy groups is especially needed to facilitate the retirement or purchase of domestic sheep grazing allotments within or near wild sheep habitats, or to preclude introduction of domestic sheep or goats into pristine wild sheep habitats. Support is also needed for transplants of wild sheep when they are opposed by other special interest groups, and for protection of wild sheep habitats in land use planning.

Education and Outreach

1. Public education programs should emphasize the values of both huntable and nonhuntable populations of wild sheep, the habitat needs of wild sheep and the impacts of land uses upon wild sheep habitats, including corridors that allow sheep to move within and between sheep ranges. The public should be better informed of the values of genetic diversity within subspecies of wild sheep.
2. Education and outreach programs should be expanded to reach more of the non-hunting public.

3. Watchable wildlife programs should not increase disturbance on wild sheep ranges. Viewing sites should be carefully planned to avoid disturbance, especially during critical seasons of the year. Viewing sites are best located below the sheep and behind a barrier such as a river. Where viewers frequently walk among sheep, restriction of viewers to designated trails is desirable.

4. Public education programs should emphasize the ethics of viewing wildlife.

5. Opportunities to involve youth in wild sheep management projects should be utilized.

6. Biologists should encourage publications on wild sheep for the public by suggesting topics, providing information and providing texts and photos.

7. Advocacy groups should assist in disseminating accurate and timely information on wild sheep management to the broadest possible public.

Law Enforcement

1. Sale or barter of picked up heads should be illegal because poached sheep may be represented as "pickups". Ownership of all wild sheep heads should be by permit only, and all heads should be registered and permanently marked (i.e., plugged, pinned) for future identification. The North American Wildlife Enforcement Officers Association could assist in developing uniform laws and regulations among state, provincial, territorial, and tribal jurisdictions.

2. Biologists should use all opportunities to photograph, PIT-tag and record characteristics of valuable wild sheep heads, as this information may be used for identification in law enforcement. Horn cores from the plugging process and other available samples should be saved for DNA and mineral analyses.

3. Penalties for illegal taking of wild sheep, including fines, should be consistent with the market values of the illegal products and the public values of illegally-taken sheep.

4. Private ownership, sale, trade or transport of native wild sheep should be illegal (Northern Wild Sheep and Goat Council 1990).

5. There is a need for public education regarding rationales and needs for strict regulations and controls on ownership of wild sheep, trophies, or body parts. Threats to wild sheep populations, loss of genetic potential, and loss of public values should be emphasized.

6. Law enforcement activities should be coordinated among federal, state, provincial, territorial, and tribal enforcement agencies.

7. Law enforcement efforts should be expanded, based upon adequate agency funding. Funding of special law enforcement efforts and programs by advocacy groups is also appropriate.
8. Management biologists should assist and support law enforcement activities.

Interagency Cooperation and Coordination

1. Better interagency communications are needed for the management of wild sheep and their habitats. Annual status reviews, including agency administrators, are desirable. Local projects should be developed using inputs from the variety of resource specialists needed to address the local issues - biologists including wildlife pathologists, sociologists, and physical scientists.

2. Interagency coordination of projects for wild sheep, especially state-federal and province-federal coordination, should be facilitated by having written agreements that facilitate cooperation, cost-sharing and timely exchange of funds to accomplish mutually agreed upon goals.

3. State, provincial, and territorial wildlife agencies should have written, long range plans including goals for the distribution and abundance of wild sheep, and addressing the restorations, land acquisitions or easements necessary to achieve these goals. Plans must be developed with input from land management agencies and interested publics.

4. Historic, current and potential wild sheep ranges, including movement corridors, should be mapped for use in land-use planning. Critical and vulnerable habitats should be identified.

5. Management biologists should work with local, state and tribal governments and nongovernment organizations to assist in planning for the needs of wild sheep in all land use decisions. State, provincial, and territorial wildlife agencies should be involved early in the scoping processes of land use planning. Using agencies merely to review already drafted plans greatly limits their abilities to protect wild sheep habitats. Biologists should monitor implementation of plans to assure that approved protections for wild sheep are not neglected.

6. Biologists should analyze and interpret appropriate data in their files, providing this information for land use planning. Historic and current populations should be compared for evaluating the impacts of past changes in land uses, and as evidence for discouraging continued habitat degradations.

7. Too many wild sheep management plans are restricted to individual populations or are constrained by political boundaries. Metapopulation management and planning are needed (Bleich et al. 1990, Bailey 1992, Armentrout and Boyd 1994). Interagency coordination will be necessary where metapopulations extend across international, state, provincial, tribal, or other administrative boundaries.

8. The needs of wild sheep should be considered in all agency land exchanges.

9. Where necessary, plans of the Bureau of Land Management, Forest Service, Park Service and other land management agencies should be amended to adequately recognize the importance of wild sheep habitats. Threats to these habitats should be identified and mitigation measures should be developed and implemented.

10. Use easements, exchanges and acquisitions of land to develop and maintain complete wild sheep ranges, including movement corridors within and among populations.

11. Biologists should be conservative and proactive in protecting wild sheep habitats, and should anticipate impacts of land uses.

12. Federal grazing and other land use plans should allocate needed amounts, kinds and distributions of forages to meet the year-round needs of wild sheep, in both normal and abnormal years.

13. State and federal agencies should coordinate to address National Environmental Policy Act (NEPA) requirements for wild sheep habitat and transplant projects. For some projects, the state wildlife department, as the project proponent, may be more effective as the lead agency for NEPA activities. Projects covered in prior NEPA documents, such as Habitat Management Plans or other land use plans, may not need additional NEPA analysis. Management decisions should be based upon legal mandates of the agencies, supported by accurate biological and social information developed under NEPA. The NEPA process is not intended to be a "popularity contest." Management decisions should not be directed by special interests that use the NEPA process to publicize and develop support for their personal goals.

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