International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 3; Issue 6; June 2016; Page No. 89-93

Forensic approaches in the solution of wildlife crime

[1] Dr. Sudhir Yadav, [2] Dr. Dixit AK

[1] Assistant Professor (Adhoc), Department of Forensic Science, School of Life Sciences, Guru Ghasidas Vishwavidyalaya, (A Central University), Bilaspur Chhattisgarh, India

[2] Associate Professor & Head (In-charge), Department of Forensic Science, School of Life Sciences, Guru Ghasidas Vishwavidyalaya, (A Central University), Bilaspur, Chhattisgarh, India

Abstract
Wildlife crime is an important part of the law enforcement and it involves the illegal trade in animals, plants and their derivatives and has observable effects with the dramatic decline in many species of flora and fauna. The forensic methods those are pertinent to the enforcement of wildlife legislation include: veterinary pathology, where persons skilled in this discipline perform a similar role as their human counterparts and determine cause and time of death; crime scene examination, to record and collect such as latent fingerprints and DNA, both of the animal and human. The two principal issues that are addressed and these transmit to the phrasing of the various types of legislations in Wildlife crime. The Ist being the ability to identify a particular species and 2nd is the ability to determine whether the biological material can be assigned with confidence to a particular individual member of that species. The present article mainly focuses on the wild life crime and detail description of forensic science approaches i.e. various tools and techniques those may be used as safeguard for its solution.

Keywords: Wildlife Crime, Forensics, Techniques, Applications

1. Introduction

Wildlife crime (WLC) is an important part of the law enforcement and it involves the illegal trade in animals, plants and their derivatives and can result in the depletion of natural resources, invasion of pest species and the transmission of diseases [1].The measure of crime related to wildlife is still mysterious but it is on the increase and has observable effects with the dramatic decline in many species of flora and fauna. The estimated size of the trade in wild life, and the threat to species, it would be assumed that there is investment in forensic science to aid in combating these illegal activities [2].

The types of forensic science methods pertinent to the enforcement of wildlife legislation include: veterinary pathology, where persons skilled in this discipline perform a similar role as their human counterparts and determine cause and time of death; crime scene examination, to record and collect such as latent fingerprints and DNA, both of the animal and potential human DNA from the perpetrator [3] morphology/ microscopy**,** as simple comparison of hairs, furs and feather is often the first step to determining what species is present; ballistics, in the comparison of bullets recovered from carcasses to cartridge cases found at a poaching scene and a particular firearm if seized subsequently; document examination, to determine authenticity of documents relating to the trade in species; chemical profiling, to determine possible geographical origin based on isotope ratio; and DNA analysis to determine species and potentially link to a particular individual in a similar manner as their human counterpart.

Therefore, it is important to realize that forensic science has many techniques that can be complementary. Forensic science has a range of tools and it is essential that the appropriate tool is used to address the allegation. There are two principal issues that are addressed in wildlife crime and these transmit to the phrasing of the various types of legislations. The first being the ability to identify a particular species and the second is the ability to determine whether the biological material can be assigned with confidence to a particular individual member of that species. The present article mainly focuses on the wild life crime and detail description of forensic science approaches i.e. various tools and techniques those may be used as safeguard for its solution.

2. Scope of WLC

The scope of wildlife crime covers a wide range of diverse crimes and for this reason many newspaper articles, as well as journal papers, will often cite figures such as: *"The illegal trade in wildlife is a $20 billion a year industry, second only to trade in illegal drugs"*. It takes many forms from trafficking in live specimens, hunting out of season, cruelty to animals, habitat destruction, poaching for meat, poaching for trophies, poaching to use animal parts in medicines, horns and tusks used for jewellery and ornaments etc.

The monetary figure will often range between 6 and 20 billion US dollars a year and the figure are often cited to Interpol[1]. However, Interpol has confirmed that this statement did not come from them. While this seems to be a fabricated figure, it is difficult to estimate the exact amount of illegal trade as there are not the same international surveillance teams that are used for drug enforcement for the prosecution of offences involving wildlife. Organized crime has not been proven to be linked to wildlife crime but there are indications that this is the case [3]. Another influencing factor in wildlife crime is that there is a high financial return with little chance of being caught and, even if the perpetrators are caught, the penalties are light. Rarely does the maximum penalty for the alleged event meet the potential financial gains [4].

According to a recent census by the World Wildlife Fund only 3200 tigers (Panthera tigris spp.) exist in the wild [5]. This is a reduction of over 90% in the last century which has lead to

more tigers existing in captivity in Texas than exist worldwide in the wild. Similarly, the population of black rhino (Diceros bicornis) decreased by 96% between 1970 and 1992 [6]. In 1970, it was estimated that there were approximately 65,000 black rhinos in Africa - but, by 1993, there were only 2300 surviving in the wild. Intensive anti-poaching efforts have had encouraging results since 1996. The numbers of black rhino have been recovering and still are increasing very slowly; there is now an estimated wild population of 4420.

The above examples illustrate the affect of trade on the numbers for the tiger and rhino populations. The biological material that is traded is not the whole animal but body parts such as skin, bone or powdered horn. Other examples of mammalian species that are part of the illegal trade in wildlife include elephant ivory [7, 11], bear bile [12] and deer products [13, 15]. Mammalian species are high profile in the public perception but the trade in reptiles and amphibians is much higher, partly because these species are smaller and therefore easier to conceal in order avoiding detection [16].

3. Forensic Approaches Concern to WLC Investigation

A paradox to the limited prosecutions is the rise in interest in the forensic community in wildlife forensic science. There have been reviews of the subject [17, 20], a text book on non-human DNA [21] and on wildlife forensic science [22]. One thing should be kept in mind by any forensic scientist during investigation of the crime concern to the wildlife that all the general techniques i.e. Fingerprint analysis, fibre analysis, footwear and tyre marks, questioned documents and handwriting analysis, digital forensics, human DNA analysis, firearms analysis, soil and chemical analysis etc. Those has been used to investigate other types of crime can also be used for wildlife crime [23].

A summary of current forensic techniques those are available till now for the investigation of wildlife crime are briefly summarized here under:

A) Taxonomy

Mainly deals with the study of the structure of animals and plants and is useful for identification of species.

B) Stable Isotope Analysis

Principally based on measuring natural variation in the chemical elements present in biological samples to establish the geographical origin or the age of a sample.

C) Radiocarbon Dating

Generally used for aging samples based on levels of carbon isotopes following the start of atmospheric nuclear bomb tests. The technique can be applied to discriminate specimens that were alive before and after the 1947 convention cut off.

D) Wildlife DNA Forensics

DNA is the genetic material present in all fauna and flora and can be found in all biological samples such as timber products, hair, fur, feathers, bones, blood, ivory, horn, saliva, faeces, nails, claws, teeth etc. and therefore, it can then be used in several applications, including molecular species identification, parentage testing and individual identification.

E) Toxicology analysis (including pesticides)

Wherever any wildlife poisoning is suspected, the chemical analysis of the victim and any bait material can establish for the presence or absence of pesticide, if any, has been used.

4. Specific Applications for WLC Investigation

A) Identification of Species

The identification of the species is a key point in many wildlife crime investigations and it involved to determine whether a crime has taken place. Basically two methods can be employed to identify a species:

i) Physical inspection

From a whole specimen, or even only parts of an animal or plant it may be possible for specialists in taxonomy to identify the species present from its morphological characteristics.

ii) DNA analysis

Where the evidence cannot be confidently identified by physical inspection, DNA can be analyzed to identify the species present. Specific regions of DNA that show variation among species but are generally conserved within species are targeted. These regions of DNA are sequenced from the specimen, and compared to a validated reference database of known species. The level of similarity between the specimen and reference sequences enables the species of origin to be inferred.

B) Identification of Geographic Origin

This may be important for species which are protected by varying legislation across their range, for example ivory from African Elephants is listed under CITES Appendix I everywhere except in Botswana, Namibia, South Africa and Zimbabwe where it is listed under CITES Appendix II . Again, two possible methods can be employed.

i) Stable isotope analysis

Stable isotope analysis is based on measuring natural variation in the chemical elements present in biological samples. Many common elements, such as hydrogen, oxygen and carbon occur in different forms, known as isotopes. The presence or relative abundance of different isotopes allows isotope profiles to be generated for individual samples, which can then be compared to each other, or to reference data. Profiles from different environments will vary due to a number of physical, geological and biological factors. These factors may correspond to different geographic localities and therefore these profiles can be used to infer the geographical origin of a sample. Stable isotope analysis has been used in the UK to examine hydrogen isotope levels in Bramblings to determine if levels are consistent with UK captive-bred individuals or individuals taken from the wild in their Scandinavian home range.

ii) DNA analysis

If populations of a species are sufficiently distinct from one another, it may be possible to use genetic analysis assign a sample to its population of origin. In order to carry out this analysis, genetic information from all likely source populations must be available. Genetic population assignment is now being used to identify the origins of a wide range of illegally traded species, including fish and tigers.

C) Aging samples

In some wildlife crime investigations it is necessary to know

the age of a sample. For example, if a rhino horn was collected prior to 1947, then it pre-dates laws prohibiting trade in rhino horn. In order to determine whether the rhino horn was legally collected prior to 1947, a form of stable isotope analysis known as radio carbon dating can be employed. During the early part of the 1950's atmospheric nuclear weapons testing became common and had the effect of artificially increasing the amounts of different isotopes of the element carbon, particularly the normally rare carbon 14 (14C) which had doubled in abundance by 1965. As such, rhino horn that pre-dates this period will be expected to have a lower ratio of 14C than more modern specimens.

D) Animal sexing

Where the open and closed hunting season vary between males and females (e.g. deer) it is often necessary to know the gender of a specimen to determine whether an animal was legally killed. If a carcass has been prepared for sale, morphological differences between males and females are often no longer present (e.g. antlers or genetalia). DNA analysis can, however, determine the gender of the specimen.

E) Parentage analysis (captive breeding verification)

The patterns of inheritance from parent to offspring allow DNA profiles to be used to verify family relationships. The genetic variants present in the DNA profile of an individual must be represented in its putative parents. If genetic variants are observed in an individual that do not match those found in the putative parents, then the possibility of the individual being their offspring can be excluded. This method of parentage analysis has been used successfully on many occasions to challenge the captive breeding claims of people illegally laundering wild taken birds of prey. Tests are available for a number of birds of prey and other species.

F) Individual identification

Perhaps the most powerful DNA analysis we can perform is individual DNA profiling. This technique allows investigators to link trace evidence from a suspect to a specific incident. For example, if a dead hare is found following a coursing incident, there may be traces of dog saliva on its body. The DNA from this dog saliva can then be analyzed, and compared to DNA from dogs believed to have been involved the coursing. If the DNA Profile from the saliva on the hare matches a particular dog, this provides strong evidence that the dog was involved in the crime.

DNA profiling works by targeting genetic markers that are highly variable within species and are therefore likely to show differences among individuals. If two samples produce different DNA profiles, the possibility that they originate from the same individual can be excluded. If two samples share the same profile, it suggests that they may come from the same individual and it is then necessary to calculate the probability that two individuals have the same profile by chance. For evidence from animal DNA profiling to be used in court, a very high level of accuracy is required. In order to achieve this, there is a large amount of validation required for any species before the DNA profiling tool can be used for forensic analysis. This tool is currently available in the UK for dogs, badgers and several bird of prey species.

G) Toxicology analysis

A number of pesticides may be involved in the illegal poisoning of wildlife. This may be the deliberate abuse of a product or misuse of the product, through carelessness or failure to comply with a safe code of practice. The practise of placing illegal poison baits in the open to target birds of prey, foxes, corvids and badgers continues around the UK. These methods are indiscriminate and may result in the death of other non-target species. A relatively small number of highly toxic products have been persistently used to illegally poison wildlife. These products may be decanted from original containers into unmarked containers. Pesticides in liquid form may be injected into bait by use of a syringe.

The government Wildlife Incident Investigation Scheme (WIIS) investigates the deaths of wildlife potentially caused by pesticide poisoning, in addition to deaths of companion pets (dogs/cats) and beneficial insects (honeybees/bumblebees). Analytical chemistry is used to detect the presence of pesticide residues in a variety of animal tissues including gut contents, vomit, faeces, blood, urine, liver, kidney and lung, as well as in poisoned bait. Pesticide residues are extracted from the tissues band analyzed to determine the type of chemical, typically groups such of compounds such as organochlorines, organophosphates, carbamates, pyrethroids, anticoagulant and other rodenticides, or individual compounds such as strychnine, paraquat, cyanide and phosphine are found to be the cause. Pesticide analysis is a proven method of identifying deaths caused by poisoning or identifying pesticides held by suspects or finding traces in syringes, vehicles or other relevant items [25].

H) Forensic Veterinary Pathology

This technique aims to determine whether the death or injury of an animal was caused by human activity or due to natural influences. A forensic clinical examination of a specimen is carried out by a suitably qualified and experienced forensic practitioner. A thorough examination by the practitioner will determine the condition of the specimen, any trauma or abnormal findings, life history data (age/sex etc.) and any rings/microchips/collars or tattoos. Radiographs are a useful method to determine internal trauma such as broken bones or bullets. Samples (blood/tissue) may be sent for further analysis. The practitioner may also visit the crime scene to assist in the collection of important evidence such as feathers, faeces, pellets, egg shells etc. Forensic veterinary pathology is particularly useful in cases where illegal killings have involved shooting, snaring, trapping, starvation, poisoning, drowning, hare coursing and badger baiting.

I) Taxidermy

Taxidermy involves preparing, preserving and mounting the skins of deceased animals to replicate their lifelike state. It may be possible to determine the likely cause of death even once the specimen has been mounted. An examination by an experienced taxidermist can reveal external traumas such as bullet wounds or feathers damaged by the passage of shot. Some of the larger bones and the skull may be left inside a prepared taxidermy specimen to help support the internal structure. Consequently, radiographs can be used in conjunction to determine internal traumas. However, as all of

the tissue and organs have been removed this does limit the causes of death that taxidermy can uncover.
A taxidermist should be able to estimate the age of a specimen. Materials used in modern taxidermy such as enamel and acrylic eyes, nylon thread and foam bodies can all be used to estimate a date. An examination of the case and style of taxidermy can also provide useful information. It is important to age a specimen as some legislation is only applicable during certain time periods. Professional and experienced taxidermists can be sourced through the Guild of Taxidermists. If specimens are found in a taxidermist's freezer and are thought to be from illegal killings, a post mortem and or radiography can be carried out to determine the cause of death. Birds of prey with full crops may also be indicative that the bird has been poisoned.

J) Soil analysis
Soil evidence at a crime scene can be used to link a suspect with an offence and is normally collected by the Scenes of Crime Officer. Soil is comprised of a mixture of organic, mineral and/or synthetic components and is considered as trace evidence. As the ratios of these components can vary over a very small area it is possible to profile the characteristics of the soil at the crime scene and compare this with a soil sample found on a person's clothes, shoes, tools or vehicle.
This is done by comparing the soil colour, particle size and shape, mineralogical composition and biological components. Reflected light microscopes can be used to compare the particle size and shape and x-ray diffraction can be used to compare mineralogical and biological composition. Soil analysis can be useful in cases where small amounts of soil have been found on a spade thought to be involved in a badger digging incident or in the tread of a shoe of a suspected egg collector where the raided nest location is known.

K) Pollen analysis
Pollen grains are abundant in almost all environments, are very durable and may persist on surfaces and in soils for many years .The pollen produced by flowering plants and conifers, along with the spores produced by ferns are microscopic and not visually obvious trace evidence at a crime scene. However, by examining the morphology of a tiny pollen grain it is possible to identify the genus and often the species of the plant. Conducting analysis on multiple pollen grains allows for the vegetation composition of an area to be determined.
The composition of pollen grains at a crime scene can then be compared with a sample taken from a suspect's clothes, shoes, hair or car. The time of year that the crime took place can also be derived as some pollen is only released during certain seasons. Pollen analysis works best when the crime scene is small such as the placement of an illegal snare or destruction of a bird of prey's nest. In both these cases pollen from the surrounding soil can be compared with pollen found on the suspect.

5. DNA Techniques Available for Specific CITES Enforcement Issues
The following methods are available for immediate application. Several other methods can also be developed as per need of depth of investigations by varying the levels of R&D.

I) Timber
Species identification from timber is usually possible using genetic analysis. Identification of treated wood products depends on the ability to recover DNA from the sample. DNA extraction methods are continually improving for this application. A reliable test has recently been developed for the rapid identification of ramin.

II) Caviar
The majority of sturgeon species can be identified, although some species pairs are indistinguishable and hybrids cannot be easily verified. Work is currently underway in some countries to authenticate farmed caviar using DNA profiling.

III) Traditional Medicines
Components of traditional medicines are difficult to identify and require species specific tests. Tests exist for species such as tiger, rhino and bear, however in highly processed samples, negative results may occur, and these can be difficult to interpret.

IV) Ivory/horn
Species identification and individual matching is possible using genetic analysis. Note that samples can also be aged with respect to being pre- or post- 1947, using radiocarbon dating (non-genetic technique).

IV) Bird parentage (parrots, falcons etc.)
DNA profiling methods are available for excluding parentage in some species (peregrines, merlins, goshawks, golden eagles, gyr and saker falcons). Parentage identification is more limited, as it requires population data for each target species.

6. Conclusion
Investigating wildlife crime is never easy and it is also exacting in nature. Many offences take place far from urban areas where enforcement agencies are usually based and where forensic science laboratories and forensic scientific expertise are most likely to be found. Poorly equipped countries such as India face particular problems and may have very limited facilities even ex situ. Therefore, a team work is needed to do so. Whenever possible, a planning meeting is advisable an opening to bring everyone together and to diminish the risk of insufficient statement before the investigation commences.
A methodical plan will ensure that all those involved are responsive of the steps that will be taken, that the scene of the alleged crime is fully examined and that potential evidence is not lost or missed during the process. It is essential to prepare well for site visits and fieldwork and to ensure that those involved are familiar with the necessary rules, SOPs and codes of practice. This is particularly important when backup or direction from the police or other experienced people is not available.

7. References
1. Christy B, Wildlife Smuggling, Why Does Wildlife Crime Reporting Suck? The Huffington Post, 2010. [http://www.huffingtonpost.com/2010/01/04/wildlife smuggling-why-do_n_410269.html].
2. Sellar JM: In Illegal trade and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), in Wildlife Forensic Investigation.

Edited by: Linacre AMT. London: Taylor and Francis, 2009, 11-18.
3. Li YM, Gao Z, Li X, Wang S. Illegal wildlife trade in the Himalayan region of China. Biodiversity Conservation 2000; 9(7):901-918.
4. World Wildlife Fund Tiger Overview, 2010 [http://www.worldwildlife.org/ species/finder/tigers/index.html].
5. International Rhino Foundation, 2008. [http://www.rhinos-irf.org/black/].
6. Lee JC-I, Hsieh HM, Huang LH: Ivory identification by DNA profiling of cytochrome b gene. Int J Legal Med 2009, 123(2):117-121.
7. Comstock KE, Ostrander EA, Wasser SK: Amplifying nuclear and mitochondrial DNA from African elephant ivory: A tool for monitoring the ivory trade. Conservation Biol 2003, 17(6):1840-1843.
8. Gupta SK, Thangaraj K, Singh L: A simple and inexpensive molecular method for sexing and identification of the forensic samples of elephant origin. J Forensic Sci 2006, 51(4):805-807.
9. Wasser SK, Clark B, Laurie C The Ivory Trail. Sci American 2009, 301(1):68-74.
10. Wasser SK, Clark Joseph William, Offir Drori, Kisamo Emily Stephen, Celia Mailand, Benezeth Mutayoba, and Matthew Stephens: Combating the illegal trade in African elephant ivory with DNA forensics. Conservation Biol 2008; 22(4):1065-1071.
11. Peppin L, McEwing R, Carvalho GR, Ogden R. A DNA-based approach for the forensic identification of Asiatic Black Bear (Ursus thibetanus) in a traditional Asian medicine. J Forensic Sci., 2008; 53(6):1358-1362.
12. Brinkman TJ, Hundertmark KJ: Sex identification of northern ungulates using low quality and quantity DNA. Conservation Genetics 2009; 10(4):1189-1193.
13. Jobin RM, Patterson D, Zhang Y: DNA typing in populations of mule deer for forensic use in the Province of Alberta. Forensic Sci Int-Genet 2008; 2(3):190-197.
14. Perez-Espona S, Perez-Barberia F, McLeod JE, Jiggins CD, Gordon IJ, Pemberton JM. Landscape features affect gene flow of Scottish Highland red deer (Cervus elaphus). Molec Ecol 2008, 17(4):981-996.
15. Alacs E, Georges A: Wildlife across our borders: a review of the illegal trade in Australia. Australian. J. Forensic Sci., 2008; 40(2):147-160.
16. Linacre A. Application of mitochondrial DNA technologies in wildlife investigations - species identification. Forensic Sci. Rev, 2006; 18(1):1-8.
17. Ogden R, Dawnay N, Mc Ewing R. Wildlife DNA forensics - bridging the gap between conservation genetics and law enforcement. Endangered Species Res 2009; 9:179-195.
18. Alacs EA, Georges A, Fitz Simmons NN, Robertson J. DNA detective: a review of molecular approaches to wildlife forensics. Forensic Sci Med.Pathol 2009; 3:180-94.
19. Tobe SS, Linacre A. DNA typing in wildlife crime: recent developments in species identification. Forensic Sci Med Pathol 2010; 6:195-206.
20. Miller Coyle H. In Nonhuman DNA Typing: Theory and Casework Applications. Edited by: Houck M. London: CRC International Forensic Science and Investigation Series 2008, 214.
21. Linacre A, ed: Forensic Science in Wildlife Investigations International Forensic Science and Investigation Series. Boca Raton: CRC, 2009.
22. Butler JM, Schneider PM, Carracedo A. Journal update. Forensic Sci Int Genetics 2010; 4(3):143-144.
23. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): What is CITES. 2010 [http://www.cites.org/eng/disc/what.shtml].
24. (http://www.defra.gov.uk/paw/files) accessed on 015/05/2016.
http://www.pesticides.gov.uk/environment.asp?id=58 accessed on 02/06/2016