



To protect or neglect? Design, monitoring, and evaluation of a law enforcement strategy to recover small populations of wild tigers and their prey

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ABSTRACT

Many remaining wild tiger populations persist in small numbers at sites where densities are less than half of their estimated carrying capacity and will continue to decline if not protected from poaching. Although law enforcement is frequently used to protect tigers and their prey, the conditions under which enforcement is likely to be effective in recovering small populations of wild tigers are not well understood. We evaluated the effectiveness of a law enforcement strategy to recover tigers and their prey in Lao PDR where extensive habitat provided favorable conditions for large increases in tiger numbers if protected from poaching. Over a seven-year period, we monitored along a theory of change to evaluate assumptions about the causal linkages between intermediate results and biological outcomes. Although we found a strong positive correlation between funding for enforcement and days patrolled ($r_s = 0.786, n = 7, p = 0.05$) and a significant negative correlation between days patrolled and overall hunting catch per unit effort ($r_s = -0.893, n = 7, p < 0.05$), ultimately a proliferation in snaring was associated with decline in several indices of tiger abundance. We conclude that actions were sufficient to reduce poaching and increase prey populations, but insufficient to curtail extirpation of tigers. Recovering small populations of high-value wildlife such as tigers in promising source sites is dependent on establishing a complete enforcement regime, complimentary strategies that build support for the enforcement regime, and a nimble monitoring and evaluation system for agile adaptive management.

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1. Introduction

Many remaining wild tiger populations persist in small numbers at sites where densities are less than half of their estimated carrying capacity (Walston et al., 2010b). These populations are threatened by poaching for illegal trade in tiger parts or as the result of human-tiger

conflict (Karanth et al., 2011). In most cases, tiger prey populations at these sites are also declining due to over-hunting (O'Kelly et al., 2012, Vongkhamheng et al., 2013). To reverse tiger decline, conservationists are urged to vigorously protect remaining "source sites", defined as areas with the potential to maintain at least 25 breeding females that can in time repopulate the larger landscapes in which they are embedded (Walston et al., 2010b, Karanth et al., 2011). Studies of tiger population dynamics indicate that high recruitment rates are possible with adequate prey and protection (Karanth et al., 2006). To better protect tigers and prey, wildlife law enforcement is a commonly applied conservation strategy (Lynam, 2010, Stokes, 2010, O'Kelly et al., 2012, Goodrich et al., 2013, Hötte et al., 2015). In contrast to larger tiger populations that may be able to withstand up to 20% annual losses (Karanth et al., 2006), recovery of small tiger populations requires conservation strategies that are initially able to nearly eliminate poaching.

The 5950 km² Nam Et-Phou Louey (NEPL) National Protected Area (NPA) in northern Lao PDR (People's Democratic Republic; hereafter Laos) provides an illustrative example of the opportunities and challenges of achieving the necessary conditions to protect and recover small but promising tiger source sites. Among the six remaining tiger

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subspecies, the Indochinese tiger (*Panthera tigris corbetti*) is considered one of the most vulnerable to extinction due to increasing threats of poaching, prey depletion and habitat loss (Lynam, 2010, Goodrich et al., 2015). NEPL was identified as the only potential tiger source site remaining in Indochina (Laos, Vietnam, Cambodia, Walston et al., 2010a, O'Kelly et al., 2012), and was considered an “irreplaceable site” for maintaining tigers in Indochina (Lynam, 2010) and a Class 1 Tiger Conservation Landscape with sufficient habitat for a small tiger population to expand if successfully protected (Wikramanayake et al., 2010). A 2004 baseline survey confirmed that tigers persisted at low density (<1 individual/100 km²) in NEPL, but were suppressed by commercial poaching and overhunting of prey (Johnson et al., 2006). If these threats could be reduced, several features of the landscape provided optimism for rebuilding tiger and prey populations. These included: 1) the lowest human population density in Southeast Asia (Sodhi et al., 2010), with space for tigers and people to coexist; 2) an estimated ungulate density of 5.29 (SE 0.30) individuals/km², sufficient to support an estimated 25–30 tigers (Karanth et al., 2010, Vongkhamheng et al., 2013); and 3) evidence of tiger reproduction confirmed through DNA analysis of tiger scat (Vongkhamheng, 2011). Given these features, it was assumed that with adequate resources to effectively protect tigers and prey, tiger numbers could increase by 50% by 2015, with an ultimate goal to establish 25 breeding females that could expand to potentially 150 individuals in the very long term (Walston et al., 2010a).

To achieve these goals, two conservation strategies – law enforcement and conservation outreach – were initiated in NEPL in 2005 (Johnson, 2012). The law enforcement strategy included working with local government, communities and the military to establish and enforce sizable inviolate core zones where tiger and prey would not be hunted (Johnson et al., 2006). The outreach strategy involved changing the attitudes and ultimately behavior of villagers, local hunters, and government officials to support and comply with law enforcement to reduce tiger poaching and illegal hunting of their prey (Johnson et al., 2012, Saypanya et al., 2013). Contrary to many conservation projects where monitoring to evaluate strategy outcomes is lacking (Pullin et al., 2004, Sutherland et al., 2004, Brooks et al., 2006), the NEPL site was relatively unique in that as a *Tigers Forever* site (Stokes, 2010; Walston et al., 2010a), monitoring the status of tigers and prey as well as the effectiveness of strategies to achieve anticipated results had been ongoing since conservation activities were initiated in 2005 (Johnson et al., 2012, Goodrich et al., 2013).

In this paper, we present the initial assumptions of how a law enforcement strategy was expected to reduce poaching and ultimately increase tigers and prey over time. We report the results of law enforcement and biological monitoring over a seven-year period and evaluate the linkages between law enforcement funding, effort and action, shifts in hunting and the status of tigers and prey over time. We use the evidence generated to define recommendations for improving effectiveness of conservation strategies to recover wild tigers and ungulates in sites such as northern Laos, where success is dependent on vigorously protecting and rebuilding initially small, but promising populations of high-value wildlife.

2. Methods

2.1. Study area

Established in 1993, the NEPL NPA is an IUCN Category VI protected area where a proportion of the area is open to sustainable use of natural resources (Berkmuller et al., 1995, Johnson, 2012). Altitudes range from 400 to 2257 m with over 60% of the NPA above 1000 m and 91% along slopes > 12%. The habitat includes montane grasslands, mixed deciduous forests and an extensive river network. There is a long history of human settlement with most villages engaged in subsistence activities and limited integration into the market economy. Livestock, a principle source

of cash income, graze freely in forested areas and grasslands. Wild foods make up >50% of household food consumption.

NEPL has been under active management with ongoing international technical and financial support from the Wildlife Conservation Society (WCS) since 2003 through the *Tiger Conservation Project* (hereafter called the project, Johnson, 2012). The geographic focus of the project is the NPA and three adjacent provinces (Fig. 1). WCS's *Landscape Species Approach* (Didier et al., 2009) and the *Open Standards for the Practice of Conservation* (CMP, 2013) were used to design the project and a monitoring framework to assess effectiveness of strategies to reduce threats and achieve the goal of increasing tigers and prey. Following this approach, results from the 2004 baseline survey on human-carnivore conflict were used to develop a conceptual model (Margoluis et al., 2009) illustrating the project's assumptions of the major factors that were understood to be driving poaching of tigers and prey in the NPA (see Johnson et al., 2012). Based on this situation analysis, a law enforcement strategy to protect tigers and prey was designed and initiated in 2005.

2.2. Implementing and monitoring the effectiveness of law enforcement

2.2.1. Law enforcement implementation

The expected outcomes of the law enforcement strategy were that increased technical and financial support to the NPA would result in demarcation of a Totally Protected Zone (TPZ) and lead to increased patrol effort that would improve detection and apprehension of poaching and trade, reduce hunting in the TPZ, and increase the abundance and distribution of ungulate prey and ultimately tigers. In conservation planning and evaluation, this string of expected outcomes that result from implementing a conservation strategy is defined as a “theory of change” (Margoluis et al., 2013). To evaluate the accuracy of these assumptions, we monitored along the theory of change to assess linkages between key intermediate results and biological outcomes (Fig. 2). Law enforcement and biological monitoring results were reviewed regularly at three different venues, i) monthly meetings of the NEPL Management Unit, ii) annual NEPL meetings that included government agencies, partner organizations, and donors, and iii) annual meetings of *Tigers Forever* projects from across Asia. Operational and financial data were analyzed annually to assess the relative cost of implementing the strategies and monitoring plan. Internal and peer review of monitoring results were used to revise assumptions, and with analysis of operational and financial data, to adapt strategies accordingly (Johnson et al., 2012).

The law enforcement strategy included three major activities. The first was working with district governments to delineate a 3000 km² NPA TPZ with sufficient habitat to sustain viable populations of tigers and their prey and where access and hunting was prohibited in accordance with national Forestry and Wildlife Laws (GoL, 2007a, 2007c). This activity also included developing regulations to specify what and how wildlife could be hunted outside the TPZ. The national laws prohibited all wildlife trade as well as any hunting of tiger and large ungulates (Gaur *Bos gaurus*, Southwest China serow *Capricornis milneedwardsii*, Sambar deer *Cervus unicolor*). These laws permitted hunting of other ungulates, including wild pigs (*Sus spp.*), and muntjacs (*Muntiacus spp.*) outside the TPZ by adjacent villages for subsistence, following NPA regulations on gear and harvest seasons. The NEPL regulations that resulted from this process (GoL, 2007b) included a map of TPZ boundaries (Fig. 1) and procedures for issuing warnings, collecting and distributing fines, and for rewarding the public and government enforcement officers with some part of the fine, which was intended to incentivize wildlife crime reporting and response. Fines were set at twice the market value of the traded animal to reduce the incentive for trade.

The second activity was training and deployment of foot patrol teams to detect and apprehend wildlife crime in the TPZ. Each team was made up of 4–7 village, forestry and military officers that patrolled on foot through designated TPZ enforcement sectors (Fig. 1). From 2005 to 2007, part-time teams were intermittently deployed from NPA

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