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INTRODUCTIONS OF MOUNTAIN GOATS IN THE GREATER YELLOWSTONE ECOSYSTEM: THEY'RE HERE TO STAY! OR ARE THEY?

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Abstract: Mountain goats have apparently been absent from the Greater Yellowstone area since the last ice age. Introductions by state wildlife agencies in mountain ranges peripheral to Yellowstone National Park have been successful. Goats are now colonizing inside park boundaries where they are viewed as exotics, and where there is great concern over potential ecological consequences. It is widely accepted that exotic species can have serious effects on native biota and exotic mountain goat populations have become management issues in at least nine western states. For example, mountain goats introduced to Olympic National Park have altered native plant communities and reduced the abundance of some endemic plants. Debates over native vs. exotic designations, the effects of goats on native plants and animals, and the appropriate management scheme has become an interesting and lively blend of ecology, politics, practicality, and perhaps most importantly, reality.

Mountain goats (*Oreamnos americanus*) were historically distributed in the coastal range from Alaska to northern Washington and in the Rocky Mountains from northern Canada to northern Montana and central Idaho. Through introductions by state wildlife agencies, their distribution has been successfully expanded into vacant habitats in their historic range, as well as in habitat outside their historic range in the western United States (Johnson 1977, Wigal and Coggins 1982).

Mountain goats introduced to non-native ranges have become management issues in Colorado, Oregon, Washington, Idaho, Wyoming, South Dakota, Nevada, Utah, and Montana (Johnson 1977). One such area is Yellowstone National Park where goats were widely introduced to mountain ranges on the periphery of the Park during the 1940-60s by the state wildlife agencies of Montana and Idaho for recreational hunting purposes. Goats have since colonized mountainous portions in Yellowstone where they pose a problematic management issue. Yellowstone Park officials are concerned with the ecological consequences of mountain goat colonization. Evidence that mountain goats were a member of the Yellowstone fauna during historic time (Schullery and Whittlesey 1995), or at any time during the Holocene, is lacking (Mead 1983).

There is little doubt exotic species may have serious impacts on native communities (Berger 1991, Soule' 1996). The National Park Service position on management of exotic and native species is guided by statutory law (17 Stat. 32; 39 Stat. 535), regulatory law (36 CFR 2.1(a)(2)), and by policy (NPS Management Policies 1988, NPS-77, 1991). This guidance is the strongest of any federal or state laws or policies against invasions of exotic species. This has been at least somewhat effective, as national parks are often considered "the best of what's left" in terms of pristine ecosystems and the preservation of native biodiversity. Yellowstone National Park is believed to be the only place in the 48 contiguous states that has all of the native flora and fauna that was here 500 years ago when Columbus arrived in the new world. As a result, the classification of mountain goats in Yellowstone as exotic or native is not a trivial matter. These designations and the direction of management of goats in Yellowstone, however, is clouded in several issues regarding the law, politics, ecology, practicality and reality.

Post-Pleistocene Distribution

Much of the debate over native versus exotic centers around the post-Pleistocene distribution of mountain goats. After *Oreamnos* emigrated from Asia across the Bering Strait, their distribution in North America seemed to have oscillated with the distribution of continental ice during the mid- and late-Pleistocene so that in many local mountain ranges, goats appeared and disappeared with fluid transience. Thriving in the cold, wet climate of the time, goats colonized the mountain ranges that protruded from the ice-covered valleys that receded and advanced below their lofty habitats. At that time, a smaller species of mountain goat, which has since become extinct, *Oreamnos harringtoni*, roamed the canyons of the present-day deserts of Arizona and Mexico. The last advance of the Cordilleran ice sheet (20,000 - 18,000 years B.P.) may

have had the greatest effect on limiting goat distribution to islands of mountainous refugia and the southern terminus of the ice-sheet which included Yellowstone (Laundre' 1992). Mead (1983) hypothesized that the Greater Yellowstone area was an avenue for goat dispersal at that time.

If goat presence has been established in the mountain ranges of most western states within the last 10-20,000 years, then designations of native vs. exotic are a judgement in which managers have to arbitrarily select one point in time from which species collections are considered native. This point has usually been considered the time of European contact with the ecosystems in question, less than 200 years in all cases in the western states. Houston and Schreiner (1995) write, "Given the dramatic changes in species distribution in North America from the close of the Pleistocene, what temporal and spatial scales of species distribution are appropriate to consider for defining "alien" and "native" ?" then suggests natural areas should be "set aside to conserve the outcome of dramatic ecological events of the late-Quaternary, including local extinctions..." American national parks are primarily managed in such a manner.

This viewpoint reflects the famous "Leopold Report" (Leopold et al. 1963) and the often-misunderstood "Vignette of Primitive America" approach which is invoked as suggesting that we preserve biological "snapshots" of the parks as they were when first visited by modern humans. Of course, Starker Leopold and his colleagues knew it wasn't that simple—that we must consider ecological processes and all the change it brings—that the vignette was not a snapshot but a motion picture, a sort of endless IMAX presentation. Almost all students of the subject recognize that there is no magic date at which a park setting achieved appropriateness.

Allowing natural processes to proceed while discouraging human-induced processes becomes problematic with Yellowstone goats when the two blend together imperceptibly. On the north, east and south boundaries of the park, introduced goat populations are colonizing or poised to do so. On the western boundary of the park, however, two adjacent mountain ranges hold two distinct populations of goats: one population was introduced to the Madison Range while the Centennial Range was colonized by a native populations from the Bitteroot Mountains (Laundre' 1992). According to N.P.S. regulatory and policy authorities, if the Centennial population colonizes Yellowstone, the goats are considered native and thus welcomed. If the Madison population (or goats from the north, east or south) comes into the park, the goats would be considered exotic and the agency should try to prevent colonization. Of course, colonizing goats are indistinguishable from one another, and therefore the question of "Is it a natural colonization?" becomes seriously blurred.

Ecologically Exotic?

If mountain goat presence has been established through fossil evidence in Yellowstone and other ecosystems of western states within the last 10-20,000 years (if not more recently), then they may not be considered ecologically exotic to the extent that ecosystems will be severely affected by their return. Laundre' (1991) writes, "goats co-occur in other climatologically and physiognomically similar areas with most, if not all, the recognized native faunal and floral species of the Yellowstone area. Thus, given the Pleistocene occurrence of goats, native plants and animals of the Yellowstone area have had an evolutionary past that included goats."

Goats co-evolved with their habitats as their distribution advanced and receded with the glaciers across North America. Habitats sharing an evolutionary past that includes goats, or even a substantial herbivore presence in goat environs in their absence, will likely have buffers sufficient to accommodate goat (re-)colonization without undue long-term ecological impacts. The challenge becomes one of assessing each case on an individual basis by asking, "What is the goat's history with the ecosystem in question?" bearing in mind that further archeological and paleontological excavations would continually update any suppositions.

Mountain goat studies in and near Yellowstone Park have attempted to predict ecological effects of goat colonization prior to goats becoming established based on literature review (Laundre' 1992) and field data (Varley 1996). Both studies predicted that impacts to the native community would be minor. These studies suggested introduced goats filled a vacant ecological niche in which mountain goats share an evolutionary past with current members of the ecosystem.

An example may be the relationship of goats with their fellow alpine ungulate the bighorn sheep, *Ovis canadensis*. Competition between these two species has been a management concern particularly where goats have been introduced to sheep ranges. Interference competition between the two species was recorded in the Mt. Evans area of Colorado where goats were introduced (D. F. Reed, unpublished data). Furthermore, Hobbs et al. (1990) used a long-term (100 years) model which predicted local extinction of mountain sheep that occurred after 27 years of sympatry. However, native mountain goats clearly coexist with wild sheep in many areas. In most cases, it appears feeding behavior and temporal and spatial habitat selection differences minimize conflict. The

contrasting resource use patterns found in sympatric populations are indicative of a niche divergence that would be expected in most cases given the two species' extensively overlapping distribution and evolutionary history in North America (Adams et al. 1982, Varley 1994, 1996).

Whether or not the same adaptations apply to the relationship of goats with the vegetation community is less certain. Following a goat introduction, changes can be expected to occur as the ecosystem adjusts to the presence of goats. Significant modifications to the vegetation communities would occur assuming the Riney-Caughley model of population growth following introduction (Riney 1955, Caughley 1970). The basis for population irruption and subsequent decline in the model is the modification of vegetation resulting from the establishment of ungulates in formerly unexploited habitat. The extent of the changes would depend upon the ecosystem and the ability of its affected components to adapt and respond to exploitation by goats.

Very few studies have reported the nature and extent of these changes, particularly for alpine ungulates. The establishment of exotic Himalayan thar in New Zealand incurred changes in mountain vegetation documented by Caughley (1970). Another case involved changes resulting from mountain goat introductions in Olympic National Park, Washington. Mountain goats altered vegetation communities through grazing, wallowing and trampling (Olmsted 1979, Pfitsch et al. 1983, Schreiner 1994).

The Olympic case is the only known case of goats having an adverse affect upon an ecosystem, and the best documented case of introduced ungulates causing impact to sensitive native biota. Goats introduced to the range in the 1920s have altered vegetation communities and reduced the abundance of some endemic plants (Pike 1981, Pfitsch et al. 1983, Pfitsch and Bliss 1985, Schreiner 1994).

A comparison between the Olympic ecosystem and the Yellowstone ecosystem could be valuable in helping to predict the effects goats could have in Yellowstone. The Olympic system differs from Yellowstone in a number of major aspects which makes extrapolation from one case to the other tenuous. The Olympic mountains receive high rainfall (100-400 cm, annually, depending on elevation, topography, etc.) compared to the principle mountain range in Yellowstone, the Absarokas (80-150 cm annually). The biota present in the Olympic ecosystem includes 35 endemic plant and animal forms, including 14 vascular plant taxa (Houston and Schreiner 1995, Houston et al. 1994). Although not studied to the same extent as the Olympic plant community, the Absaroka plant community is not particularly unique nor does it have any documented threatened or endemic plant taxa (Laundre' 1992). The Olympic Range vegetation coevolved with few alpine and subalpine herbivores. For example, bighorn sheep, pika (*Ochotona princeps*), and golden-mantled ground squirrels (*Spermophilus lateralis*) are absent in the Olympics. Yellowstone is a grazing ecosystem occupied by 7 ungulate species. The alpine vegetation in the Absarokas has coevolved with herbivory by at least 3 ungulate species: bighorn sheep, elk (*Cervus elaphus*), and mule deer (*Odocoilus hemionus*). Based on this comparison, the effects of an additional ungulate in the Yellowstone alpine may not be as severe as documented in the Olympic ecosystem.

The potential for competition between sympatric sheep and goats would be greater during winter when resources are more limited (Adams et al. 1982). Mountain goats currently do not occupy sheep winter ranges in Yellowstone Park. However, wintering areas for the goat population in the Beartooth Mountains overlap with those for some sheep herds that migrate from Absaroka summer range. Investigating the relationship between the two species on this winter range would be essential in further addressing the question of competition between native bighorn sheep and introduced mountain goats.

Natural Extinction

Current goat distribution in North America has been described based on the occurrence of goats at the time of European settlement of the west, and has not included areas such as Colorado and northeastern Oregon. Historical documents and paleontological evidence indicate populations of goats likely occurred in these areas (Matthews and Coggins 1994, Irby and Chappell 1994). In the case of mountain goats in Colorado, the small populations that occurred were likely driven to extinction through habitat loss and overhunting by Euroamerican prospectors prior to adequate documentation of their presence (Irby and Chappel 1994). Archeological evidence places goats in the Wallowa Mountains (Oregon) and Hells Canyon (Idaho-Oregon) where they disappeared at about the time of contact with Europeans in the early 1800s for unknown reasons (Matthews and Coggins 1994).

These reports suggest the occurrence of remnant populations probably on the brink of a natural extinction associated with a larger, shrinking distribution driven by a climate that was becoming increasingly more dry. After the recession of glacial ice in the late-Pleistocene, favorable climate conditions diminished and left isolated goat populations, particularly those in dry regions, on a declining trend. Many of the areas in which mountain goats have been introduced are areas in which they seemed to have recently become

extinct. After a cycle of irruptive population growth and the consumption of residual vegetation, these areas may turn out to be marginal habitats in the long-term. Climate in the west is forecasted to become drier, allowing for the invasion of trees and loss of alpine habitats, particularly in Yellowstone (Romme and Turner 1991). Perhaps, the touchstone for goat habitat suitability ought to be "As the glacier goes, so goes the mountain goat."

An Integrated Effort

Questions of nativeness, park law and policies aside, the removal of goats from Yellowstone would unquestionably be a contentious public issue. To be successful it would require an integrated effort involving challenging logistical operations, interagency cooperation, long-term commitment, and large changes in public perception. Techniques for goat removal are costly, dangerous and perpetual so the difficulties of a removal policy must be weighed against the perceived benefits. Hunting to control numbers would be the most practical approach, however it is illegal in the national park, and it is likely to be politically untenable. Intensive hunting on the periphery of the park may slow colonization initially, though in the long-term it may only succeed in concentrating numbers inside the park boundary. Culling by rangers is legal, and would likely be effective, but the American public has proven time-after-time they find this scenario unacceptable. Ultimately, a management scheme that attempts to satisfy all agencies' objectives would be desirable but recognize that the agencies involved have differing goals and mandates which have frequently collided in the past. Interagency cooperation would be necessary to prevent conflicting policies that may lead to ineffective and perpetual management. For example, it would be no stretch of the imagination to find a removal area and a sustained-harvest area juxtaposed along the boundary of the park so as to create a classic source/sink situation.

Conversely, as has been discovered in many alien invasions, the problem is best dealt with early in the colonization period, before population numbers are high, and in the case of charismatic species like mountain goats, before the goats themselves have human constituencies.

A goat removal policy, particularly by lethal means, would likely be met with an unfavorable public response. The charisma of the mountain goat in the public's eyes can certainly be expected to out-weigh the philosophical and ecological issues evoked as the purpose behind a goat control policy. The non-palatability of control would pit politicians and high-level bureaucrats against biologists – and even biologists vs. biologists – to the extent that the only perceivable chance of success would rest on a large-scale educational effort to change public perception. This is certainly possible, and would be similar to the successful process of educating people about returning gray wolves (*Canis lupus*) to Yellowstone which took twelve years and six million dollars to accomplish. This would require extensive and thorough documentation of the negative impacts exotic goats would cause in the park which is questionable and, at present, does not exist.

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