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# Tiger poaching and trafficking in India: Estimating rates of occurrence and detection over four decades

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ABSTRACT

Poaching, prey depletion and habitat destruction have decimated the world's wild tiger population to fewer than 3200–4000. Despite focused efforts, poaching continues to be the key threat to tiger populations in India, home to more than half of the world's tigers. A rise in the number of incidences of tiger poaching and trafficking may not essentially represent an increase in the actual occurrence of tiger poaching and trafficking, but can instead be an indication of better enforcement. With ad hoc detection rates, it becomes difficult to estimate the true quantum of poaching and the efficiency of enforcement. We empirically estimate the probability of occurrence of tiger crime and that of detecting it during periods of 3–7 years in the past 40 years in the 605 districts of India. We test the hypotheses that tiger crime is influenced by the presence of tiger trade hubs, proximity to a number of tiger habitats, and that tiger poachers prefer to use rail routes over road highways. The annual probability of detecting tiger crime was estimated to be highest (0.46, 95% *CI* = 0.38–0.54) in the period between 1993 and 1995. Our results identify 73 districts as current tiger crime hotspots with high (>0.5) probability of occurrence of tiger crime. We propose that the probability of occurrence of tiger crime can be a more reliable estimator of changing poaching pressures and that probability of detecting tiger crime provides a robust estimate of the efficiency in tackling tiger poaching and trafficking.



## 1. Introduction

The tiger is one of the world's most popular animals. Critically endangered, there are fewer than 3200–4000 tigers that survive in the wild (Chundawat et al., 2014). India, home to perhaps half of the tiger's global wild population remains crucial for the species' survival. From as many as 58,200 tigers a couple of centuries ago (Mondol et al., 2009), India's population was decimated to possibly as few as 1800 tigers by the year 1972 (Panwar, 1987). Numbers improved marginally in India after the launch of Project Tiger the following year. However, by the end of 2008 the population was estimated to be as low as 1411 (Jhala et al., 2008). Depletion of prey, habitat destruction and poaching have long been considered the key reasons behind declining tiger populations (Chapron et al., 2008; Chundawat et al., 2005; Karanth et al., 2004; Karanth and Stith, 1999). Models based on tiger population dynamics have indicated the inability of many of the fragmented tiger populations to sustain poaching pressures despite high fecundity (Chapron et al., 2008). Recent extinctions of tigers in Sariska (in 2004) and Panna (in 2009) Tiger Reserves highlight the role poaching can play in exterminating tiger populations despite large prey bases (Chundawat and Van Gruisen, 2009; Gopal et al., 2010; Mazoomdar, 2005; Narain et al., 2005).

The persecution of wild tigers in India became widespread with the availability of modern firearms in the late 19th Century. However the hunting of tigers remained the purview of the elite until after the introduction of the 4WD Willys Jeep to civilians in 1945, when it spiralled out of control (Wright, 2010). In the 1960s tiger skin coats became fashionable in the United States and Europe; for the first time the tiger had become a commodity. An indication of the volume of the trade is that in 1968 government licenses were issued for the export of 3000 tiger skins, whereas in the same year only 500 tiger hunting permits had been issued. This indicates that at least 2500 of these skins were illegally obtained (Wright, 1969).

In 1967, IUCN recommended that nations controlled and restricted the import and export of all "spotted cat" skins. India responded by banning the export of tiger and leopard skins in June

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1968, except for personal baggage and clothing. They later relaxed the ban to allow the export of all pre-ban commitments, including 5000 tiger and leopard skins claimed by Delhi traders alone (Wright, 1969). A total ban on tiger shooting was introduced in 1970 and the landmark Wild Life (Protection) Act was passed in 1972 (Anonymous, 1972). Project Tiger, one of the world's most ambitious conservation projects, was launched in 1973. Despite considerable efforts, tiger populations have continued to decline and tiger crime in the form of poaching and illegal trafficking remains a key threat.

Crime detection rates are never 100%, and the proportion of actual crime that gets detected is seldom estimated empirically. The challenge with unknown detection rates is that it makes it impossible to monitor impacts of policing and other control mechanisms. Actual crime rates depend largely on the quality of enforcement. For example, if crime rate is reportedly declining, it can either indicate that the incidences of crime are reducing, or mean that the reduced crime rate is an artefact of poor reporting. Wildlife crime is harder to estimate given that unlike other forms of crime, the victims of crime (or their families) cannot report it (Sellar, 2014). Similarly, the rate of detection of poaching and illegal wildlife trafficking is unknown and usually stated to be the tip of the iceberg or given an ad hoc value, e.g. customs officers generally opine that capabilities for seizing illegal "general goods" such as wildlife contraband are about 10%.

Empirical estimates of detectability provide a reliable estimate of populations by correcting for imperfect detection (Williams et al., 2002). Methods using mark-recapture sampling to estimate wildlife populations were developed in the early 20th century and have since improved multi-fold to additionally address many sources of variants (Cooch and White, 2008). The methods rely on maximum likelihood estimates of the unknown parameters including detection probability and populations obtained for a given mark-recapture dataset. The use of mark-recapture modelling has found applications in streams outside ecology and biology, e.g. counting taxis in Edinburgh, enumerating homeless people in the UK, and estimating populations of people at risk from sexually transmitted diseases in the USA (Rubin et al., 1992; Williams, 2010). Recently, Raza et al. (2012) estimated the number of undetected localities involved with leopard trade using mark-recapture open population models to describe the magnitude of leopard trade in India.

Using the maximum likelihood estimation, MacKenzie et al. (2002) developed methods to estimate probability of occurrence or occupancy of a species in an area while addressing the issue of imperfect detection. Later, Mackenzie et al. (2003) proposed a multi-season model where two additional parameters, probability of local colonization and local extinction, were estimated to obtain changes in occupancy of a species in an area over time. The underlying principle was that occupancy remains constant during a single season, but may change as a result of local colonization and extinction between seasons. Several factors may influence the probabilities of occurrence, extinction and colonization, as well as that of detection. These can be incorporated in the analysis using logistic insertion to address spatial and temporal variability in the estimates. In this paper we have used occupancy modelling (Mackenzie et al., 2003; MacKenzie et al., 2002) to empirically estimate the probability of tiger poaching and/or trafficking (henceforth called 'tiger crime') taking place in a district during predefined periods of time (3–7 years), and the annual probabilities of detecting it. Based on our prior knowledge about the scenario of tiger poaching, these periods were expected to reflect documented crises and spurts in demand from the illegal international markets. We have assumed that the probability of occurrence of tiger crime remained constant during each pre-defined period within a district. Changes may have taken place in the probability of occurrence of tiger crime between these pre-defined periods as a result of initiation and/or discontinuation of tiger crime in specific districts. Detection probabilities, on the other hand, may change over shorter periods as the enforcement agencies are constantly challenged by criminals who continuously change their tactics to avoid detection. We have assumed that the probability of detecting tiger crime, given its occurrence within a district remained constant for at least a year, though may have changed between years.

Tiger poaching in India has always been a specialized job mostly led by family groups and individuals with traditional expertise. The poachers prefer to operate in specific tiger habitats, mainly because of their familiarity with these areas and the trusted networks that individual poaching gangs have set up over several years. The entire scenario of illegal trafficking of tiger parts has two components; that of poaching tigers and that of selling, buying and smuggling the goods out of the country to cater to the illegal international market. Between 82 and 88 districts have been identified as traditional and new trade hubs based on the number and kind of confiscations over the years and reliable intelligence inputs. We hypothesize that these tiger trade hubs also underwent a change around 1999–2000 when tiger trade became more organized; it went from being opportunistic to structured, organized crime. This also resulted in some hubs being abandoned and some new districts becoming trade hubs, though many have remained traditional tiger trade hubs for at least the past 40 years. Our second hypothesis was that tiger crime occurred in districts that were in close proximity to a number of tiger habitats. The third hypothesis that we tested was that poachers preferred rail routes over road highways, and that the probability of tiger poaching or illegal trafficking has been greater in districts with access to rail routes.

We provide empirical estimates of changing probability of occurrence of tiger crime for each district in India over the past 40 years while incorporating the potential effects of covariates that could have influenced it. We also estimate the variable probability of detecting tiger crime given its occurrence within these districts. With distinct estimates of probabilities of occurrence and detection, we provide a framework that can potentially be used to monitor crime and crime detection rates as long as the assumptions hold true for different temporal and spatial scales. Such information can thus be useful in prioritizing intelligence and enforcement efforts, subsequently leading to prevention of crime.

## 2. Methods

### 2.1. Data collection on tiger crime

The Wildlife Protection Society of India (WPSI) systematically collected data on poaching cases and confiscations, from 1972 onwards, and recorded information for confirmed incidents of illegal killing or trafficking of wildlife. This information is collated, categorized and stored in WPSI's database on wildlife crime. Primary information comes to WPSI from a network of field officers, local NGO's and concerned citizens. WPSI field-staff constantly liaise with enforcement agencies including the Forest Department, Customs and Police, to collect information on wildlife crime. Primary information is also obtained from sources such as newspapers and other media, both local and national. This information is then verified from the relevant agencies for their authenticity before entry into the database. Wherever possible, additional information such as copies of First Information Reports or Preliminary Offence Reports is obtained. A large amount of information was also acquired by WPSI as part of wildlife trade studies conducted on various states of India. In addition, the Right to Information Act, 2005 has been used to elicit information about incidents of crime. The total database consists of more than 25,000 entries on poaching, confiscations, raids, retaliatory killings and accidents involving nearly 400 species of India's wildlife.