



UNODC

United Nations Office on Drugs and Crime



**Development of an electronic directory of
laboratories that conform to a defined minimum
standard for conducting wildlife forensic testing**

Commissioned by the Secretariat of the Convention on
International Trade in Endangered Species of Wild Fauna and
Flora (CITES)

Undertaken by the United Nations Office on Drugs and Crime
(UNODC)

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COMBATING
WILDLIFE AND FOREST CRIME
UNITED NATIONS OFFICE ON DRUGS AND CRIME



Executive Summary

In 2016, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Secretariat commissioned a global review of forensic laboratory capacity. The resulting report reviewed laboratory capacity for performing wildlife forensic analysis in support of CITES implementation and enforcement ([Annex 4 to document CoP17 Doc. 25 on Enforcement matters](#)), and aimed to facilitate understanding about the range of laboratories and services in operation, whilst the details of the laboratories concerned remained confidential in nature. To further build upon this work, the Conference of the Parties to CITES at its 17th meeting (CoP17, Johannesburg, 2016), adopted Decision 17.83, paragraph c), which directed the CITES Secretariat to compile an electronic directory of wildlife forensic laboratories.

To implement this Decision, the United Nations Office on Drugs and Crime (UNODC), at the request of the CITES Secretariat, led work to enable the creation of a publicly available directory of global laboratories that conduct wildlife forensic testing, meet minimum quality assurance standards and, subject to available resources, are able and willing to carry out wildlife forensic analyses upon request from other countries.

This work was conducted in two stages. Firstly, to revise the original 2016 review of wildlife forensic laboratories, a survey was issued requesting updates from previous responders and new submissions from laboratories that did not take the first survey. Secondly, wildlife forensic laboratories were requested to indicate their desire to be listed in the public directory of wildlife forensic laboratory services. Those that responded positively, were asked to provide evidence that they meet the following criteria:

1. The laboratory must carry out forensic casework;
2. The laboratory must operate in accordance with a Quality Management System;
3. The laboratory must have passed an external audit of its Quality Management System, conducted by a competent third party, within the past two years;
4. The laboratory must be able and willing to carry out wildlife forensic analyses upon request from other countries; and
5. The laboratory must explicitly request to be included in the directory.

Laboratory submissions were evaluated against these criteria by a UNODC wildlife forensic expert and by an independent panel of experts drawn from the Technical Working Group of the Society for Wildlife Forensic Science.

A total of 75 responses were received from 128 laboratories invited to participate (58% response rate). Of these, 63 (84.0%) laboratories stated they conduct some type of forensic casework, while a further nine indicated that they are developing casework capacity.

The responses in relation to analytical capacity broadly reinforced the findings of the 2016 report. The most common technique employed remained DNA analysis, followed by morphology, except for timber samples where the opposite trend was observed. Over one third

(22/63) of the labs claiming to conduct forensic analysis did not follow any type of quality management system, which remains a concern, as quality assurance is a fundamental requirement in forensic casework analysis.

With respect to listing laboratories in the directory, based on the answers provided by the respondents, 23 laboratories met the first three criteria, however, of these only seventeen were willing to offer international services and be listed in the directory (criteria 4 and 5). Of these seventeen, nine submitted evidence for review, resulting in all nine labs being approved for directory listing.

The directory of laboratories is to be made available on the CITES webpage on *Wildlife Forensics*.¹ As the wildlife forensic community develops under a series of ongoing capacity building programmes, it is envisaged that the number of laboratories qualifying for inclusion in the directory will grow. To facilitate this, it is proposed that the directory accepts new applicants annually and reviews existing listings every two years.

For further details on any part of this report please contact: cites.info-cites@un.org

¹ https://www.cites.org/eng/prog/imp/Wildlife_forensics

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Part 1. Introduction

CITES is an international agreement between governments with the aim of ensuring the international trade in specimens of wild animals and plants does not threaten their survival. CITES works by subjecting international trade in selected species to certain import, export, re-export and introduction controls.

Against a backdrop of widespread illegal trade in wildlife that is affecting the conservation of traded species and of biodiversity as a whole, the need for effective wildlife law enforcement is now widely recognized by national governments and inter-governmental organizations, including CITES and the UNODC.

Tackling wildlife crime requires a well-coordinated, multi-faceted approach, with good international cooperation and the use of all the tools and resources available; this includes forensic science applications. One issue routinely faced by enforcement agencies is the definitive identification and characterisation of wildlife specimens in trade, necessary to demonstrate legal or illegal activity. The definitive identification of evidence in criminal investigations can often only be achieved through the application of forensic science. In the case of CITES implementation and enforcement, the investigative questions to address in relation to the identification of animals and plants, or their parts and derivatives, can generally be categorized into five groups, concerning:

- the species involved;
- the geographic origin of a specimen;
- the wild or captive/cultivated source of a specimen;
- the individual origin of a specimen; and
- the age of a specimen.

The purpose of this report is to provide, for the first time, a list of laboratories able to offer quality assured international wildlife forensic analysis services in support of CITES implementation and enforcement.

This document begins by providing a brief introduction to wildlife forensic science (Part 2), followed by the background to this particular review (Part 3). The survey methods used to conduct the current review are summarized in Part 4, with survey results describing laboratory capacity and capabilities are presented in Part 5. Finally, the criteria required for inclusion in the electronic directory are specified and the current laboratories meeting those criteria listed (Part 6).

Part 2. Wildlife Forensic Science

What is forensic science?

Forensic science is an applied discipline concerned with the controlled use of analytical scientific methods to generate evidence in relation to legal proceedings. The forensic scientist addresses the needs of prosecution or defense investigators, by applying appropriate tools to answer questions that arise during the investigation or prosecution of a case.

In this context, it would normally be incorrect to refer to a particular method as being 'forensic'. For example, DNA profiling methods employed to individually identify a sample (person, animal, plant) can be performed within a university undergraduate project, or to provide compelling evidence to support a murder conviction; but only one of these would be considered forensic analysis. The term 'forensic' refers to the purpose of the analytical method and the way in which that method is performed, rather than the method itself.

In its strictest sense the term 'forensic' relates solely to the production of scientific evidence for legal proceedings and the development of tools specifically for that purpose. This sets a very high standard for the methods, data and laboratory procedures employed in any forensic analysis. Each aspect of the analysis must be formally validated to demonstrate fitness-for-purpose and details of the analytical process must be thoroughly documented within an established quality assurance system. All activities involved in the generation of evidence may be subject to legal scrutiny, and in many countries, all personnel involved may be considered as witnesses in the eyes of the law. In this respect, the standard of forensic analysis required to investigate crimes involving wildlife is no different to that applied to crime against humans.

In addition to ensuring that a laboratory can generate forensic evidence using appropriate methods and processes, capacity for wildlife forensic science depends on the broader organizational framework surrounding its use. Any wildlife forensic investigation extends from the point of evidence collection through to the presentation of analytical findings in court. In the simplest scenario this will still involve issues of evidence preservation, secure collection, storage and transport to the lab, followed by appropriate use of the forensic evidence by investigators and the ability of the judiciary (and jury) to accept and understand the evidence as it is presented. Such issues must be considered when seeking to identify suitable facilities for forensic analysis, or the development of capacity in this area.

Wildlife forensic science

The investigation of crime against wildlife may raise questions that can be addressed through a range forensic analytical approaches, from mainstream applications such as human DNA profiling and ballistics, to specialist applications such as species identification. The term *wildlife forensics* is commonly understood to refer to the process of identifying non-human biological evidence relating to wildlife crime.

Quality Assurance

The level of confidence in any laboratory analytical result relates to the degree of quality assurance (QA) surrounding the production of the data. The QA concept is fundamental to the performance of any test where the results are later relied upon by a third party, such as medical diagnostics or forensics. QA is usually delivered through a Quality Management System, which describes a series of control processes and protocols surrounding the implementation of a test. Quality Management Systems cover all aspects of test implementation, from method performance and validation, through staff training, laboratory operating procedures and the systems in place for reporting and reviewing analytical results. While a Quality Management System is designed to be specific to a laboratory process, general standards have been developed, such as [ISO17025](#) or [Good Laboratory Practice \(GLP\)](#) regulations, which describe general QA requirements for laboratory testing and under which individual laboratories may choose to become formally accredited.

Laboratory accreditation to the ISO17025 standard has become a requirement for human forensic laboratories in many countries and is considered the gold standard in wildlife forensic testing. However, accreditation to such a standard is time consuming, expensive and may require a level of staffing and infrastructure that is simply not realistic for wildlife forensic laboratories to achieve, irrespective of the quality of their work. While a number of wildlife forensic laboratories do hold ISO17025 accreditation, an absolute requirement for laboratory accreditation to this level in wildlife forensic science is an unrealistic expectation at this time. To address this issue, the Society for Wildlife Forensic Science (SWFS), has established a set of Standards and Guidelines specifically for several disciplines within wildlife forensics (SWFS Standards and Guidelines 2018). For details on this system, [SWFS can be contacted](#).

The technical nature of laboratory quality assurance standards complicates the task of law enforcement agencies in selecting a suitable laboratory for forensic analysis of wildlife specimens, and can create difficulties in court when assessing the reliability of evidence. This is a matter that has been recognized by the International Consortium on Combatting Wildlife Crime (ICWC)². In response, UNODC, in cooperation with its ICWC partners, have developed guidelines for the analysis of wildlife specimens to inform investigators, scientists and the judiciary on their respective roles and responsibilities, and the standards that should be met by different actors in a wildlife crime investigation³. At the very least, laboratories conducting wildlife forensic testing should have implemented a Quality Management System and casework documentation system, available for review by relevant investigation agencies and the court. Furthermore, this Quality Management System should be subject to internal auditing and external assessment by an independent third party.

Ultimately, it is the decision of the court to determine the relevance, veracity and strength of any evidence presented to it. It is however the responsibility of both agencies responsible for wildlife law enforcement and forensic scientists to ensure that the evidence will withstand legal scrutiny and deliver forensically robust evidence that is relevant to an investigation.

For a more detailed review of the techniques used in forensics science please see, '[A review of wildlife forensic science and laboratory capacity to support the implementation' and enforcement of CITES](#)', commissioned by the CITES Secretariat and undertaken by UNODC.

² <https://cites.org/eng/prog/icwc.php>

³ '[Guidelines on Methods and Procedures for Ivory Sampling and Laboratory Analysis](#)'; 'Guide for Forensic Timber Identification'.

Part 3. Background

In 2016, the CITES Secretariat commissioned a global review of wildlife forensic laboratory capacity, which was undertaken by the UNODC. All CITES Parties were invited to participate and data was collated from 110 institutions in 39 countries. This review provided, for the first time, a comprehensive picture of laboratory capacity at the global level for performing forensic analysis in support of CITES implementation and enforcement.

Given the developing nature of wildlife forensic science and its broad community of scientific stakeholders, the purpose of the review was not to judge the quality or performance of any laboratory or practitioner, but rather to take an inclusive approach and gather information on all on going wildlife forensic activities, including applied research. The review was confidential in nature and was designed to elicit self-declared information on capacity from as many laboratories as possible.

The full report on the review is available as [Annex 4 to document CoP17 Doc. 25 on Enforcement matters](#), prepared for CoP17.

To further build upon this work, the Conference of the Parties at CoP17, adopted Decision 17.83, paragraph c), which directs that the CITES Secretariat to, subject to external funding:

- c) *in consultation with identified laboratories, and in collaboration with ICCWC partner organizations and the ICCWC Wildlife Forensics Advisory Group, compile an electronic directory of laboratories that conduct wildlife forensic testing, that meet the minimum quality assurance standards and that, subject to available resources, are able and willing to carry out wildlife forensic analyses upon request from other countries.*

To implement this Decision, UNODC, at the request of the CITES Secretariat, led work to enable the creation of a publicly available electronic directory of laboratories worldwide that conduct wildlife forensic testing, meet minimum quality assurance standards and, subject to available resources, are able and willing to carry out wildlife forensic analyses upon request from other countries. This work was conducted under the auspices of ICCWC, and implemented in consultation with previously identified laboratories and in close collaboration with the CITES Secretariat and the Society for Wildlife Forensics Science (SWFS).⁴ It built upon the global review of forensic laboratory capacity commissioned by the Secretariat in cooperation with UNODC, available as Annex 4 to document CoP17 Doc. 25.

⁴ See paragraph 25 in document [SC70 Doc. 30.2 on the International Consortium on Combating Wildlife Crime \(ICCWC\)](#)

Part 4. Methods

The information included in the current review was gathered through an online survey. Expanding on the global review of forensic laboratory capacity presented to CITES CoP17, the survey had two aims:

1. To update the original confidential survey of wildlife forensic laboratories by requesting updates from previous responders and new submissions from laboratories that have not previously taken the survey.
2. To establish a publically available database of quality assured wildlife forensic laboratories willing and able to provide analysis services to other countries in support of CITES-related investigations.

To achieve these aims, a series of questions was devised to assess current laboratory capacity to perform wildlife forensic casework. Laboratories were also asked whether they would like to consider offering international forensic casework analysis services, and be included in an online electronic directory of laboratories. Inclusion of laboratories in the directory was subject to meeting defined criteria on quality assurance process. These criteria are described in Part 6 and are available via the [CITES webpage on *Wildlife Forensics*](#) to enable any existing or new laboratory not included in the electronic directory from the outset to determine if it meets the specified criteria before requesting inclusion.

All the laboratories invited to complete the survey were assured that no information provided, would be shared with any third parties without the express prior permission of the responding organisation.

Questions put to the laboratories were designed to cover a range of topics relevant to wildlife forensic science, including: the nature of analysis performed, the methods used, the taxa identified, the investigative questions addressed, the reference materials used, the quality assurance systems in place and the level of staff training. As with the previous survey, the review included specific focus on capacity for the identification of elephant ivory and rhinoceros horn. For the current survey, questions regarding laboratory capacity for methods associated with the identification of pangolin were also included.

The survey was designed to maximise response and completion rates while minimising various quality issues commonly encountered when gathering data using self-reported or self-complete methods. Each respondent's path through the survey was dictated by how they answered each question, so as to reduce the need to answer questions that were not relevant to a particular laboratory's capacity (see Appendix for survey map). The questionnaire was distributed via individual emails that were provided during the previous survey. The emails explained the purpose of the survey and use of the data whilst also providing a unique respondent link.

Almost 130 individualized invitations were sent out via email. These were targeted towards organisations that had provided contact details in responses to the previous survey. A timeframe of approximately six weeks was provided to participants to complete the questionnaire.

Upon receipt, the questionnaire responses were entered into Microsoft Excel to enable data cleaning, recoding and analysis. Data recoding consisted of using logic functions in Excel to combine answer options and allow filtering.

Part 5. Survey Results

Summary of response level

A total of 75 responses were received from 128 invitations to participate (58% response rate). This is a 32% reduction compared to the response rate of the previous survey, however, this survey was only open by invitation and was largely restricted to laboratories believed to have some forensics capacity, primarily identified from the earlier survey.

Of the 75 responses, 53 (70.7%) conduct both research and forensic casework, 10 (13.3%) only conduct forensics casework, and 12 (16.0%) only do non-casework research, resulting in 63 (84.0%) laboratories stating they conduct some type of forensic casework (figure 1). Of the 12 responses solely performing research work, nine (75%) are striving to be in a position to provide forensic casework. One laboratory stated that it conducts no wildlife related forensics or lab work and, as a result, was removed from the analysis.

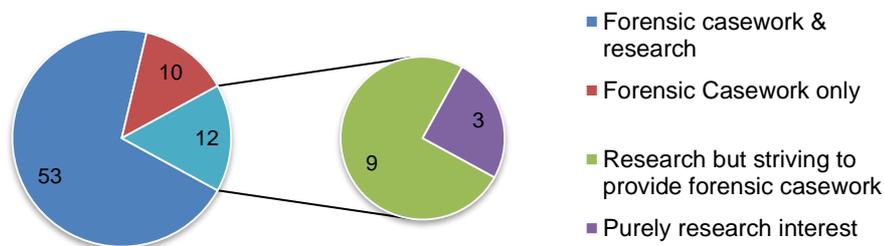


Figure 1. Type of work conducted by laboratories responding to the survey.

The 74 remaining responses included laboratories from 30 different countries, distributed across all CITES regions (Figure 2). This is a reduction of nine countries compared with the previous survey. Every region had responses from at least two laboratories, with Europe having the most responses from laboratories conducting forensic casework (Figure 3).

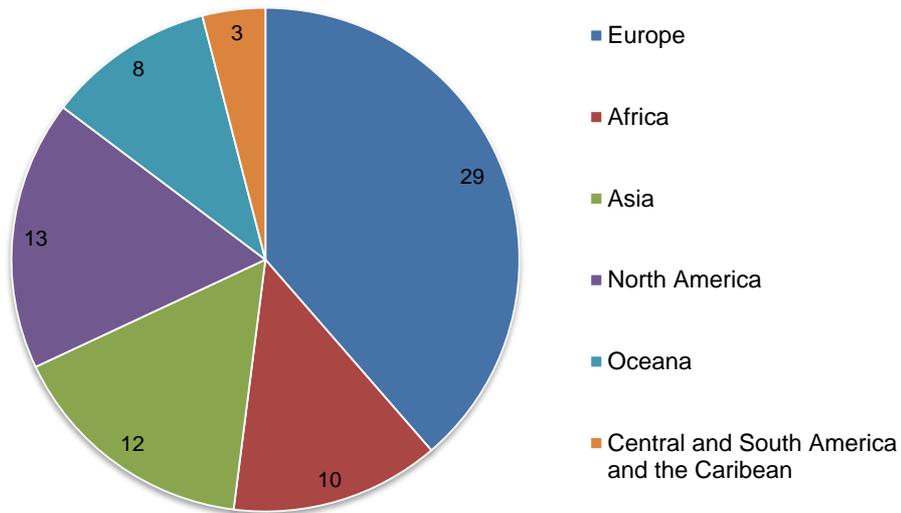


Figure 2. Distribution of survey responses by CITES region.

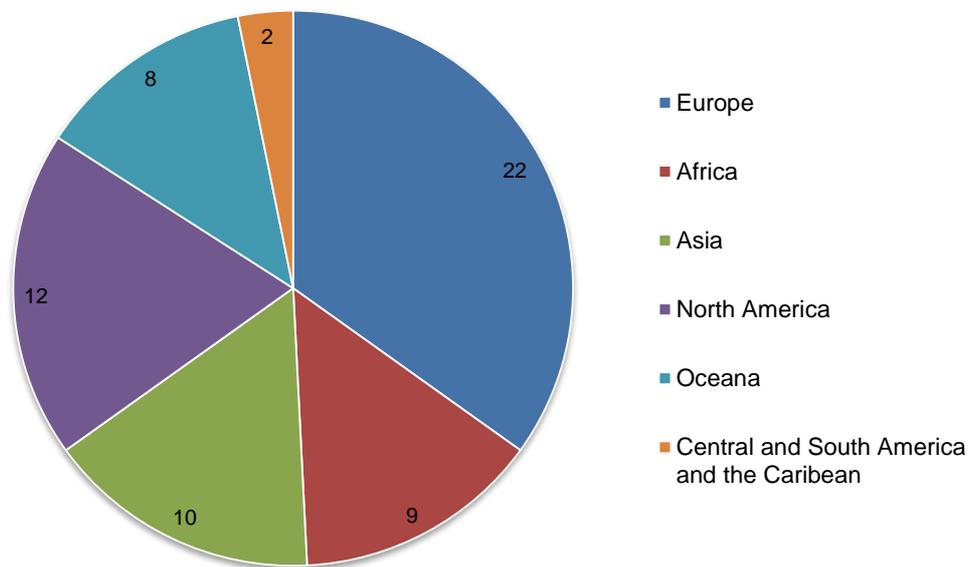


Figure 3. Distribution across CITES regions of laboratories stating they perform forensic casework.

Analytical techniques used across taxa

The most common taxonomic group analyzed is terrestrial animals and the majority of this work is performed using DNA analysis (figure 4). This is similar to what was reported in the previous survey. DNA analysis is the most commonly used technique for all samples types except for timber, for which morphology/anatomy is most commonly used. In all other cases morphology/anatomy is the second most commonly used technique. This pattern was similar to that found previously, although the number of laboratories conducting DNA work on plants has outstripped the number conducting morphology/anatomy. Chemical profiling is also quite commonly used for plant and timber work.

The relative lack of chemical profiling and stable isotope work across the board is likely to reflect both the level of forensic method development for these techniques, for which fewer validation studies have been conducted, and the limited availability of equipment in forensic laboratories, as opposed to research labs. Less than three laboratories (8%) for each sample type performed other techniques.

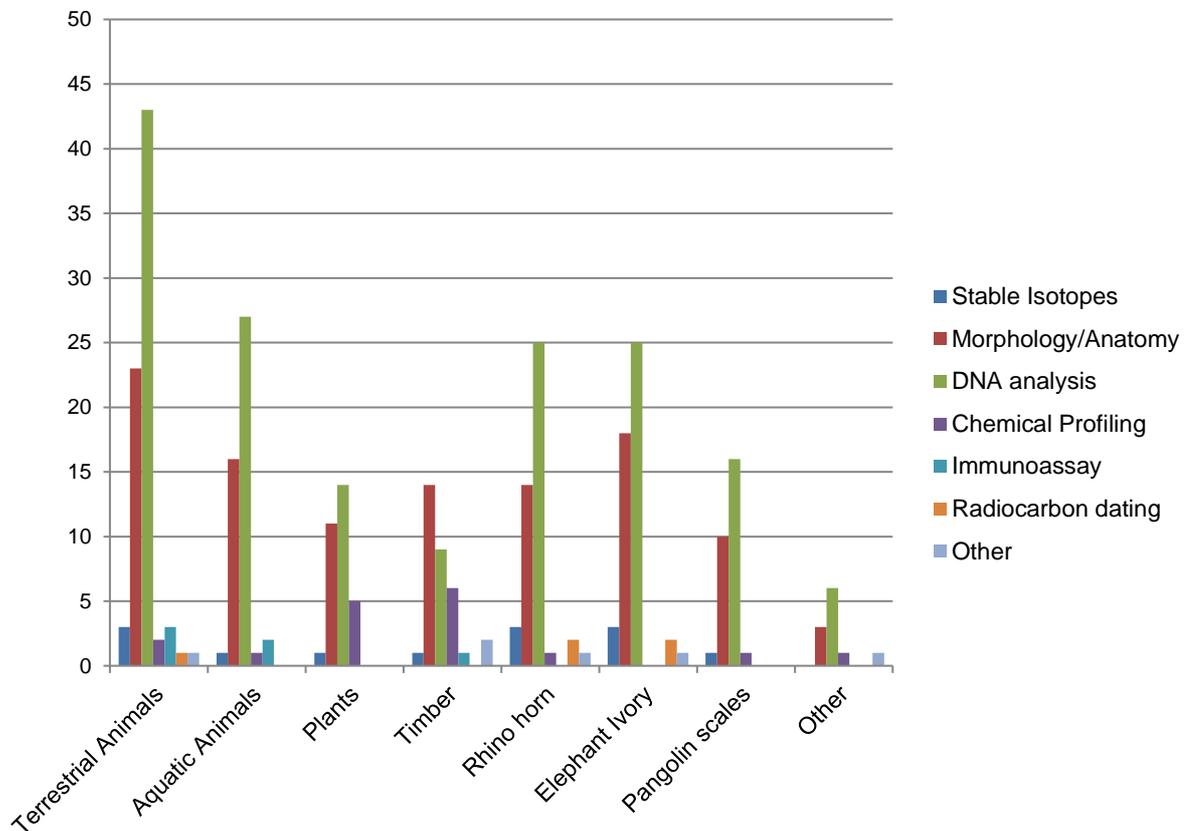


Figure 4. Sample types used and methodologies performed across all laboratories stating they conduct forensic casework.

Investigative questions

Species identification is by far the most widely available service with almost all the forensics labs, 59 of 63 (94%), able to address this issue to some extent (Figure 5). The figure for individual identification was much lower, with only 37 of the 63 (59%) forensic casework labs offering this service and even then, for only a limited number of species. Less than half of all the forensics labs that responded to the survey are able to perform sex determination or geographic origin work (29 and 28 respectively). Of the investigative questions addressed, ageing is the least widely covered, with services only provided by seven (11%) labs.

These results reflect the investigative drivers (species ID is the most commonly asked question), the body of background reference data (greater for animals than plants), the technical complexity of the test and the fact that species identification methods are typically generic and applicable across multiple taxa. This last point is in contrast to parentage, individual and geographic origin identification methods that are typically species specific, requiring much greater laboratory investment to develop and maintain.

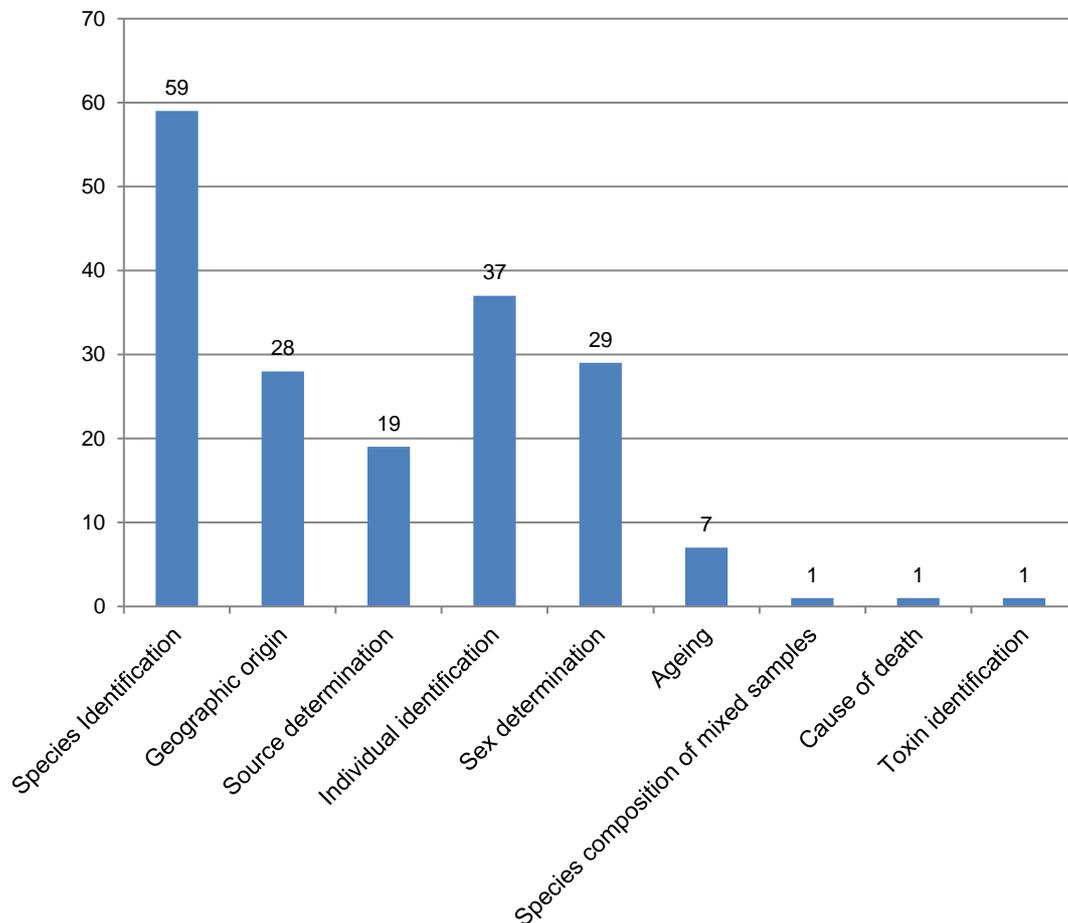


Figure 5. Number of laboratories able to address different types of investigative question.

Quality Assurance (QA)

Two thirds of the laboratories (41 labs, 66%) conducting wildlife forensic analysis stated that they conform to some form of QA standard (Figure 6). This was much higher than the previous survey, which identified just 44% conforming to a QA standard. This improved result is likely due to the targeted nature of this survey. Of the 41 labs that implement to some form of QA system, 95% (39 labs) conduct auditing, 63% (26 labs) of which submit themselves to external auditing, with the remainder (32%, 13 labs) having only their own internal audit system. Three labs provided conflicting answers stating that whilst conforming, they do not follow any particular standard.

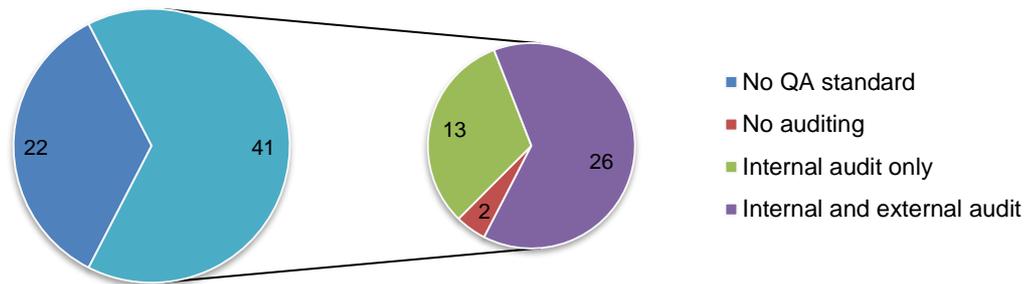


Figure 6. Quality Assurance (QA) standards followed across all labs stating they conduct forensic analysis.

Of all the labs stating they undergo both internal and external auditing, 35 (85%) identified the use of one of the standards listed as an option in the survey (ISO17025, GLP/GMP, ISO9001, SWFS) (Figure 7). By far the most common QA standard adhered to is ISO 17025 (24 labs, 69%), considered to be the gold standard for forensic science, followed by SWFS (15 labs, 43%). A number of labs stated they followed standards of guidelines not listed. These were: International Society for Forensic Genetics (ISFG) recommendations, forensic regulations issued from national governing bodies, standards issued by national universities and ANAB forensic science (American National Accreditation Board).

It should be noted that standards are not mutually exclusive, so for example, a single lab may be accredited under ISO9001 (quality management), ISO17025 (analytical testing) and adhere to SWFS standards. For the purposes of inclusion within the electronic directory, passing an external audit under any recognized standard will be acceptable.

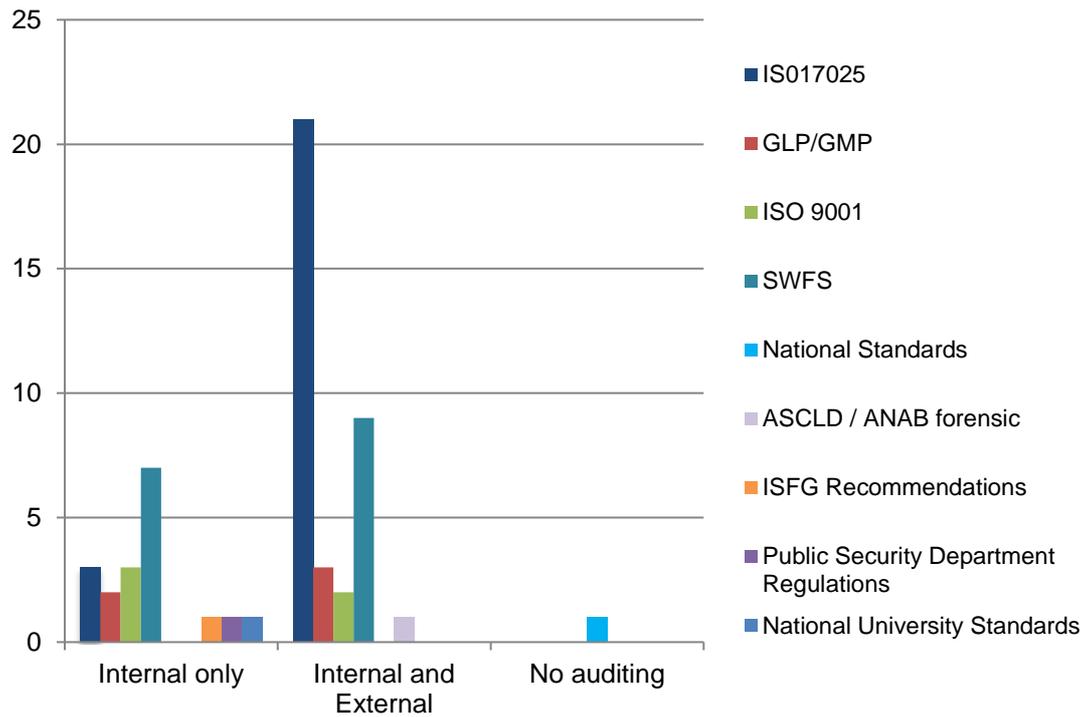


Figure 7. Quality Assurance standards and types of audit used by laboratories.

Geographically, 75% of European (9 labs) and North American labs (6 labs) reported both internal and external auditing, with Africa only slightly less at 71% (5 labs) (figure 8). Asia and Oceania reported 60% (3 labs) and 50% (3 labs) with external audit respectively, while no externally audited labs based in Central and South America and the Caribbean responded to the survey.

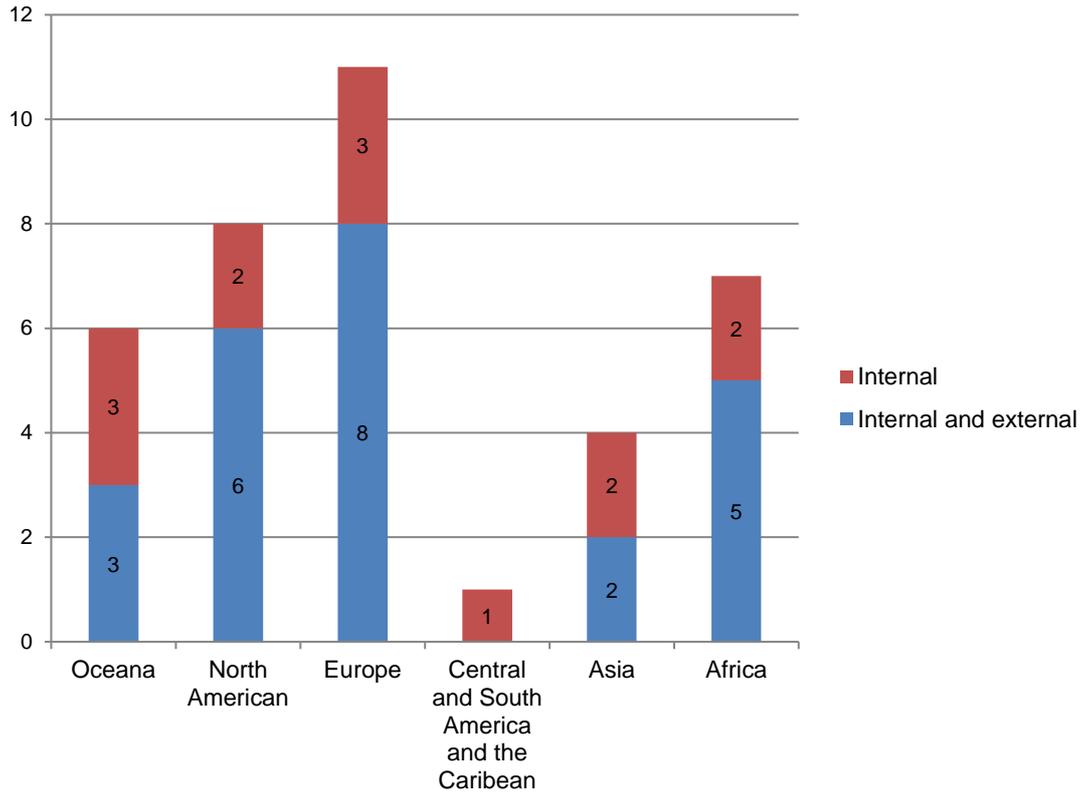


Figure 8. Geographic distribution by CITES region of laboratories undergoing internal and/or external auditing

Of all the labs offering forensic services, 43 (68%) intend to improve their QA over the next three years (Figure 9). Of the 63 labs stating they are able to conduct forensic analysis 32 labs (51%) stated that they have conducted forensic work on behalf of another country. Of these, just over half (56%, 18 labs) undergo both internal and external auditing, 19% (6 labs) perform just internal auditing, and 25% (8 labs) have no QA and/or no auditing (Figure 10).

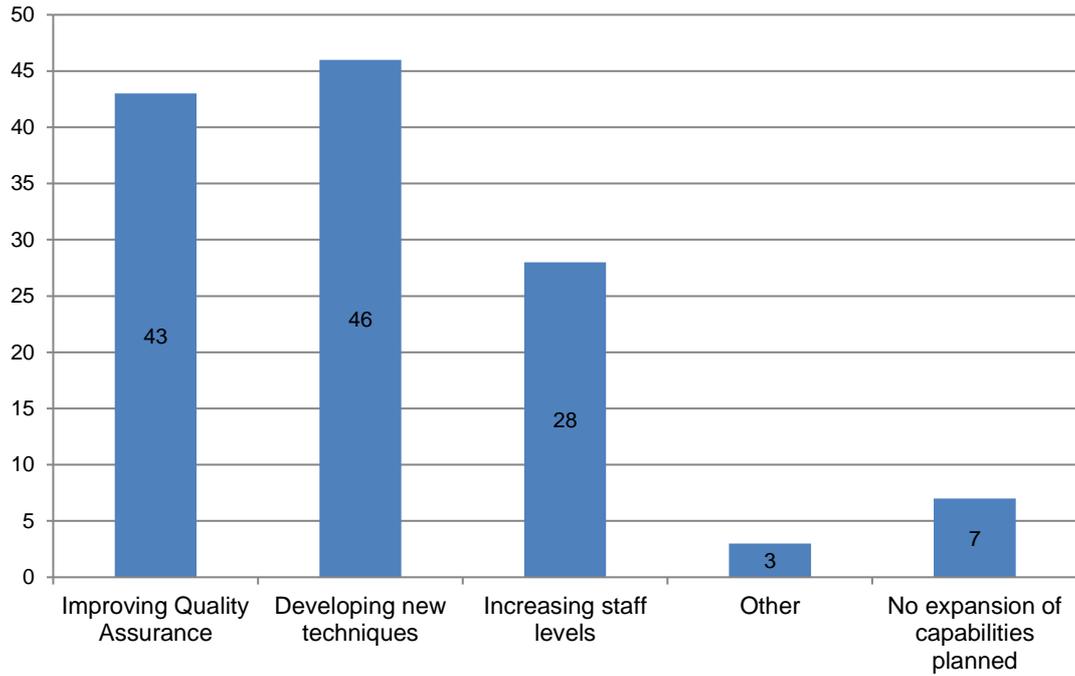


Figure 9. Intended capacity development across all laboratories over the next 3 years

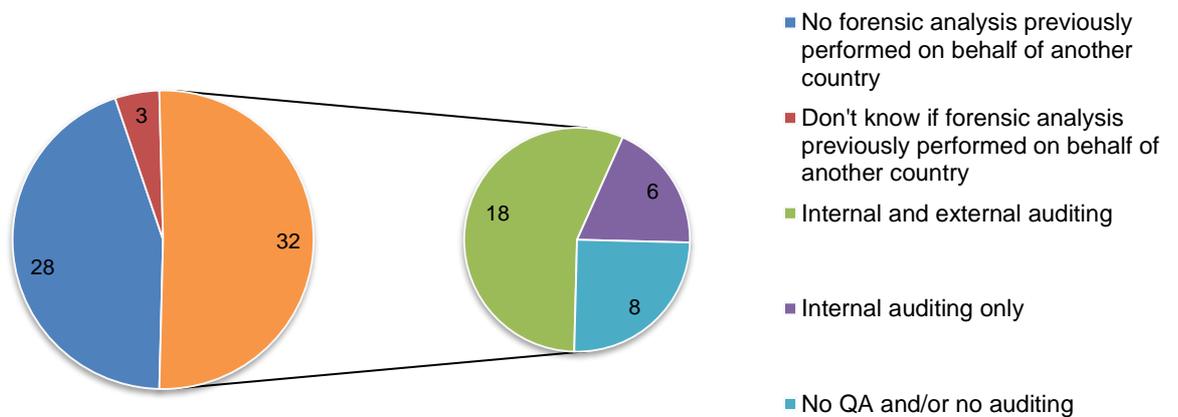


Figure 10. Levels of auditing of laboratories stating they had provided forensic services in the past

Wildlife forensic capacity for priority taxonomic groups

Elephant ivory

On the specific issue of elephant ivory identification, a total of 32 laboratories (51%) stated that they undertook forensic analysis of ivory samples. Some labs use multiple techniques, however across the labs, 25 perform DNA analysis, 16 use a morphological approach, 3 use stable isotopes, 2 use radiocarbon dating and 1 uses electron microscopy.

In total, 27 of the 32 labs (84%) operate under externally audited quality assurance schemes.

Rhinoceros horn

A total of 32 labs (51%) stated that they undertook forensic analysis of rhinoceros horn samples, the same number of laboratories as for elephant ivory. There was a slight reduction in the number able to conduct a morphological approach (n=12), compared to ivory, however, the numbers for all other techniques undertaken on rhinoceros horn mirrored that of ivory.

In total, 27 of the 32 labs (84%) operate under externally audited quality assurance schemes.

Pangolin

Only 20 laboratories reported conducting forensic analysis on pangolin. Of these, 16 use DNA analysis, seven use a morphological approach, one uses stable isotopes and one uses electron microscopy.

In total, 16 of the 20 labs (80%) operate under externally audited quality assurance schemes.

Summary

The analytical capacities for ivory and rhinoceros horn are very similar with 27 labs reportedly operating forensic testing under external audited quality systems for these species groups. This is a significant increase from the previous 2015 survey, which identified just six labs meeting these criteria, indicating a significant effort to improve capacity in this area. Pangolin was added as an additional question, due to the increased global scale of the illegal market for pangolin specimens. Fewer labs undertook forensic work on pangolin, however this may simply reflect the relatively recent emergence of this species group as a significant issue within the illegal trade in wildlife.

Part 6. Establishing an electronic directory of laboratories

Criteria and process for the inclusion in the electronic directory

Criteria

As mentioned earlier in this document, laboratories wishing to be listed in the CITES electronic directory need to meet a set of criteria which include their ability to conduct quality-assured forensic analysis.

These criteria are as follows:

1. **The laboratory must carry out forensic casework;**
2. **The laboratory must operate in accordance with a Quality Management System;**
3. **The laboratory must have passed an external audit of its Quality Management System, conducted by a competent third party, within the past two years;**
4. **The laboratory must be able and willing to carry out wildlife forensic analyses upon request from other countries;**
5. **The laboratory must explicitly request to be included in the directory.**

To be considered for inclusion in the directory, laboratory questionnaire responses needed to indicate conformance to these criteria. These criteria are available on the [CITES webpage on Wildlife Forensics](#) to enable any existing or new laboratory not included in the electronic directory to determine if it meets the specified criteria, before requesting inclusion.

It should be stressed that these criteria have been formulated specifically to allow CITES to confidently recommend a laboratory as an international wildlife forensic service provider. The results of the survey should not be taken to imply that laboratories which do not meet the criteria are not conducting good quality forensic casework. Nor should it be concluded that they should not be providing services at a national, or regional level. However, in the absence of documentary evidence that a laboratory is following a quality management system designed for forensic casework, it is not possible for CITES to formally recommend the use of such laboratory services.

Verification

Before listing, documentary evidence that the above criteria are met was requested from each laboratory. The information provided was evaluated by a UNODC wildlife forensic expert and by an independent panel of experts drawn from the Technical Working Group of the Society for Wildlife Forensic Science. Laboratories that were found to have successfully demonstrated conformity with the criteria were recommended for inclusion in the electronic directory and informed accordingly.

In the event that a request for inclusion in the electronic directory was not approved, feedback was provided to the laboratory explaining why it could not be included at this stage and what needs to be addressed in order to qualify for inclusion in future.

Every laboratory included in the directory will be required to undergo re-verification every two years to ensure that they still meet the criteria.

Results of the present survey for inclusion in the electronic directory

Based on the answers provided by the respondents, 23 laboratories met the first three criteria. Of these only 17 were willing, should they have met all criteria, to be listed in the directory (Figure 11 – green shading).

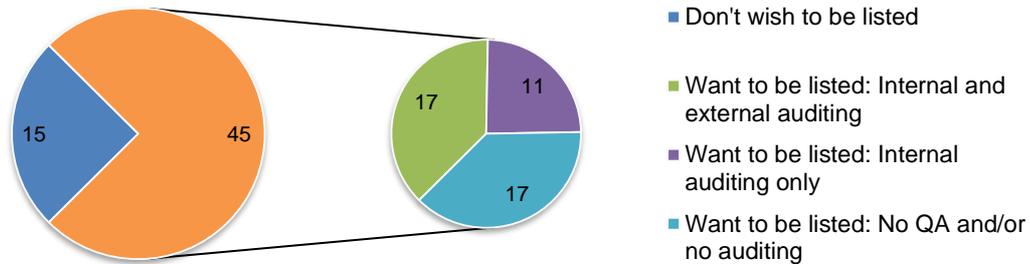


Figure 11. Audit status of laboratories that indicated a desire to be listed in an electronic directory.

Of those not meeting the first three criteria but wishing to offer international services, eleven laboratories conformed to the first two criteria, but did not have external auditing (Figure 11 – purple shading). Of the remaining seventeen, four were laboratories which claimed to conform to some form of QA, but did not declare what standard they adhered to, or did not adhere to a recognised QA standard, with the remaining thirteen reporting that no quality management system is in place. Feedback will be provided to each of the laboratories not meeting the required criteria and the opportunity to reapply for inclusion, once they do meet the criteria, will be emphasized.

It should also be noted that an additional nine laboratories, which currently only perform research work, responded that they are striving to provide wildlife forensic services in the future.

Based on the survey results, six laboratories in Europe, four laboratories in Africa, three laboratories in North America, two in Oceania, and two laboratories in Asia declared themselves able and willing to be listed in the electronic directory (Figure 12). Only the CITES region of Central and South America and the Caribbean has no laboratories claiming eligibility to be listed. One laboratory in Africa, two in Europe and three in North America are eligible for listing in the directory but do not wish to be included.

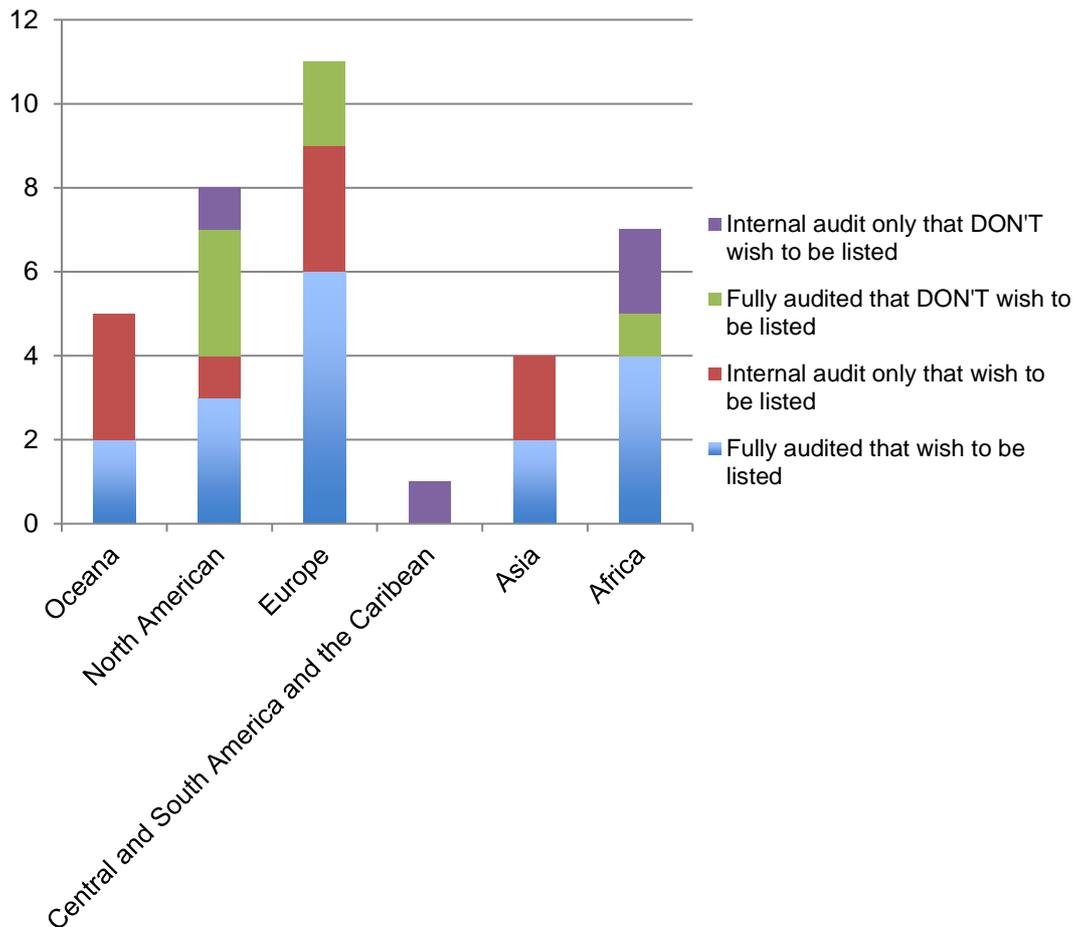


Figure 12. Distribution of laboratories indicating a desire to be listed in an electronic directory of laboratories willing and able to provide forensic services to other countries upon request

Results of independent assessment for directory listing

The 17 laboratories that were willing to offer international wildlife forensic services and that claimed to conform to the five eligibility criteria for listing on the CITES directory were invited to submit evidence of conformance for evaluation by a UNODC wildlife forensic expert and by an independent panel of scientists drawn from the Technical Working Group of the Society for Wildlife Forensic Science. Nine laboratories opted to submit evidence for consideration and all nine of these were found to fulfill all criteria and have therefore been approved for listing. Details of these nine laboratories are provide below.

Directory of laboratories eligible and willing to be included in an electronic directory of wildlife forensic providers

The below table lists all of the laboratories fulfilling all criteria necessary to be listed in an electronic directory of forensic providers able and willing to carry out wildlife forensic analyses upon request from other countries. Each of these laboratories (i) carry out forensic casework; (ii) operate in accordance with a QMS; (iii) are audited internally and externally by a competent third party (and have provided confirmatory evidence of this); (iv) are able and willing to carry out wildlife forensic analyses upon request from other countries; (v) have explicitly requested to be included in the directory.

| Laboratory name | Country, CITES region | QA standard | Sample types analysed | Contact name / email |
|--|---|-------------|---|---|
| Australian Centre for Wildlife Genomics, Sydney | Australia, Oceania | ISO17025 | Terrestrial animal, Aquatic animal, Rhinoceros horn, Elephant ivory | Greta Frankham Greta.Frankham@austmus.gov.au |
| Criminalistic Service, Guardia Civil | Spain, Europe | ISO17025 | Terrestrial animal, Aquatic animal, Plant, Microorganisms | David Parra Pecharromán crimquimica@guardiacivil.org |
| Genomia s.r.o. | Czech Republic, Europe | ISO17025 | Terrestrial animal | Markéta Dajbychová marketa.dajbychova@genomia.cz |
| Institute of Forensic Medicine, Zurich | Switzerland, Europe | ISO17025 | Terrestrial animal, Aquatic animal, Elephant ivory | Morf Nadja Nadja.Morf@irm.uzh.ch |
| James Hutton Institute | United Kingdom, Europe | ISO 9001 | Plant, Diatoms, Soil | Lorna Dawson Lorna.Dawson@hutton.ac.uk |
| Netherlands Forensic Institute (NFI) | The Netherlands, Europe | ISO17025 | Terrestrial & Aquatic animal, Plant, Timber, Rhino horn, Elephant ivory, Pangolin | Irene Kuiper i.kuiper@nfi.minvenj.nl |
| Science and Advice for Scottish Agriculture (SASA) | United Kingdom, Europe | ISO17025 | Terrestrial animal, Aquatic animal, Rhinoceros horn, Elephant ivory | Lucy Webster Lucy.Webster@sasa.gsi.gov.uk |
| US Fish and Wildlife Service, National Forensic Laboratory | United States of America, North America | ISO17025 | Terrestrial animal, Aquatic animal, Timber, Rhino horn, Elephant ivory, Pangolin | Ed Espinoza ed_espinoza@fws.gov |
| University of California, Davis | United States of America, North America | ISO17025 | Terrestrial animal, Rhinoceros horn | Christina D Lindquist cdlindquist@ucdavis.edu |

7. Discussion and Conclusions

Number of active wildlife forensic laboratories

The primary goal of this work was to identify laboratories around the world that are able to provide wildlife forensics services upon request and that are willing to be listed in an electronic directory. In addition, the survey results have enabled the 2016 confidential records of laboratory capacity around the world to be updated and expanded.

Invitation to participate in the present survey was based on the responses received during the 2016 survey, in which all CITES Parties were invited to take part. While many of the laboratories asked to complete the present survey did not respond (58% response rate), it is considered likely that no response indicates a lack of interest in being listed in the electronic directory. It is expected that, upon publication of the directory, a number of additional laboratories might request inclusion if they did not reply to the survey or did not receive an invitation.

The questionnaire was designed to distinguish labs undertaking forensic casework from those conducting research to support the development of new techniques applicable to forensic analysis. However, as with the previous survey it was clear from a number of the responses that this distinction is not necessarily understood by some of the laboratories. This may be due to the language used in the survey, or because some research labs do not fully appreciate the distinction between research and forensic practice. The latter explanation remains a concern within the wildlife forensic community (see subsequent sections) and is an area that will be informed by the detailed results of this survey.

Regardless of the total number of responses, an estimate of the number of active wildlife forensic laboratories should take into account whether or not the lab operates a Quality Management System, which is fundamental to forensic practice. Of the 63 labs stating that they conduct forensic work, only 66% stated they conformed to a quality assurance standard and of these only 63% also state they undergo internal and external auditing. This would indicate that the maximum number of forensic casework labs that may be operating to a minimum level of quality and are subject to an external audit of their testing procedures is 23. Of these 23 laboratories, 17 indicated a desire to be listed in an electronic directory of wildlife forensic service providers. However, when evidence of external auditing of their QA standards was requested, only nine of the 17 laboratories provided suitable evidence. These remaining nine laboratories are consequently listed in the final directory.

This analysis shows that a relatively small number of labs are available that meet the criteria for inclusion in the directory. However, it should be noted that standardization and implementation of formal QA procedures in wildlife forensic science is in its relative infancy and many laboratories are in the process of addressing this issue, as indicated by 'future plans' provided by respondents. It is anticipated that the number of labs meeting the required criteria to be listed will grow steadily over the next five years.

Future listing of laboratories not included in the current directory

A number of laboratories stated a desire to be listed in the directory but could not be listed at this time. Furthermore, there are likely to be a number of labs that did not respond to the survey or were inadvertently omitted from the initial survey distribution. In both cases, it is important that the opportunity for future listing is made available and that steps to achieve listing are made clear.

Based on this survey, the primary reasons for not achieving listing are either that labs do not follow a recognized Quality Assurance standard or that they are not able to demonstrate a successful independent external audit of their laboratory's Quality Management System. Laboratories falling into these categories, who wish to be listed, are advised to first develop and follow an appropriate quality management system, based on recognised standards, and second, to undertake formal accreditation or, as a minimum, to pass an independent laboratory assessment. For advice on how to address these issues, laboratories are recommended to contact the Society for Wildlife Forensic Science ([SWFS](#)).

Laboratories that meet these criteria in future and wish to be considered for listing should contact the CITES Secretariat in the first instance (cites.info-cites@un.org). Laboratories will be asked to provide appropriate documentary evidence for review.

It is recognized that the criteria relating to quality assurance represent a significant bar to inclusion in the directory for many laboratories. Laboratories whose primary focus is research may view the steps required for laboratory listing to be too onerous, or to require too much financial investment, to be worth taking. Consequently, specialist analytical services offered by laboratories that are not listed in the CITES directory, may be more difficult to access. As stated above (Section 6), lack of inclusion in the directory should not be interpreted as a lack of ability to conduct forensic casework. However, from the perspective of the mainstream forensic science community, these criteria represent a recognized minimum set of quality requirements that should be in place in order to demonstrate to a courtroom that forensic evidence has been produced in a robust and reliable manner.

Appendix – Survey map

Flow diagram of the survey questionnaire highlighting the individual steps followed by participants based on their responses.

