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Modifying landscapes and mass kills: Human niche construction and communal ungulate harvests

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ABSTRACT

This special issue of *Quaternary International* includes case study consideration of communal ungulate hunting structures situated in open alpine, tundra, grassland, and desert settings in North America and the Near East. Along with being constructed in a variety of different environments, the mass kill structures described in this issue of *QI* also exhibit variation in design, as each was specifically tailored to capture a particular prey species, with target species including bighorn sheep (*Ovis canadensis*), bison (*Bison bison*), caribou (*Rangifer tarandus*), pronghorn (*Antilocapra americana*) gazelle (*Gazella* spp.), and onager (*Equus hemionus*). In this introductory article I employ the interrelated concepts of niche construction and traditional ecological knowledge to provide a broader frame of reference for consideration of the underlying similarities and sophistication of these diverse ungulate drive structures, and bring them into clearer focus as comprising important and integral components in the overall socio-economic systems of the small-scale human societies that constructed them. Requiring detailed understanding of local landscapes and patterns of seasonal movement and flight behavior of prey species, such structures were constructed to reduce acquisition effort and increase the predictability of prey species by channeling and constraining their movement for easier harvesting. This was accomplished by creating structural modifications to the landscape designed to direct the prey into killing zones or enclosures.

1. Introduction

In this special issue of *Quaternary International*, co-editors Guy Bar-Oz and Dani Nadel have brought together nine archaeological case studies of how prehistoric human societies living in the alpine, tundra, grassland, and desert regions of North America and the Near East constructed structural modifications to the landscape in order to enhance communal hunting of ungulate species, including bison (*Bison bison*) (Carlson and Bement, 2013), pronghorn (*Antilocapra americana*) (Brink, 2013; Hockett et al., 2013; Wilke, 2013), bighorn sheep (*Ovis canadensis*) (Labelle and Pelton, 2013), caribou (*Rangifer tarandus*) (Friesen, 2013; O'Shea et al., 2013), gazelle (*Gazella subgutturosa*, *Gazella gazelle*, *Gazella dorcus*) (Nadel et al., 2013; Zeder et al., 2013) and onager (*Equus hemionus*) (Nadel et al., 2013; Zeder et al., 2013) (Fig. 1; Table 1). Eight of these case studies document the efforts of small-scale societies to capture and kill target species for meat, hides, and other raw materials, while one considers the more elaborate construction efforts of a state level society that was intended to capture gazelle and perhaps onager in a context of social integration (Zeder et al., 2013). Along with these nine case studies of how human hunters tailored their communal hunting construction efforts within the context of local landscapes and the seasonal movements and behavior of different prey species, four additional articles consider the complications and challenges involved in the analysis and interpretation of archaeofaunal assemblages, particularly those that can result from mass kills of ungulate populations (Bird et al., 2013; Driver and Maxwell, 2013; Lubinski, 2013; Speth, 2013). In this brief introductory article I am interested in the nine case studies that are presented, and outline a set of general underlying similarities that provide a broader context for comparison and interpretation of such communal ungulate harvesting structures.

2. Communal ungulate drive structures as human niche construction

The communal ungulate hunting structures documented in this issue of Quaternary International are situated in different

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Table 1

No.	Authors	Target species common name	Target species scientific name
1	T.M. Friesen	Caribou	*Rangifer tarandus*
2	J. O'Shea et al.	Caribou	*Rangifer tarandus*
3	K. Carlson, L. Bement	Bison	*Bison bison*
4	J. Labelle, S. Pelton	Bighorn Sheep	*Ovis canandensis*
5	P. Wilke	Pronghorn	*Antilocapra americana*
6	B. Hockett et al.	Pronghorn	*Antilocapra americana*
7	J. Brink	Pronghorn	*Antilocapra americana*
8	M. Zeder et al.	Gazelle	*Gazelle* ssp.
9	D. Nadel et al.	Gazelle, Onager, Oryx	*Gazelle* ssp., *Equus hemionus*, *Oryx leucoryx*

environmental settings in different regions of North America and the Near East, and are intended to capture a number of different species of prey. They also take a variety of forms, as indicated by the range of descriptive names assigned to them (e.g. arroyo traps, jumps, kites, corrals, enclosures, pounds, pens, and traps, with or without associated wings, drive lines, or drift fences). All of these different forms of communal hunting structures, which I will refer to in general as "ungulate drive structures" can be seen to share a number of basic characteristics that come into clearer focus when viewed within a human niche construction frame of reference.

Niche construction or ecosystem engineering has been documented in a wide range of different animal species (Odling-Smee et al., 2003), with human societies recognized as "the ultimate niche constructors" (Odling-Smee et al., 2003: 28; Smith, 2007a, 2007b). Rather than being passive participants in local environments, confined to simply utilizing what the ecosystem offers in the way of natural resources – adapting to what's available, small-scale human societies both inadvertently and deliberately modify their local environments and their *relationship* with their environments in a variety of ways, large and small (Odling-Smee et al., 2003; Laland et al., 2007; Smith, 2011). For more than five decades researchers have employed a confusing array of different terms in characterizing how human populations situated in a variety of different ecosystem settings have deliberately changed their environments to suit their preferences, modifying "natural" landscapes and managing "wild" species of plants and animals (Smith, 2011). All of these different terms for human management of wild (and domesticated) species can be usefully subsumed under the general heading of *niche construction*, and recognized as comprising a large and coherent category of human behavior.

Human and non-human species alike modify ecosystems because it offers individuals and populations an evolutionary advantage. Modification of surrounding environments, and associated selective pressures, can increase the chances of survival of subsequent generations of a population: "Niche construction by organisms significantly modifies the selection pressures acting on them, on their descendants, and on unrelated populations" and as a result, "niche constructing organisms frequently influence their own evolution by modifying their own selective environments" (Odling-Smee et al., 2003: 2, 25).

Deliberate human niche construction efforts are intended in large part to increase the relative abundance and reliability of preferred wild species of plants and animals, and to reduce the amount of time and energy required to harvest them. One of the primary ways in which this is accomplished is through a restructuring of local ecosystems so that more of the solar radiation entering it each year is transformed into new organic matter in plants (and subsequently in the animals that feed on them) that human groups depend on for food and raw material. Through niche construction, a higher percentage of an ecosystem's net primary production is directed to species of economic value to humans. These linked goals of increasing resource abundance, predictability, and availability directly focus for the most part on plant species, with animal consumer species usually influenced more indirectly (Smith, 2011). The simple explanation for this is that given their stationary nature, wild plants are much more feasible and more predictable targets for successful management than wild animals.

By far the most visible human ecosystem engineering efforts that directly target animal components of biotic communities are fish weirs and terrestrial ungulate drive structures like the ones discussed in this issue of Quaternary International. Once constructed, such structures reduce acquisition effort and increase the predictability of prey species by channeling and constraining the movement of target populations for easier harvesting. This is

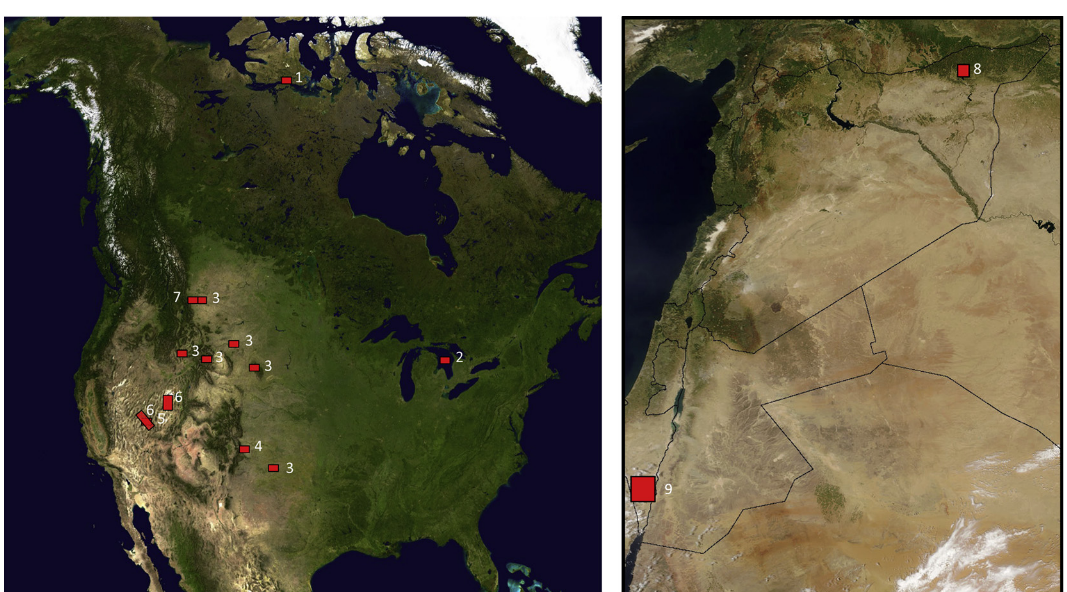

Fig. 1. Location of case studies discussed in the text.

accomplished by creating structural modifications to the landscape designed to direct the prey into killing zones or enclosures.

3. Prey behavior, terrain mapping, and traditional ecological knowledge

The ungulate drive structures documented and analyzed in the following case studies are situated in open alpine, grassland, tundra, and desert environments of North America and the Near East – habitats characterized by relatively low resource density. Within these limited resource environments, the general placement of such structures is not random, but rather reflects a substantial understanding on the part of hunters regarding the patterns of movement that were followed by target species across these open landscapes on a recurring annual basis. Where natural bottlenecks occur along the migration routes of target species, such as the high mountain passes discussed by Labelle and Pelton (2013) and the Alpena–Amberley dry land corridor or isthmus across the Huron basin described by O'shea et al. (2013), such regional placement decisions can be easily understood. In many cases, however, it may be more difficult, looking back in time, to appreciate decisions that were reached regarding where to situate communal hunting structures. A number of natural arroyos in the southern plains of North America discussed by Carlson and Bement (2013) that were selected and used 10,000 years ago as bison traps, for example, appear to have been located along no longer extant east–west seasonal migration routes of bison herds. Similarly, many of the gazelle kites described from the Near East are thought to have been situated along seasonal north-south routes of movement of the target species (Zeder et al., 2013). In the case of non-migratory prey that grazed in small herds year round, such as Dorcas and mountain gazelle (*Gazella dorcas*, *Gazella gazelle*) and onager (*Equus hemionus*), ungulate drive lines were placed along frequently used game trails in advantageous topographical settings (Nadel et al., 2013).

Once ungulate herds had reached the general proximity of drive structures, arriving in staging areas from which they could be directed toward the kill zone (Carlson and Bement, 2013; Friesen, 2013; Hockett et al., 2013), hunters then drew upon extensive knowledge of the behavior patterns of their prey in this complex and difficult aspect of their communal drive. Of critical importance was selecting the jump site or situating the hunter blinds or corral entrance so that approaching prey could not see it in time to escape, and planning the drive lanes to take advantage of existing topography (Nadel et al., 2013). Drive lines or fences would be preplanned and placed to provide terrain maps to both demarcate for hunters where to maneuver herds for a successful kill, and to channel prey toward the kill areas. Solid fences or rock walls often were built close in to the kill zone, while simple rock piles or cairns, spaced some distance apart, and sometimes festooned with objects that would flap in the wind, would often prove sufficient in demarcating the route to the kill zone farther out (Labelle and Pelton, 2013). In his discussion of caribou behavior, for example, Friesen (2013) notes that caribou herds are considered highly predictable, and once frightened or unsettled by drivers, they can be expected to move alongside landforms or barriers rather than crossing them, and will follow drive lines of cairns ("inuksuit") into kill zones: "thus rows of inuksuit act to guide caribou even when they are not in panicked flight. As a result knowledgeable hunters are able to control caribou movement in a very precise fashion, and could decrease or increase their speed, and fear response, by altering their driving techniques".

The in-depth knowledge of target species reflected in the regional placement of ungulate drive structures, as well as both their careful placement in order to take advantage to local topography and the preplanned positioning of demarcation drive lines, all underscore a fundamental aspect of the human societies that constructed them. Small-scale human societies have a detailed and comprehensive knowledge of the biotic communities within their resource catchment area – the landscape they occupy and rely upon for survival. They develop and maintain in the form of shared oral traditions, beliefs, myths, and stories, large amounts of environmental information, which is passed down through the generations: "Detailed observation and experimentation with the natural environment over many generations led to a profound native knowledge of how natural systems work." (Anderson, 1999: 88). A society's continuing knowledge of its local landscape is of obvious critical importance to its well-being: "Traditions are the products of generations of intelligent reflection tested in the rigorous laboratory of survival. That they have endured is proof to their power." (Hunn, 1993: 13).

The term *Traditional Ecological Knowledge* is often used to refer to these environmental information sets: "Traditional Ecological Knowledge: a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment." (Berkes, 2008: 7). The ability to accurately identify and locate resources in both time and space, including ungulate herds, is of course an obvious aspect of traditional ecological knowledge, and over their life-span members of small-scale societies will construct and refine high-resolution cognitive maps of the seasonal habitat preferences and spatial distribution of a wide variety of high-value target species of plants and animals. Knowledge of the seasonal movements and general behavioral characteristics of ungulate prey populations, along with skill in identifying promising locations for ungulate drive structures, is an integral part of this larger corpus of traditional ecological knowledge.

4. Communal construction and ecological inheritance

Depending on their size, complexity, and the type of material employed (e.g. wood vs. stone), the ungulate drive structures described in the following case studies exhibit considerable variation in the amount of planning and human energy that was invested in their construction. For smaller, faster and more skittish pronghorn and gazelle herds, for example, substantial corral and wing construction designed to contain animals for longer periods of time in the kill zone is typical (Hockett et al., 2013; Wilke, 2013; Zeder et al., 2013) while drive structures targeting larger prey such as bison and caribou exhibit less containment construction (Carlson and Bement, 2013; Friesen, 2013; O'Shea et al., 2013). As Friesen (2013) discusses, the width of constriction points in kill zones and both the placement and size of hunter blinds is dictated by the type of weapons employed – i.e. the use of thrusting spears requires narrower bottlenecks and closer placement of blinds than that needed for hunters using bow and arrow technology.

With the exception of the bison arroyo knickpoint traps of the southern Plains discussed by Carlson and Bement (2013), for which arroyo walls comprised the drive lanes, these drive structures reflect the coordinated construction effort of individuals drawn from a number of basic family units (see, for example, the discussion by Hockett et al., 2013 of construction costs associated with Great Basin pronghorn traps).

Such communal construction efforts intended to enhance the yield and reliability of wild resources are not, of course, restricted to the building of ungulate drive structures. In addition to fish weir construction (Connaway, 2007), large-scale landscape modification projects focusing on improving harvest yields have been documented for a diverse array of species, from clams on the Northwest

Coast to agave in the Southwest and both root and seed plants in the Great Basin (Smith, 2011). While they certainly involve a substantial initial investment of time and labor, as well as the continuing cost of some level of regular maintenance, all such substantial landscape modification efforts, including ungulate drive structures, have the advantage of providing long-term annual dividends in terms of more productive and more reliable harvests of economically important species over spans of hundreds or even thousands of years.

Given their long life span, ungulate drive structures and other "permanent improvements" to the landscapes provide an excellent example of ecological inheritance (Odling-Smee et al., 2003), in that such physical modifications to the environment are passed down from generation to generation, and along with the associated cultural transmission of information regarding the behavior of target species, they significantly increase the chances of survival of subsequent generations of the small-scale societies that employ and maintain them.

5. Ownership, rock art, and cyclical nucleation

The open alpine, desert, grassland, and tundra environments like those in which the ungulate drive structures discussed in the following case studies are situated are characterized by relatively low resource availability. In such environments, where resources are scattered across the landscape in relatively low density, small-scale human societies will have relatively large resource catchments, but overall ownership (control of outsider access) to land areas and resources will be relatively weak (Dyson-Hudson and Smith, 1978). Against this general background of low resource availability and weak development of ownership, however, specific locations within the resource catchment area that offer high resource abundance and predictability will be the subject of clear and strongly enforced control of access: "Resources that are predictable in their spatio-temporal distribution have greater economic defendability than unpredictable resources." (Dyson-Hudson and Smith, 1978: 24). Such high value resource locales or patches within the resource catchments of small-scale societies would include both naturally occurring sites (e.g. seasonal fish run river bottlenecks, piñon groves, mussel shoals), as well as deliberately constructed landscape modifications such as ungulate drive structures or the clam gardens of the Northwest coast of North America (Smith, 2011).

High value resource locations such as ungulate drive structures, not surprisingly, often play a central role in the annual economy of the small-scale human societies that construct and maintain them, and as a result, also occupy a significant place in their overarching system of Traditional Ecological Knowledge and in their overall world-view and belief system. Such high value resource locations thus are more than physical locations on the landscape, but also figure prominently in shaping the system of values and meaning developed by small-scale societies: "Ecological knowledge and activities (are) symbolically and instrumentally embedded in the places and life worlds out of which they developed and which they help constitute." (Butz, 1996: 52); "Stories and legends are part of culture and indigenous knowledge because they signify meaning. Such meaning and values are rooted in the land and closely related to a 'sense of place'." (Berkes, 2008: 6).

The rock art that has been documented in proximity to ungulate drive structures in a number of the case study contributions (Hockett et al., 2013; Zeder et al., 2013) underscores in a very graphic way the importance of these deliberate environmental enhancements to the societies that created them. Enduring rock art images can underscore the deep time depth of a group's use of a location and impart the imbedded message of ownership and stewardship. They can also recount memorable hunts of past years, and help to communicate basic information regarding key aspects of the conduct of a drive.

Along with rock art, associated habitation sites, when they can be identified (they will understandably be situated some distance away from kill sites), also underscore the important role of ungulate drive structures in a broader social context. Carlson and Bement (2013) employ the useful concept of "cyclical nucleation" in their discussion of the larger social significance of such communal niche construction efforts: "Cyclical nucleation is the scheduled aggregation of multiple subsets of band society at a predetermined and repeatedly, often seasonally, visited node or location." Ungulate drive structures provide a node for cyclical nucleation for smaller family groups that are dispersed through much of the rest of the year. Such structures both provide a substantial harvest of meat and raw material such as bone and hides, and require the coordinated cooperation of a substantial number of people to ensure a successful hunt. By requiring and enabling amalgamation of otherwise dispersed groups, communal harvesting of ungulate herds through the use of drive structures sets the stage for a range of activities of larger macroband social integration, including feasting, social networking, information exchange, mate selection, and trade (Carlson and Bement, 2013).

6. Conclusions

The ungulate drive structures considered in this special issue of Quaternary International represent successful efforts by small-scale human societies, at different times and in different ecosystems, to modify their environments in order to increase the yield and predictability of a major food source – in this case a range of different herd animals. Comparable communal construction efforts intended to increase the size and reliability of harvest of a variety of other wild plant and animal food sources are well documented, and ungulate drive structures fall comfortably into this larger category of niche construction or ecosystem engineering efforts by small-scale societies world-wide (Smith, 2011). The geographical and temporal scale of the case studies presented here underscore the convergent evolution/independent solution aspect of the ungulate drive structures discussed – they each represent variations on a common theme – how to create structural modifications to the landscape designed to direct a particular prey species into killing zones or enclosures (Smith, 2012).

In each case, drive structures were situated along routes of seasonal movement known to be followed by target species, often taking advantage of natural bottlenecks such as mountain passes and ridge systems. The specific placement of the kill zone structures along such corridors of movement, in turn, were carefully selected, based on proximity to natural staging or milling areas, and the presence of favorable topography for channeling herds of the target species toward hidden hunter blinds, traps, and enclosures. Cairns and fences were preplanned and placed to define the desired corridor of movement from the staging area to where concealed hunters waited. Detailed knowledge of the behavior and likely patterns of movement of the prey species shaped both the design of the drive lines and the actions of the human drivers in moving the herd along the corridor to the kill area.

The detailed and in-depth understanding of the prey species that is reflected in the general placement and the specific design of ungulate drive structures is part of a larger general category of sophisticated understanding that small-scale societies have of the natural world and the biotic communities of resource catchment areas. This corpus of "Traditional Ecological Knowledge" is built up and maintained generation to generation, through innumerable life experiences and related oral traditions. Structural modifications to the landscape, including ungulate drive lines, are passed down from generation to generation as a form of ecological inheritance, while the knowledge necessary to undertake successful communal hunts is inherited through social learning. Ungulate drive lines, often viewed as isolated and enigmatic aspects of barren landscapes, when viewed in a larger interpretive context of human niche construction, come into clearer focus as an integral and often central element in the overall cultural and economic lives of the societies that constructed them.

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