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Pastoralism Partnerships: Recognizing the Value of Local Involvement in China's Snow Leopard Conservation Efforts

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Abstract: Pastoralists are key stakeholders in environmental management decisions in China. Thus, their involvement in wildlife conservation and research is imperative for the success of long-term initiatives. Despite the many opportunities for herders to be included in these efforts, biases have hindered knowledge exchange and collaborative outcomes. This is detrimental for species living in quickly changing landscapes reliant on effective conservation, such as that of the snow leopard (*Panthera uncia*). Pastoralists living in snow leopard habitats on the Qinghai–Tibetan Plateau of China possess a deep and intricate understanding of the environments in which they live, and can serve as strong conservation allies by playing direct roles in scientific endeavors via expert elicitation and engagement. Here, we draw on our own experiences as academically trained scientists to present a framework for broadening opportunities for local community member participation in research efforts on the species. Framework outcomes include better targeting of conservation concerns, increased integration of Western science and local ecological knowledge, additional income to the community, clearer communication and trust between conservation stakeholders, greater flexibility in research, and additional platforms for community-based conservation. We outline avenues of involvement and considerations when working with local community members in snow leopard habitat, and submit this as an example with wide-ranging applicability to other parts of the world where livelihoods are intrinsically tied to the environment.

Keywords: grassroots conservation; local ecological knowledge; *Panthera uncia*; pastoralism; Qinghai–Tibetan Plateau

1. Introduction

The Qinghai–Tibetan Plateau (QTP) is one of the world's largest pastoral ecosystems [1]. It has experienced rapid environmental and societal changes under the context of nearly two millennia of human–wildlife coexistence [2,3]. The area is significant geographically, providing the headwaters for the Three Rivers, on which 40% of the world's population depends or is significantly influenced by [3,4]. The QTP has a rich diversity of unique mammalian species, including kiang (*Equus kiang*), argali (*Ovis ammon*), blue sheep (*Pseudois nayaur*), Tibetan wolf (*Canis lupus*), pika (*Ochotona* sp.), zokor (*Myospalax* sp.), woolly hare (*Lepus oiostolus*), Himalayan marmot (*Marmota himalayana*), Pallas's cat (*Otocolobus manul*), Tibetan fox (*Vulpes ferrilata*), Eurasian lynx (*Lynx lynx*), and snow leopard (*Panthera uncia*) [2,5]. In addition to these, there are a number of livestock species occupying rangelands located in

extremely harsh environments [6]. Domestic yak (*Bos grunniens*) are one of the predominant livestock, as they are adapted to withstanding extremely low temperatures, high winds, and low levels of atmospheric oxygen [7]. Other domestics commonly kept include domestic goat (*Capra aegagrus hircus*), domestic sheep (*Ovis aries*) [6,8], horse (*Equus caballus*) [9], and Bactrian camel (*Camelus bactrianus*). The presence of the pastoralist communities who subsist on these livestock has been traced using ecological evidence as far back as 8800 years ago [1].

Most inhabitants of the QTP are Tibetans that practice Tibetan Buddhism, a religion that combines Bon and Buddhism [10] and views humans as part of an interactive network of living entities where kindness to all creatures earns one good karma [11]. This even extends to protection of the soil itself, so as not to disrupt the deities housed there [12]. The residents on the QTP have adapted and thrived for millennia [13] and have developed strong environmental ties to the land as necessitated by pastoralism [2,14–16]. Livestock owners, whose animals depend on the range, possess a broad and intricate relationship with nature that reflects intimate understanding of complex ecological processes [14,17–19]. Herders are dependent on such understanding to reliably provide their livestock with forage and water, through husbandry practices passed down from generation to generation, and adapted as necessary to shifting cultural and societal norms, which communities in this region have increasingly faced in recent years [14,20].

Given the environmental, societal, and cultural importance of the QTP, the Chinese government has implemented policies aimed at ecological preservation following two large-scale communal farming periods in which land was tended as a collective effort, the first in 1949 and the second in the early 1980s. This was followed by widespread development that places unprecedented pressure on China's ecosystems [21,22], with particular concern toward the alarming increase in grassland degradation [20,23]. Subsequently, policies and projects aimed at environmental protection, like the establishment of the National Parks Network and grassland zoning regulations, were formulated [3,24,25]. However, these necessitated large economic investments [24] that radically impacted lives of Tibetans residing in these landscapes [20]. One well-known example is the establishment of the 152,300 km² Three Rivers Nature Reserve (*Sanjiangyuan*) in May 2000, an area home to nearly 200,000 Tibetans [26]. Sanjiangyuan consists of three sectors—a 31,200 km² core area where all flora and fauna are protected and no husbandry is permitted; a 39,200 km² buffer area in which husbandry is permitted in limited amounts with relocation of Tibetans in only seriously degraded areas; and a 81,900 km² area development zone not substantially protected from human disturbance, and where activities like ecotourism and conservation research are encouraged [20].

Funding allocation for conservation research in China has rapidly expanded since 2000; for example, the National Science Foundation of China funds increased 34% annually from 2001 to 2008, with the Ecology Section seeing a four-fold increase in their budget [25]. In 2014, biodiversity studies consumed large portions of the foundation's 3.1 billion USD budget [27]. In addition, China's invitations targeting foreign biologists, starting in the 1980s, prompted fruitful collaborative efforts [28]. While notable barriers to conservation science in China remain [29,30], this push for enhanced biodiversity knowledge has proven especially beneficial toward shaping policies and protection for at-risk species.

Community involvement, consultation, and requests for assistance from local residents have been largely lacking in QTP research and conservation initiatives [10]. Historically, most involvement has taken the form of "passive participation" via government mandates surrounding resettlement and "ecological migrations" [20,31]. The misconception by outside entities that rural pastoralists are ignorant and lack innovation has proven difficult to overcome [32]. Because herders do not fall within the category of an "academic elite", their expertise has often been dismissed as unscientific or uninformed [20]. Local knowledge and informational legitimacy is often called into question due to the lack of quantitative measures provided by herders in support of their statements. This is particularly relevant in relation to researchers trained in Western science, whereby "facts" observed between scientists and study subjects are prioritized over the "human–nature relationships" perceived by indigenous peoples and the environments they live in [33]. However, because many Tibetans "live

off the land”, utilizing native plants and animals, they may in fact possess expansive knowledge about wildlife in the area, and potentially play an important role in its protection. Policies shaped using information gathered by scientists and shared with government officials both directly and indirectly impact local people [26], while often excluding them from planning or decision-making [34]. Fortunately, the value of local knowledge is becoming more widely accepted and recognized on international scales [35]. These relationships are particularly important for at-risk species, like the snow leopard.

The snow leopard is an International Union for Conservation Nature (IUCN) Vulnerable listed large felid endemic to the high mountains of South and Central Asia [36,37]. Threats to its survival include livestock overgrazing and range degradation, which lead to prey depletion, low prey densities [38], conflict with humans [15,39], habitat loss and fragmentation [37], and climate change [40,41]. Range-wide population estimates vary from approximately 4000 to 8745 adults [36,38,42]. Scientific publications surrounding snow leopards in China emerged in the 1980s, with substantial increases in breadth since 2000 [43,44]. Knowledge of snow leopard status and ecology in China is vital to tailoring effective conservation action plans globally, for China holds an estimated one-third to one-half of the existing snow leopard and 60% (1.1 km²) of the species’ global range [22]. Despite sizable advances in knowledge surrounding this species over the last 25 years [45], numerous information gaps remain [38].

Local residents can hold a plethora of knowledge surrounding the species and its habitat given their overlap, importance as a symbol associated with Tibetan religion [9,46], and intensity of conflicts surrounding livestock depredation [46]. This knowledge is applicable and can complement scientific snow leopard research efforts through the participatory approach of expert elicitation of traditional or local ecological knowledge. We use local ecological knowledge (LEK), which differs from traditional ecological knowledge (TEK), as defined by Olsson and Folke (2001). “LEK is knowledge held by a specific group of people about their local ecosystems . . . it concerns the interplay among organisms and between organisms and their environment. LEK may be a mix of scientific and practical knowledge; it is site specific and often involves a belief component” [47]. Expert elicitation refers to structured discussions with experts concerning areas of uncertainty and is valuable in fields with limited data availability [48,49]. Indigenous people with long-standing knowledge of a specific geographic area should be considered as “experts” for their possession of LEK and its value for strengthening conservation science. Successful examples include studies in Cameroon [50], Greenland [51], India [52], and Spain [53].

Although the knowledge possessed by local communities may be seen as helpful to conservation efforts, published examples and perspectives of how such research may involve or engage these communities is lacking [54]. To help bridge this gap, and by drawing on our perspectives and experiences from our own two original snow leopard studies undertaken on the QTP, we highlight how local community residents and those who are not academically trained (1) can be involved in snow leopard research efforts (2) through a logical framework that (3) supports local capacity for environmental management in ways that draw in diverse stakeholders. Specifically, we believe the targeted elicitation of local resident knowledge can assist in goal formulation, study design, execution, and identification of representative study types. This refines sampling, helps integrate Western science with indigenous knowledge, offers supplementary income to local people, increases levels of trust and communication between researchers and local stakeholders, enables greater research flexibility, and increases community-based conservation capacities.

2. Case Studies of Local Involvement in Snow Leopard Research

Cumulatively, the authors of this manuscript have conducted numerous studies surrounding snow leopards that have depended on local participation, support, and involvement. Figure 1 shows examples of this specifically with research conducted on the QTP of China. In the Sections 2.1 and 2.2,

two specific studies are highlighted to later demonstrate how local herders and residents were involved in research efforts, as well as how their involvement was integral to the completion of each study.



Figure 1. Examples of herder participation in snow leopard research studies conducted by the authors on the manuscript: (a) Manuscript author Dr. Yuguang Zhang administers a verbal questionnaire in Mandarin Chinese to a Tibetan translator during the interview of a herder in their home; (b) a Foxlight® installed with herder participation for a study testing the device’s effectiveness against predator attacks of livestock; (c) manuscript author Charlotte Hacker stands with a local herder serving as a field guide for scat sample collection; (d) two residents of Qinghai Province trained in scat sample collection collect scat samples in the absence of lead researchers due to the travel restrictions from COVID-19 in March 2020.

2.1. Study 1: Temporal Changes in Snow Leopard Diet

Determination of diet is necessary for understanding the roles snow leopards play as apex predators in their habitats, their dependence on livestock, and how this species adapts to large-scale landscape and distributional changes caused by climate change. New techniques harnessing the power of Next-Generation Sequencing (NGS) have the ability to reliably discern prey DNA extracted from scat down to multispecies levels [55,56]. This method has been applied to snow leopards previously at local [57] and range-wide scales (Hacker et al.; accepted and in review) [58]. One pressing question involves how snow leopard diet may change seasonally, and, thus, we initiated a study to repeatedly sample a site in Dulan County, Qinghai Province, China across seasons beginning in September of 2019.

2.2. Study 2: Determination of the Effectiveness of Foxlights® at Deterring Predators from Livestock

Livestock depredation often imposes severe financial burdens on herders, their families, and the local economy [59], leading to tension between local residents and conservation or government agencies seeking to protect “at-risk wildlife” [60]. The killing of carnivores is neither an effective solution [61–63] nor does it necessarily align with the actual damage caused by predators [64]. Unfortunately, widespread testing of the effectiveness of non-lethal deterrents is lacking [62,65], and, thus, we initiated a study seeking to test the functional and perceived effectiveness of the solar-powered Foxlight® (Caloola, New South Wales, Australia) as one example of a cost-effective non-lethal predator deterrent that emits a series of bright intermittent flashing colored lights, starting at dusk and continuing through the night until dawn. The device projects lights in an irregular circular fashion that are visible up to about one kilometer, depending upon the local terrain. Foxlights® have proven effective at deterring large predators [66], and thus the authors decided to examine their effectiveness on the QTP,

particularly for deterring snow leopards from attacking livestock as a food source in Yushu Prefecture, Qinghai Province, China.

3. Framework for Community Engagement via Expert Elicitation in Snow Leopard Research

There are many opportunities for local residents to be involved in research and conservation efforts, related to a wide array of skills and knowledge typically possessed by residents of remote rural areas. Figure 2 offers a framework for involving local residents in snow leopard research on the QTP under such themes as problem identification, design, and execution, as well as the outcomes associated with these efforts.

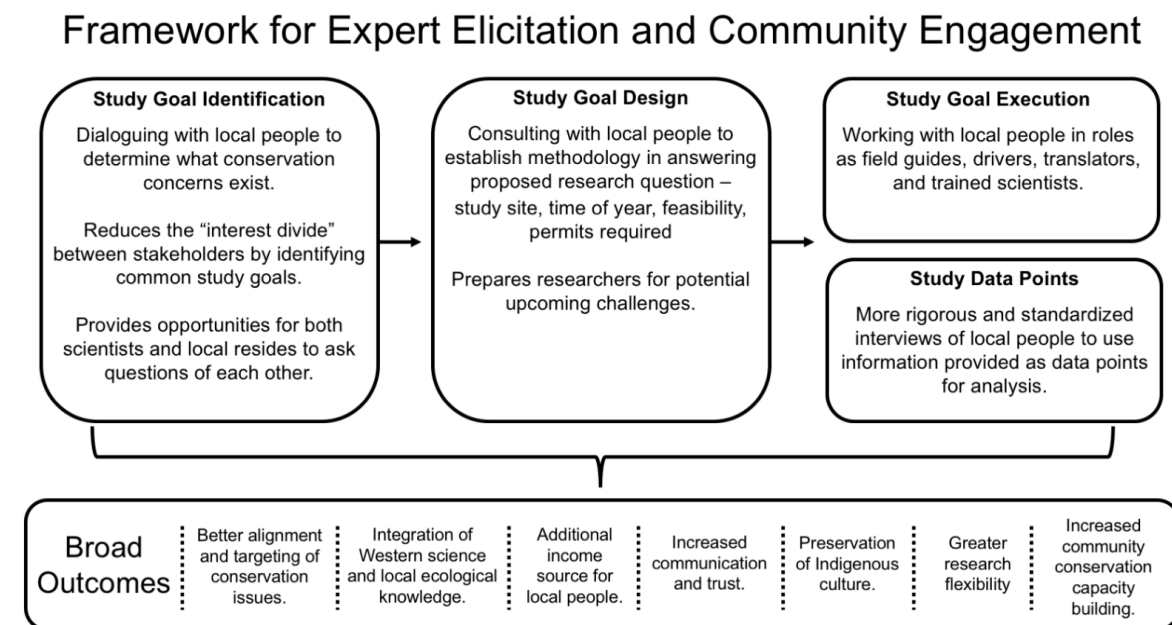


Figure 2. A framework for expert elicitation and community engagement in snow leopard research and its associated broad outcomes for stakeholders.

3.1. Expert Elicitation in Study Goal Identification

Communities are more likely to actively participate in environmental research if they perceive the potential for resource management as providing benefits that address concerns relating to their own livelihoods [67]. Indeed, some advocate strongly that outside researchers should find ways of contributing to local needs in an effort to remove the “interest divide” between them [68,69]. In addition, participation in conservation efforts is likely to be greatest when a high level of engagement with the local community is present from the beginning of the proposed initiative [70]. At minimum, researchers should first interact with area residents to determine the most pressing conservation challenges that they and local ecosystems or species may be facing. This approach was followed in Study 2, where local interviews revealed loss of livestock to snow leopards was high, and that depredation generally comprised the greatest concern to livestock owners compared to other causes of death. The herders’ desire to mitigate such conflicts resulting from domestic animal losses using non-lethal measures naturally followed, and with local participation, the research team designed mitigation measures around testing the effectiveness of Foxlights® for deterring predators from attacking livestock. It should be noted that while much of this process involved asking local herders questions, it also offered a platform for them to question researchers regarding the study, scope, intent, and outcomes [71].

3.2. Expert Elicitation in Study Design

The QTP consists of four broad ecosystem types—montane forest, alpine shrub/meadow, alpine steppe, and alpine desert [72,73]. Within these are several ecoregions that are unique to

only the QTP and hold a rich biodiversity of flora and fauna [73]. The extensive LEK of these smaller ecoregions is helpful for selecting sampling locations that are feasible to access, as well as the best times of year for undertaking research activities along with potential logistical and other research constraints. For example, in Study 1, answering questions surrounding dietary changes over time required continuous scat sampling along fixed transect lines over all seasons. This requires that transect lines be accessible on a year-round basis, and not be subject to flooding or high levels of snowfall that would prohibit scat sample collection. Thus, local residents were consulted to help determine which transect lines should be selected. With the exception of some heavy snowfall during certain winter months, the transects selected remained largely accessible during the winter, enabling scat sample collection across a temporal gradient while controlling for spatial sampling requirements.

3.3. Expert Elicitation for Study Execution

Field Guides: The QTP covers 2.5 million km² [73]; thus, LEK from area residents is vital for successfully navigating this vast landscape. LEK regarding the surrounding geographic features, local flora and fauna identification, or how to reach specific GPS coordinates and study sites plays a critical role in ensuring both study success and safety. Beyond the traditional field guiding role, local people are usually knowledgeable about nearby towns and can assist in many tasks, from procuring food to locating the nearest medical facility in case of an emergency. During Study 1, we found that field guides were essential for finding suitable sampling areas and then navigating the transects. They were well informed on routes through the harsh terrain. They were also key during prey counts, the collection of carnivore sign data, and species identification of pugmarks and bird calls, often spotting wildlife from long distances. For Study 2, field guide knowledge greatly facilitated locating herders suitable for the deployment of the Foxlight® devices while also maintaining the planned spatial requirements of testing sites.

Drivers: The QTP has undergone rapid societal, socioeconomic, and infrastructural development changes starting in 2000 with China's campaign to "Open Up the West" [3]. This has included the construction of extensive road networks [74], with greatly decreased travel times from population centers [75]. Local people are familiar with all types of roadways and their conditions within reach of their homes, vital information for accessing field sites. Some are familiar with the greater QTP landscape, places accessible only by all-terrain vehicles. Those holding a valid driver's license and with proven driving skills are widely sought after by both national and international researchers. Driving conditions in the QTP's remote mountains require experienced drivers to ensure the wellbeing of the entire field crew. We used the same experienced driver for both studies, who was integral for navigating complex and often unmarked roadways encompassing a combination of pavement, dry river beds, dirt tracks, and fragile grasslands amongst a backdrop of steep terrain and, at times, unpredictable weather conditions. The driver proved their worth in an emergency by quickly getting a field team member suffering from severe altitude sickness to the nearest hospital, where this person was able to recover from a potentially life-threatening condition.

Translators: One of the greatest challenges researchers face is recruiting suitable translators for ensuring that interviews are accurate and largely free of misunderstandings when involving different language speakers [76]. The majority of QTP pastoralists are Tibetan, although smaller ethnic groups of Kazak and Mongol nomads are also present [6]. Local dialects may differ, but Tibetan is the ubiquitously spoken language [6]. Mandarin Chinese has been promoted as China's national language since 1956 [77,78]. Children living in minority regions of the country start learning Mandarin in state schools from the third grade onward [79]; however, many Tibetans have not received a formal education, nor do all children attend state schools [80]. This scenario is changing as the current generation has greater opportunities for education, given an increased emphasis on fluency in Mandarin Chinese for improving their job prospects [81]. Thus, while many QTP native residents are not proficient in Mandarin, there are skilled community members able to bridge this gap and communicate seamlessly between these two languages, and are thus better positioned to assist researchers in different ways:

First, they assist in communication with other residents along with translating information in Tibetan records and historical documents. Second, they are able to gather information specifically related to study execution, such as directions to field sites or arranging hotel accommodations and food purchases. More importantly, they may translate information from scientists, sharing knowledge with local people on diverse topics from conservation education to study outcomes and scientific results. However, researchers need to be aware that the “local elite” status of some translators may introduce their own bias or cause them to fail to fully disclose information from respondents [82]. Study 2 mentioned above would not have been possible without a reliable local translator, for it required the understanding and consent of participants, LEK on the surrounding area’s carnivores, and instructions for the proper placement and use of solar-powered Foxlights®.

Scientific Assistants: With proper training, area residents can play very useful and active roles in research. This may include wildlife observation, site monitoring, data recording, and camera trap servicing and noninvasive scat sampling collection for genetics and dietary studies [83]. In Study 1, local residents and the driver were trained in scat sample collection techniques. Such training was taken as part of an effort to establish a long-term study field site whereby community participation was perceived more as “Collegial” and “Indigenous” rather than simply “Collaborative” [54]. A trip in September and December of 2019 yielded summer and fall data. With researchers outside of the QTP facing restrictions because of COVID-19 starting in January 2020 and the low priority given to field work because of the outbreak, scat collection and monitoring were suddenly dependent upon local community members. These trained project participants were able to complete collection of scats from all sampling locations by June 2020. This was only possible because of close relationships built between the scientific researchers and local partners over the preceding two years, as well as the project’s investment in field training and sharing of knowledge leading up to the COVID-19 event.

3.4. Expert Elicitation for Raw Data

While discussions with local residents to gain knowledge about conservation concerns, terrain, and the like are typically informal and constitute open dialogue, other interviews are systematically designed to gain targeted information to better understand habitat status and human–wildlife coexistence. The responses from the interviewees themselves serve as raw data for subsequent analysis. Several previous studies have interviewed local QTP residents to gather baseline information surrounding conflict between animals and humans, and how local attitudes and perceptions towards wildlife are shaped [9,46,84–86]. This kind of approach was taken in Study 2 during the initial phase of identifying areas of conservation concern held by the local community. In addition to open dialogue and the opportunity for questions, a one-page interview was administered to identify key factors driving positive versus negative attitudes towards snow leopards [9]. In addition, herders ranked snow leopard abundance on a Likert-type scale as 5 out of 7. Scat collections followed by genetic analysis done in the same area identified six snow leopard individuals in an approximately 30 km² area [87], helping to corroborate herder responses and demonstrating their important role in providing supporting information on the species’ distribution and relative abundance. Similarly, herders interviewed by Farrington and Tsering (2019) [88] in the Chang Tang region of Tibet, China claimed that snow leopards were wide-spread, a contention supported by sign surveys conducted along transects in the same area. Given this past corroboration, it was elected in Study 2 to rely on herder reports of carnivore presence within a 2 km radius of their homes to identify potential species responsible for livestock loss in the upcoming three-month study period testing the solar-powered Foxlights®. Continued data point collection from herders via monitoring, sign surveys, and observations over time will be of great value in examining long-term species population trends.

4. Outcomes of Local Participation and Inclusion

It is only fair and ethical that community members living in these habitats become more substantial stakeholders for outcomes resulting from wildlife management and economic development. Figure 3

shows how local herders and residents are intrinsically linked to a wider system of multiple key players who must work in concert for the persistence of fragile landscapes, rare species, and unique cultures found within them. The inclusion of local residents in research and conservation is imperative to the success of environmental protection efforts, and provides multi-pronged benefits for all stakeholders involved.

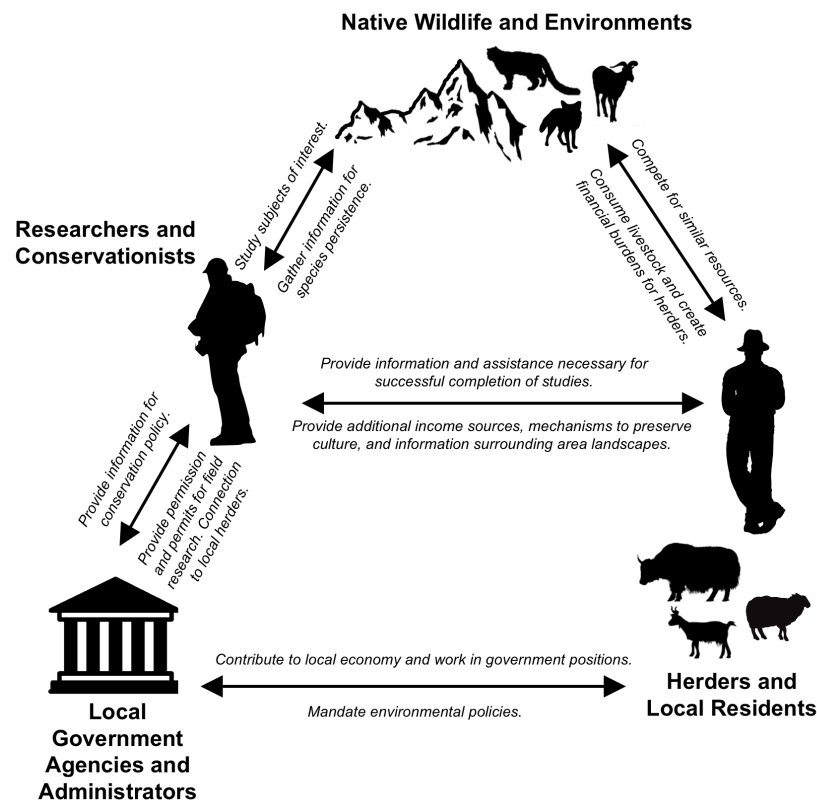


Figure 3. Relationships between stakeholders involved in conservation science and practice.

4.1. Identifying Locally Relevant Concerns

Outside scientists are not always sufficiently aware or cognizant of all conservation issues within an environment. Furthermore, what an outside scientist may perceive as a threat to the ecosystem or livelihoods of local people, the residents may view as a “way of life” or beneficial activity [76]. Dialogue, including back-and-forth consulting with local residents, will help delineate urgent areas of concern. This process is vital to building the trust needed to achieve mutual understanding and consensus for reaching a common goal.

4.2. The Integration of Western Science and LEK

Western conservationists have been criticized for ignoring the more circular holistic approach to biodiversity protection that is deeply embedded in many traditional cultures. Just because scientific knowledge has held a long-standing centralized role in advanced societies does not mean that other knowledge systems cannot contribute in a meaningful way [89]. Modern science has much to gain from the more holistic, qualitative, and geographically focused approaches taken by local communities in regards to environmental preservation [76,89]. Unfortunately, LEK has historically been repressed [90]. Integrating the two avenues of understanding is complex, but frameworks for integrating Western science and indigenous knowledge have been previously proposed [76]. Such integration has been met with continued resistance because of the notion that these two knowledge systems are “too different” from one another [91]. For this and other reasons, Western science has remained dominant and overwhelmingly the main force in wildlife conservation.

4.3. Additional Income Sources

Most researchers employ local residents on an informal basis. Nonetheless, even modest and temporary economic incentives induce a positive response for conservation and research from local people [92]. Residents who assist in the scientific process by contributing their LEK should be fairly compensated for their involvement, with payments adjusted based on the amount of time and the provision of in-kind, unique training. There is an urgent need to diversify sources of income, especially for remote mountain communities. One successful example of supplemental alternative income is that associated with the international trophy hunting program in Dulan County, Qinghai Province, China [92]. Herders were provided with opportunities to work as hunting guides and game guards, and able to lease their horses to trophy hunters. These prospects helped reduce poaching and increase local support for wildlife protection measures [92]. Lowering financial dependence on animal husbandry is thought to help reduce the amount of livestock owned and the resulting grassland degradation [93], as well as the frustrations stemming from conflicts between humans and predators [94], and limit the pursuit of local wildlife for illegal trade. Expert elicitation of LEK as a common practice in research efforts may be able to provide similar benefits.

4.4. Increased Communication and Trust

The wide disconnect between scientific research and management is all too common in wildlife studies [29]. All stakeholders need to come together to meet mutual needs; however, combining interests that are sometimes very diverse or even conflicting often complicates the implementation of wildlife policies and efforts across an otherwise cohesive geographic area [95]. In addition, distrust as a result of historical repression and exploitation by outsiders on indigenous communities can pose a large barrier [96]. Designing and carrying out studies that engage area residents provides opportunities for communication, bridging such gaps with ongoing dialogue, supporting social cohabitation, and enhancing knowledge exchange [89]. As researchers and local entities work together, an understanding of findings and trust amongst members of both parties will usually surface through conversation, cooperation, and cultural exchange. This leads to a research project that is better integrated for supporting conservation that harmonizes the aspirations of local communities as well as ecological sensitivities [97]. It should be noted that trust building with indigenous people in conservation is complex, with prominent factors such as power asymmetry, risk, historical oppression, predictability, commitment, social distance, and reciprocity playing large roles in the formation of collaborative partnerships [96]. However, trust in conservation governance is paramount. Previous work has shown that compliance with conservation policy is more likely if local people living under the policy framework trust the personnel involved than if they were provided with social or economic incentives [98].

4.5. Preservation of Tibetan Culture

Cultural exchange coupled with open communication between scientists and local herders may also aid in preserving the practices, history, and beliefs of Tibetan and other ethnic minority traditions while simultaneously cementing cultural identity and pride for younger generations [10]. Researchers are expected to take diligent field notes, which may include records of local flora and fauna, natural history, weather patterns, and the anthropology of the community they are working in. A written record of the Tibetan traditional knowledge and practices in a more accessible and widely used language, like English or Mandarin Chinese, is imperative given that Tibetan traditions are rapidly eroding as the younger generation forgoes herding for urban-based vocations [22]. These pressures and societal shifts experienced by younger Tibetans can create an identity paradigm, whereby individuals incrementally replace their unique cultural identity with ones conforming to changing societal pressures in order to be “ordinary” and to succeed [99]. Exchange of information between local stakeholders and researchers may instill a sense of pride when local residents discuss their culture and daily

herding practices for dissemination via documentaries [10] as well as through peer-reviewed literature, pamphlets, photography, and other literary or visual means.

Snow leopard conflict studies typically involve interviews addressing current and historical herding, religious, and cultural practices, as well as community demographics [9,46,84–86]. These surveys also provide snapshots of Tibetan society for cultural preservation and informing future generations. One important challenge is that most studies typically depend on the “heads of the household,” and thus predominantly represent the perspectives of men. For example, 91.8% of the respondents in Hacker et al. (2020) [9] were males between ages 21 and 73. Men similarly dominated analyses at 86% of those interviewed in Li et al. (2013) [46], and Li et al. (2015) [86] opted to remove 9 of the 295 interviews completed because the respondents were females. Interviewing females and younger individuals aged 16 to 30 would be highly beneficial for documenting more holistic views of Tibetan lifestyles. Their inclusion would help further advance snow leopard–habitat–human understanding by uncovering potential differences between the sexes along with changing attitudes within the up-and-coming generation [85]. Expanding the diversity that LEK is based upon would address important knowledge gaps surrounding local perceptions of conflict between humans and snow leopards, while ensuring more complete buy-in for any proposed conservation actions.

4.6. Greater Research Flexibility

As noted, researchers face numerous problems while working in remote regions, including study or sampling permit acquisition, visas and travel logistics, unpredictable weather patterns, periodic vehicle breakdowns, theft of supplies, safety of the field team, and obtaining food and lodging, among others. Offering local community members basic training and employment as valued team members generally brings immeasurable benefits, including enabling the study to continue after researchers have left. Local people are able to support vital research tasks on more flexible time scales given their residency and proximity to the study area, thus lowering project costs while expanding the study window.

4.7. Increased Community Conservation Capacity Building

Tibetans harbor special appreciation for the natural world emanating from their long-standing Buddhist beliefs [10]. However, willingness to tolerate predators often declines as conflicts between humans and wildlife grow [100], a trend problematic for the success of conservation efforts [15]. Herder involvement in ecological research, sustainable economic endeavors like well-managed trophy hunting, and stronger protection of endangered taxa offer avenues for personal investments. If appropriately designed, such initiatives engender positive attitudes towards wildlife, hopefully leading to lower instances of behaviors detrimental to conservation efforts, such as retaliatory killing. Education is an important force for promoting positive attitudes towards wildlife. For example, Hacker et al. (2020) [9] found that herders with additional years of formal education were more likely to have positive attitudes towards snow leopards. Participation in research studies provides valuable opportunities for gaining deeper understanding of ecosystem functions and basic biological principles that local people may be unfamiliar with. It will also likely lead to the recruitment from local communities of the next generation of conservationists and wildlife biologists.

5. Other Considerations

5.1. Ethical Review Boards and IRBs

Studies involving LEK may be subject to laws aimed at protecting local people’s rights from poorly designed or even unscrupulous research endeavors. Institutional Review Boards (IRBs, also known as Ethical Review Boards) serve to help ensure compliance and protection for these individuals and their communities. Therefore, avenues available for obtaining IRB exemptions and/or permissions should be carefully considered by all researchers in order to abide by these important and necessary regulations. It is paramount that researchers be engaged with IRBs and not view the obtainment of IRB

permission for research as a simple matter of bureaucracy for which consent from study participants can be easily secured [82]. Understanding of consent varies by culture, and should be recognized as a continuous negotiation, with either party being able to cease if they wish to do so [101]. Forms or contracts should be provided in the native language and shared or distributed with all participants; scientists should take it upon themselves to conduct their own research risk assessments to ensure that the ethical, physical, and mental implications for all stakeholders are considered [82].

5.2. Political Ecology

The term “political ecology” has a number of definitions [102]. Here, the phrase is used in reference to the combination of ecological concerns with political economy (i.e., society–environment relationships). Indigenous people have faced resettlement as the government of China expands infrastructure and its suite of protected lands [93]. The rationale for resettlement has been largely driven by government goals surrounding grassland recovery and poverty alleviation [103]. However, permanent herder relocation can lead to reduced quality of life due to novel urban, social, and financial stresses [93]. In areas where local residents are not heavily dependent on livestock, the provision of alternative income sources, such as scientific and conservation initiatives, may not require resettlement on economic or environmental management grounds. The removal of local people from an ecosystem can greatly hinder both restoration and conservation efforts. For example, the successful operation of the Bird Island Waterfowl Refuge in Qinghai Province was heavily contingent upon participation by local community members, but after people were resettled, the program failed. This was at least partially attributed to the loss of their vital partnership [92].

5.3. Dissemination of Results

Sharing results from scientific studies, especially involving LEK, is in the best interest of environmental protection and long-term stewardship. Negative extraction, in which knowledge from local people is taken but not shared with them [104], breaks the relationship of participation and trust. Dissemination of findings promotes transparency along with educating local residents in aspects of environmental management, thus helping illustrate how those involved can bring added value to their communities. However, research findings should be shared appropriately and in a considerate manner, particularly if they may cause embarrassment, create hostility toward other stakeholders, or threaten reputations [82]. Research findings that are written for publication should adequately recognize local residents and other non-academic collaborators, preferably via co-authorship [105], or, at minimum, highlight them in the acknowledgements section of the published document. Information also needs to be distributed in non-scientific articles, news, pamphlets, and in lectures, as most locals may not have access to scientific publications.

5.4. Considerations for Identifying Experts

Expert elicitation can be highly informative and valuable when done correctly; however, if it does not involve truly knowledgeable “experts”, it can lead to maligned policies and research findings [49]. Some studies harnessing LEK may be stricter than others in this definition. For example, researchers in Pima County, Arizona studying the pygmy owl (*Glaucidium brasilianum*) only considered indigenous persons as “experts” if they possessed LEK and an understanding of scientific language. The caveat of requiring previous scientific training and literacy left out a number of local people [69]. In another example, some studies may only consider elders as holding enough LEK expertise giving their perceived wisdom and experience, thus excluding the LEK that younger generations may possess [76]. We echo that in any case, experts should be carefully selected by the individuals leading the study effort with transparency in study methodology as to how experts were selected [106]. As a general note of caution, research studies should not solely rely on LEK and/or herder information as key data sources for solving complex challenges related to ecosystem management, but should integrate it with their research approach [107].

5.5. Addressing Bias

Scientists need to take necessary precautions to prevent respondents from unduly influencing, socially biasing, or bringing other perceptual data errors into play [108]. For example, interview respondents may perceive the need to provide information that supports the project's expected outcomes or is in alignment with the political interests of local leaders. Sex and age are pervasive sources of potential bias, making it important to consult all segments of the targeted society; however, this may be difficult to achieve.

6. Conclusions

Coordinated efforts to include local community members in research and their value to the realization of conservation goals is now widely accepted [109]. Our understanding of the snow leopard has greatly increased over the last 25 years [45], yet many aspects of this remarkable felid remain understudied and data deficient [44]. Pressing conservation issues that require attention include habitat distribution, population assessments, predator–prey relationships, human interactions, and conservation policy impact [44]. Addressing these knowledge gaps and range coverage for snow leopard surveys in China is a particularly massive endeavor that requires large-scale coordinated efforts by scientists, government officials, and herders working cooperatively and in tandem. One important way of fostering such relationships is to deploy a framework that includes local residents as active, employed participants in research and conservation efforts. Such interweaving of stakeholders could also provide alternative and additional income sources not directly related to animal husbandry. In addition, if young community members are engaged, it may be the spark that will inspire some of them to become the next generation of conservation biologists. Such initiatives serve to highlight the added values of natural resources affected by pastoralists, to provide the needed open communication and information sharing avenues for improving conservation outcomes, findings, and applications in accordance with traditional values, and to cement cost-effective opportunities for expanding knowledge on snow leopards.

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