## Cathie Allen

**From:** Cathie Allen
**Sent:** Tuesday, 11 February 2020 11:55 AM
**To:** Krosch.MattN[OSC]
**Cc:** Keatinge.DavidJ[OSC]; John Doherty; Allison Lloyd
**Subject:** RE: DNA success rates manuscript

Hi Matt

Thanks for your time on Friday to discuss the manuscript.

I've discussed with the Team Leaders from Forensic DNA Analysis regarding an appropriate FSS staff member, and Allison Lloyd is very happy to assist with this. Allison is currently acting in the role of Senior Scientist for the Intelligence team, so is suitably placed to assist with DNA success rates, given NCIDD is within her portfolio. I've included Allison on this email, but will email her the manuscript on a separate email.

We look forward to working with you on this and other projects in the future.

Cheers
Cathie

**Cathie Allen**
Managing Scientist

**Police Services Stream, Forensic & Scientific Services**
Health Support Queensland, Queensland Health

**p** 07 [redacted] **m** [redacted]
**a** 39 Kessels Road, Coopers Plains, QLD 4108
**e** [redacted]@health.qld.gov.au **w** www.health.qld.gov.au/healthsupport

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**From:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Sent:** Wednesday, 5 February 2020 3:13 PM
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** Re: DNA success rates manuscript

Hi Cathie,
I should be at my desk all tomorrow and Friday, when will be a good time to speak with you about this paper?

Matt

**From:** Krosch.MattN[OSC]
**Sent:** Friday, 31 January 2020 3:05:36 PM
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Cathie,

Sorry, I must not have been in reception in the depths of the building. My apologies. Wednesday it is. Enjoy your weekend.

Matt

**Dr. Matt Krosch**
Research Officer
Quality Management Section, Forensic Services Group
Queensland Police Service
Ph: (07) [redacted] | M: [redacted] | Email: [redacted]@police.qld.gov.au

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**From:** Cathie Allen [redacted]@health.qld.gov.au>
**Sent:** Friday, 31 January 2020 14:59
**To:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Matt

I tried your mobile, as suggested, but it went straight to message bank.

I'll give you a call on Wednesday sometime to discuss the manuscript.

Cheers
Cathie

[redacted]

**Cathie Allen**
Managing Scientist
**Police Services Stream, Forensic & Scientific Services**
Health Support Queensland, Queensland Health
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[redacted]

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**From:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Sent:** Friday, 31 January 2020 2:42 PM
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Cathie,

Sorry I missed your call earlier, I had to return to the lab to finish off the morning's experiments. I'm about to head off for the day, but back at the desk on Wednesday. Let's try to arrange a time to speak then.

Matt

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**From:** Cathie Allen [redacted]@health.qld.gov.au>
**Sent:** Thursday, 30 January 2020 14:37
**To:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Matt

Sorry for not getting back to you, I've had a few other priorities and some [redacted] leave.

I'll give you tomorrow at some stage, if that's ok?

Cheers
Cathie

[redacted]

**Cathie Allen**
Managing Scientist
**Police Services Stream, Forensic & Scientific Services**
Health Support Queensland, Queensland Health
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**a** 39 Kessels Road, Coopers Plains, QLD 4108
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[redacted]

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**From:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Sent:** Wednesday, 29 January 2020 9:36 AM
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Cathie,

We are keen to progress with submission of this manuscript. Can you please let me know if you would still like to meet to discuss the paper or chat over the phone. I'm available all this week and Wednesday-Friday next week.

Regards,



Matt

**Dr. Matt Krosch**

Research Officer
Quality Management Section, Forensic Services Group
Queensland Police Service
Ph: (07) [redacted] | M: [redacted] | Email: [redacted]@police.qld.gov.au

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**From:** Krosch.MattN[OSC]
**Sent:** Monday, 13 January 2020 09:59
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Cathie,

Certainly happy to meet with you to discuss the paper. I'm free all week, but Insp Keatinge has limited time this week so if he was to join us for a face-to-face then meeting here would be preferable. Anytime this week works for me at this stage.

Alternatively, I'm happy to discuss over the phone if that helps to save travel time?

Cheers
Matt

**Dr. Matt Krosch**
Research Officer
Quality Management Section, Forensic Services Group
Queensland Police Service
Ph: (07) [redacted] M: [redacted] Email: [redacted]@police.qld.gov.au

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**From:** Cathie Allen [redacted]@health.qld.gov.au>
**Sent:** Monday, 13 January 2020 09:16
**To:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>; John Doherty [redacted]@health.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Matt

Thanks for the email and the opportunity to review the manuscript.

It would be great if we could meet to discuss the paper and the data used within it. I'm happy to host you at FSS or alternatively, I'm happy to meet with you at QPS HQ. Please let me know your preference and availability.

Cheers
Cathie

[redacted]

**Cathie Allen**
Managing Scientist
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**a** 39 Kessels Road, Coopers Plains, QLD 4108
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[redacted]

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**From:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Sent:** Tuesday, 7 January 2020 1:02 PM
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>
**Subject:** DNA success rates manuscript

Dear Cathie,

Over the latter months of last year I spent some time summarising FR data for DNA results with a view to establish percentage successes for common items/substrates and collection methods. This was essentially a self-driven project that grew out of conversations with SOCOs and OICs and so the focus was on our side of the process to ensure we're making the best decisions on sampling to maximise success in the lab. In a nutshell it involved pulling information on the DNA results for every exhibit that was submitted over a set time period and searching the item description/location fields for keywords that allowed extraction of specific items/substrate results. The aim was to develop an evidence base on the success rates of sampling certain items to inform procedures and make recommendations to our officers on which collection methods were most effective for specific items based on recent data from actual casework.

I've now completed the analysis and have written the results up as a short paper that I hope to submit to AJFS as I believe this information is important to communicate to the forensic community. However, because the paper necessarily contains information about DNA profiling in Queensland we wish to offer you the opportunity to review the draft manuscript before submission to ensure that you and QHFSS are happy for the contents to be published. Please find attached the draft manuscript as a word document and the tables both at the end of the manuscript and as a separate excel file on individual sheets.

If you would like any further explanation on the methods or outcomes, please don't hesitate to get in touch.

Kind regards,

Matt

**Dr. Matt Krosch**
Research Officer
Quality Management Section, Forensic Services Group
Queensland Police Service
Ph: (07) [redacted] | M: [redacted] | Email: [redacted]@police.qld.gov.au

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# Variation in forensic DNA profiling success rate among sampled items and collection methods: a Queensland perspective.

Matt N. Krosch[a*]

[a]*Quality Management Section, Forensic Services Group, Queensland Police Service, 200 Roma Street, Brisbane, QLD 4000*

Corresponding author: Krosch.MatthewN@police.qld.gov.au, Ph +61 7 33644688, ORCID 0000-0003-0354-8189

**Variation in forensic DNA profiling success rate among sampled items and collection methods: a Queensland perspective.**

Understanding the relative success rates of recovering DNA profiles from different touched evidentiary items/substrates and between different methods of collection is critical for optimal targeting of forensic sample collection and triaging for analysis. Further, reporting of such success rates allows comparison between jurisdictions that can drive improvements and prompt discussion between stakeholders. This study analysed success rates of DNA sampling from major and volume crimes attended by the Queensland Police Service, Australia, from January 2017 to September 2019. In total, 61 344 total records were analysed, representing the most comprehensive analysis of its kind to date. Success rates were determined for various sample types and items, including those that are commonly encountered or have high probative value. Results suggested that, overall, around 10% of trace DNA samples returned full profiles, but with some disparity between swabs (13.45%) and tapelifts (7.01%). Despite this, tapelifts provided nearly 25% of total suspect identifications compared with 17% for trace swabs. Substantial variation in profiling success among items/substrates was observed, as there was between swabs and tapelifts taken from the same item. These data contribute significantly to our understanding of DNA prevalence and recovery and provide a critical evidence base to inform changes to operational procedures.

**Keywords:** swabs, tapelifts, full profile, mixed profile, suspect identification

## Introduction

DNA sampling, particularly of touched objects and surfaces, has become an increasing focus for forensic analysts globally[1,2]. Resolution of DNA profiles from such items can be highly probative and thus understanding the relative success rates of recovering profiles from items is important for targeting sample collection and triaging for analysis. Such success rates should be considered in the context of the specific collection and analysis methods used by a given jurisdiction. Comparing data generated from different extraction and profiling methods may not necessarily represent a like-for-like comparison and must be considered with some caution. Nevertheless, there can be great value in comparing between jurisdictions to determine whether substantial differences are apparent and where improvements could be made. Moreover, sampling of putatively touched items can be a point of friction between investigators and forensic scientists who may have contrasting anecdotal experience concerning a questioned item. Finally, where jurisdictions use multiple collection methods for similar items (because of officer preference or simply what consumables are available at the time), it is important to assess whether one method outperforms another to ensure operational procedures follow best practice. Therefore, there is a need for additional data to inform decision-making and assist forensic scientists in optimally targeting sampling effort.

There have been sporadic attempts over the last twelve years to address this issue in a range of national and state jurisdictions from New Zealand[3], Switzerland[4], Canada[5], Netherlands[6], Singapore[7], and Australia[8], including a comparative analysis of experimental and casework samples from Western Switzerland[9]. These studies analysed success rates for various types of casework samples; either those most commonly collected, restricted to volume crime cases, or other items of interest. Generally speaking, these studies were consistent in suggesting that, as expected, biological fluid traces (blood, saliva, semen) provided the greatest proportions of full profiles (up to 87.5%[9]), whereas touch samples were far less successful overall (<30%). Worn or touched items that often returned above average proportions of full profiles include hats/caps, gloves, adhesive tape, clothing, door handles and steering wheels[3-9], though in some cases these may represent victim profiles.

This study aimed to analyse success rates of DNA sampling from major and volume crime for the Queensland Police Service, Queensland, Australia over a period of roughly 20 months. Success rates were determined for sample types over the entire period, as well as broken down to selected items of interest, including those that are commonly encountered or have high probative value. Queensland data are then discussed in the context of previous literature.

**Methods**

Samples included in this analysis were collected from exhibits related to both major and volume crime between the 1st January 2017 and 11th September 2019. Methods of collection included swabbing with a rayon swab (Medical Wire, UK) pre-moistened with 70% ethanol, tapelifting with a custom 3M adhesive tape kit (Lovell Surgical Supplies, Australia), excision (e.g., fabric, cigarette butts), and scraping. All samples were processed at Queensland Health Forensic Scientific Services (QHFSS) following standard procedures: DNA extraction conducted using the DNA IQ™ Casework Pro Kit for Maxwell®16 (Promega Corp., Melbourne, Australia) on a Maxwell® 16 MDx (Promega Corp.); quantification using Quantifiler® Trio (ThermoFisher Scientific, Melbourne, Australia) on the 7500 Real Time PCR System (Applied Biosystems™, ThermoFisher Scientific), and STR amplification using PowerPlex® 21 (Promega Corp.). DNA quantification results determined progression to profiling, according to QHFSS standard procedures: samples of concentration <0.0088ng/µL were considered to have insufficient DNA and were thus categorised as 'no DNA'. Samples that yielded sufficient DNA (>0.0088ng/µL) proceeded to STR profiling.

Data was extracted from the in-house laboratory information management system (LIMS) for all DNA samples sent for processing between the 1st January 2017 and 11th September 2019. The LIMS was queried in such a way to return sample type (e.g., swab/tapelift) and exhibit description information, as well as STR profiling results categorised as 'full' (all 42 alleles present), 'partial/mixed' (less than 42 alleles, or more than one contributor), or 'no DNA' (DNA quantification insufficient for profiling). In some cases, profiling results could include multiple categories; for example, full+partial/mixed profile results may indicate full profiles deconvoluted from mixtures, or no DNA+full or

partial/mixed where sub-threshold information (<150rfu) was present, or where the original quantification was insufficient, but the sample was profiled following investigator request. Profiles were also recorded for whether they matched a suspect/offender reference sample. This master spreadsheet was queried using Windows Powershell to extract lines in which the exhibit description matched specific text strings. All resulting sub-sheets were manually reviewed to ensure only relevant data was included. Despite this, inconsistencies in spelling and terminology in the exhibit description limited the completeness of the analysis; however, this is unlikely to impact dramatically on the interpretation of DNA success rates. Percentages of each profile result category were calculated for the total dataset, each collection method across all items, and then broken down for collection method from each selected item. Success rates were also assessed for porous versus non-porous substrate surfaces. Sample metadata allowed separation of swabs from biological fluid stains (blood, saliva, semen) to be separated from those taken from putative touched areas or handled objects.

**Results**

In total, 61 344 total records (representing 60 332 unique exhibits) were analysed, the majority of which were swabs or tapelifts (Table 1). Swabs collected from biological fluids represented a much smaller proportion than those from touched areas/objects. Overall, 25.85% of samples returned full profiles: the greatest proportion of full profiles was obtained from samples of obvious stains of biological fluids, with the most successful being swabs of bloodstains (73.96%, Table 2). Partial/mixed profiles were rarely obtained from non-sexual assault kit semen swabs (1.96%), but otherwise ranged up to 28.04% of DNA results from other sample types. Percentages of suspect identifications ranged from 13.49% (hair) to 41.55% (blood swabs). Both swabs and tapelifts of touched objects/surfaces returned suspect identifications from ~15% of samples, but there was a significant disparity between full profile results (swabs = 13.45%; tapelifts = 7.01%). Despite this, tapelifts provided nearly 25% of total suspect identifications compared with 17% for trace swabs (Table 1), suggesting that the success of tapelifting is often reliant on partial profiles or deconvolution of mixtures.

Individual items/surfaces showed great variation in their percentage success. The greatest success for exhibits where no visible stain was observed was for swabs and excised sections from drinking straws, which produced full profiles in ~47% of samples taken, whereas tapelifts from straws were slightly less successful at 33.3%. Bedding (swab), waistbands of lower garments (swab), discharged cartridge cases (tapelift), underwear (both), zip/cable ties (both), and drinking vessels (both) all produced full profiles in >20% of samples. The least successful items (no full profiles recorded) included: swabs of cigarette packets, rocks, helmets, firearm barrels, shirt collars, power cords, rubber key handles, and several tools; tapelifts of external car door handles, sweat smears on cars, and glovemarks; and both swabs and tapelifts of public phones and fingermarks. Despite this, several of these items did return suspect identifications based on partial profiles; including, external car door handles, shirt collars, and rubber key handles. Among sexual assault-related samples, breast swabs identified the greatest percentage of suspects after penis swabs (suspect reference samples), no suspect identifications were recorded from perineum samples. The highest percentage of full profiles were reported from oral swabs (most likely complainant profiles, though 8.41% were identified a suspect), whereas the lowest proportion of full profiles were from breast swabs.

Some distinct differences in the recovery of full profiles from swabs and tapelifts of trace samples were observed for specific items. Swabs were at least twice as successful as tapelifts for car doors, car door handles, seatbelt straps & buckles, adhesive tapes, drinking vessels, firearm handles, sweat smears on cars, waistbands of lower garments, sledgehammers, mattock/pickaxes, torches, and bedding. In contrast, tapelifts were more successful for discharged car airbags, gearsticks, motorcycles (including handlebars), cigarette packets, power cords, flyscreen, rubber and metal keys, cartridge cases (both discharged and live), firearm barrels, mobile phones, shirt collars, helmets, hats, rocks, and several tools. In contrast to conventional wisdom, tapelifts of non-porous surfaces recovered slightly more full profiles than swabs, whereas swabs were better for porous surfaces (Table 3). Furthermore, porous surfaces returned a greater percentage of full profiles and suspect identifications than non-porous surfaces.

***Data caveats***

A small number of samples were recorded as returning results in more than one category: 256 records were categorised as both partial/mixed and full (likely representing full profiles deconvoluted from mixtures), representing 2% of partial/mixed records and 1.6% of full profile results; 614 samples were categorised as both partial/mixed and no DNA, representing 1.7% of no DNA results and 4.8% of partial/mixed results; 3001 samples were categorised as both no DNA and full, representing 8.2% of no DNA results and 19% of full profile results; and 92 samples were categorised across all three categories. The vast bulk of such multiple categorisations are due to sub-threshold information present in otherwise full, partial or mixed profiles, or samples that fell below the internal quantification threshold for profiling but were processed following investigator request. In the context of the total dataset these multiple categorisations are not considered to substantially impact on the interpretation of profiling success rates. Manually reviewing every record was outside the scope of this project.

**Discussion**

The analysis presented here of over 18 months of DNA sampling data, representing more than 60 000 individual exhibits, from the Queensland Police Service has revealed some interesting patterns that can inform operational procedures. Averaged over all items/surfaces, trace swabs recovered more full profiles than tapelifts; however, there was substantial variation noted among exhibit types, including many for which tapelifts were the more successful method of collection. Increasing the granularity of the analysis therefore provided a deeper insight into DNA profiling success rates among items and methods of collection. Interestingly, percentage profiling successes for swabs and tapelifts from porous and non-porous surfaces were opposite to conventional wisdom.

It is difficult to compare the data presented here with previous studies from other jurisdictions. The specifics of collection technique, consumables, DNA extraction and STR profiling procedures and kits between organisations and over time are likely to have significant influence on profiling success. In addition, there has been variation across studies

in the exhibit categorisation strategy used and hence granularity of data analysed. For example, some studies lump all clothing samples together[4,7,9], whereas others separate them into subcategories for specific clothing types[3,5,6]. Further, some studies were deliberately restricted to samples taken from volume crime scenes[8,9], whereas others either were from all crime scenes or did not specify[3-7]. This limits the ability to make truly like-for-like comparisons between studies. Nevertheless, some general trends deserve discussion.

Overall, trace DNA success was similar for Queensland as for most jurisdictions compared here (Table 4). Interestingly, profiling success for many items included in the comparison was poorer than that reported from other jurisdictions, despite the current use in Queensland of a more sensitive DNA profiling kit than that used in many of these previous studies. This suggests that there were many other more successful items sampled by Queensland that made up the shortfall (possibly including SAIK swabs, for example). Alternatively, it could be because of different collection, storage, submission and triage procedures in other regions, or a factor of analysing total sample data rather than smaller, selected subsets. Trace DNA profile success was also relatively high for items from cars (airbags, seatbelts), drinking straws, chewing gum, cartridge cases, underwear and waistbands, and bedding. The majority of comparisons with previous literature related to swabbed items (Table 4); however, tapelift sampling of many of these items in fact returned more full profiles than swabs (11 out of 19 items). Perhaps the most striking discrepancies were for swabs from hats/caps, inside of gloves, and collars compared with the results of Mapes et al[6]. Within the Queensland data, clear differences in profiling success were observed between collection methods which will contribute toward updated operational procedures.

These data provide valuable insight into DNA profiling success of one of Australia's largest police jurisdictions. Additional research is required to determine whether differences between Queensland and other published data stem from consumables used, collection technique, environmental effects (e.g., increased degradation), or some other factor. Some recent work has suggested that rayon swabs are not ideal for recovering maximum DNA from collected samples[10], although this appears to contradict other research that supports rayon as

among the most effective swab materials[11,12]. Additional research is still required here to inform better consumables choice for forensic practitioners. Pleasingly, there is good support in the data presented here for the efficacy of forensic tapelifts, particularly in preference to swabs for many non-porous items. This accords with existing literature that supports tapelifting as a highly effective collection method[13,14], including for the specific tape product used by QPS forensic officers[15]. Future research and reporting by other agencies into their success rates would benefit from a consistent approach to item and profile success categorisation, to maximise comparability between studies. This study demonstrates that increasing the granularity of data captured can reveal important trends that can inform best practice at the crime scene and laboratory.

**Acknowledgements:**

The author would like to thank Inspectors David Keatinge and David Neville (QPS) for their review of the manuscript and valuable comments and discussion.

**Disclosure Statement:**

The author declares no conflict of interest.

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## Tables

**Table 1.** Number of records included for analysis separated into major sample types (minor sample types or those not subsequently analysed are not shown). Percentages of total records, suspect identifications, full or partial/mixed profiles, and no DNA records provided for each sample type.

| Sample type | Number of exhibit records | Percentage of total records | Percentage of total suspect identifications (N=14267) | Percentage of total full profiles (N=15855) | Percentage of total partial/mixed profiles (N=12784) | Percentage of total no DNA (N=36484) |
|---|---|---|---|---|---|---|
| Cigarette butts | 2633 | 4.29 | 7.46 | 9.16 | 6.31 | 1.75 |
| Fabric | 1865 | 3.04 | 4.56 | 5.00 | 3.83 | 2.50 |
| Hair | 289 | 0.47 | 0.27 | 0.52 | 0.21 | 0.53 |
| Scraping | 922 | 1.50 | 2.28 | 2.34 | 0.82 | 1.53 |
| Swab (blood) | 7248 | 11.82 | 21.10 | 33.81 | 9.05 | 4.00 |
| Swab (saliva) | 4769 | 7.77 | 12.93 | 12.17 | 10.46 | 4.97 |
| Swab (semen) | 51 | 0.08 | 0.10 | 0.09 | 0.01 | 0.11 |
| Swab (trace) | 16518 | 26.93 | 17.18 | 14.01 | 20.24 | 34.14 |
| Tapelift | 22576 | 36.76 | 24.45 | 9.97 | 38.40 | 45.74 |
| All trace | 39067 | 63.69 | 41.63 | 23.99 | 58.64 | 79.88 |

**Table 2.** DNA profiling results for samples collected by QPS forensic officers between 1 January 2017 and 11 September 2019.

| Item | | Collection method | Total results | Percentage suspect identification | Percentage full profile | Percentage partial/mixed profile | Percentage no DNA |
|---|---|---|---|---|---|---|---|
| All | | All | 61344 | 23.26 | 25.85 | 20.84 | 59.47 |
| | | Fabric | 1865 | 34.91 | 42.52 | 26.27 | 48.90 |
| | | Hair | 289 | 13.49 | 28.72 | 9.34 | 67.47 |
| | | Scrapings | 922 | 35.25 | 40.24 | 11.39 | 60.74 |
| | | Swab (blood) | 7247 | 41.55 | 73.96 | 15.97 | 20.15 |
| | | Swab (saliva) | 4769 | 38.69 | 40.45 | 28.04 | 38.04 |
| | | Swab (semen) | 51 | 27.45 | 29.41 | 1.96 | 76.47 |
| | | All trace | 39066 | 15.20 | 9.73 | 19.19 | 74.60 |
| | | Swab | 16518 | 14.84 | 13.45 | 15.66 | 75.40 |
| | | Tapelift | 22548 | 15.47 | 7.01 | 21.77 | 74.01 |
| Cars | Steering wheel | Swab (blood) | 40 | 67.50 | 62.50 | 25.00 | 27.50 |
| | | All trace | 3676 | 16.29 | 6.41 | 22.52 | 73.07 |
| | | Swab | 696 | 12.36 | 4.17 | 17.96 | 79.60 |
| | | Tapelift | 2980 | 17.21 | 6.95 | 23.59 | 71.54 |
| | Airbags | Swab (blood) | 53 | 69.81 | 84.91 | 13.21 | 15.09 |
| | | Excised | 14 | 57.14 | 78.57 | 14.29 | 28.57 |
| | | All trace | 236 | 31.78 | 18.64 | 27.12 | 61.44 |
| | | Swab | 12 | 25.00 | 8.33 | 16.67 | 83.33 |
| | | Tapelift | 224 | 32.14 | 19.20 | 27.68 | 60.27 |
| | Gear stick | Swab (blood) | 9 | 55.56 | 55.56 | 44.44 | 11.11 |
| | | All trace | 761 | 10.91 | 5.65 | 15.24 | 82.00 |
| | | Swab | 241 | 6.64 | 2.90 | 9.54 | 88.38 |
| | | Tapelift | 520 | 11.73 | 5.96 | 16.73 | 78.85 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | All doors | Swab (blood) | 110 | 58.18 | 79.09 | 11.82 | 19.09 |
| | | All trace | 164 | 12.80 | 6.71 | 14.02 | 80.49 |
| | | Swab | 94 | 10.64 | 10.64 | 8.51 | 82.98 |
| | | Tapelift | 70 | 15.71 | 1.43 | 21.43 | 77.14 |
| | Internal door handle | Swab (blood) | 50 | 62.00 | 74.00 | 14.00 | 28.00 |
| | | All trace | 104 | 14.42 | 7.69 | 15.38 | 78.85 |
| | | Swab | 55 | 14.55 | 12.73 | 10.91 | 80.00 |
| | | Tapelift | 49 | 14.29 | 2.04 | 20.41 | 77.55 |
| | External door handle | Swab (blood) | 32 | 59.38 | 87.50 | 12.50 | 9.38 |
| | | All trace | 39 | 7.69 | 5.13 | 12.82 | 82.05 |
| | | Swab | 25 | 0.00 | 8.00 | 4.00 | 88.00 |
| | | Tapelift | 14 | 21.43 | 0.00 | 28.57 | 71.43 |
| | Seatbelt strap | Swab (blood) | 2 | 0.00 | 100.00 | 0.00 | 100.00 |
| | | Fabric | 1 | 0.00 | 0.00 | 0.00 | 100.00 |
| | | All trace | 154 | 6.49 | 3.25 | 10.39 | 87.66 |
| | | Swab | 7 | 28.57 | 14.29 | 28.57 | 71.43 |
| | | Tapelift | 147 | 5.44 | 2.72 | 9.52 | 88.44 |
| | Seatbelt buckle | All trace | 96 | 8.33 | 5.21 | 11.46 | 88.54 |
| | | Swab | 32 | 6.25 | 9.38 | 6.25 | 90.63 |
| | | Tapelift | 64 | 9.38 | 3.13 | 14.06 | 87.50 |
| Motorcycles | | Swab (blood) | 14 | 57.14 | 100.00 | 0.00 | 7.14 |
| | | All trace | 83 | 8.43 | 3.61 | 12.05 | 86.75 |
| | | Swab | 26 | 0.00 | 0.00 | 3.85 | 96.15 |
| | | Tapelift | 57 | 12.28 | 5.26 | 15.79 | 82.46 |
| | Handlebars | Swab (blood) | 2 | 50.00 | 100.00 | 0.00 | 0.00 |
| | | All trace | 73 | 8.22 | 4.11 | 12.33 | 86.30 |
| | | Swab | 22 | 0.00 | 0.00 | 4.55 | 95.45 |
| | | Tapelift | 51 | 11.76 | 5.88 | 15.69 | 82.35 |
| Cigarette butt | | Excised (majority) | 2633 | 40.41 | 55.15 | 30.65 | 24.27 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cigarette packet | | Swab (blood) | 5 | 40.00 | 100.00 | 0.00 | 0.00 |
| | | All trace | 12 | 8.33 | 8.33 | 33.33 | 58.33 |
| | | Swab | 4 | 0.00 | 0.00 | 25.00 | 75.00 |
| | | Tapelift | 8 | 12.50 | 12.50 | 37.50 | 50.00 |
| Cigarette lighter | | All trace | 185 | 7.57 | 4.32 | 11.89 | 84.32 |
| | | Swab | 141 | 8.51 | 4.26 | 11.35 | 84.40 |
| | | Tapelift | 44 | 4.55 | 4.55 | 13.64 | 84.09 |
| Bindings | | All | 421 | 9.50 | 10.93 | 14.73 | 77.91 |
| | Rope | Tapelift (majority) | 87 | 4.60 | 13.79 | 18.39 | 72.41 |
| | Zip/cable ties | All trace | 70 | 22.86 | 21.43 | 14.29 | 68.57 |
| | | Swab | 45 | 17.78 | 22.22 | 8.89 | 71.11 |
| | | Tapelift | 25 | 32.00 | 20.00 | 24.00 | 64.00 |
| | Power cords | Swab (blood) | 7 | 42.86 | 42.86 | 28.57 | 57.14 |
| | | All trace | 183 | 4.92 | 3.83 | 10.38 | 87.43 |
| | | Swab | 89 | 1.12 | 0.00 | 6.74 | 93.26 |
| | | Tapelift | 94 | 8.51 | 7.45 | 13.83 | 81.91 |
| | Tapes | All trace | 150 | 10.00 | 8.00 | 13.33 | 82.67 |
| | | Swab | 87 | 9.20 | 11.49 | 13.79 | 80.46 |
| | | Tapelift | 63 | 11.11 | 3.17 | 12.70 | 85.71 |
| | Deceased scenes | Tapelift (majority) | 37 | 2.70 | 32.43 | 35.14 | 45.95 |
| Door handles (premises) | | Swab (blood) | 66 | 51.52 | 66.67 | 25.76 | 22.73 |
| | | All trace | 519 | 3.47 | 2.12 | 10.21 | 88.44 |
| | | Swab | 278 | 2.88 | 1.44 | 8.99 | 90.29 |
| | | Tapelift | 241 | 4.15 | 2.90 | 11.62 | 86.31 |
| Window frames/sills | | Swab (blood) | 174 | 51.72 | 78.74 | 11.49 | 16.09 |
| | | All trace | 126 | 8.73 | 7.14 | 6.35 | 88.89 |
| | | Swab | 73 | 8.22 | 8.22 | 6.85 | 87.67 |
| | | Tapelift | 53 | 9.43 | 5.66 | 5.66 | 90.57 |
| Flyscreen mesh | | Swab (blood) | 37 | 59.46 | 81.08 | 8.11 | 13.51 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Excised | 7 | 28.57 | 14.29 | 14.29 | 71.43 |
| | | All trace | 1117 | 5.01 | 4.57 | 10.92 | 85.50 |
| | | Swab | 159 | 2.52 | 1.89 | 6.29 | 92.45 |
| | | Tapelift | 958 | 5.43 | 5.01 | 11.69 | 84.34 |
| Mouth/rim of drinking vessel | | All trace | 4578 | 35.23 | 37.70 | 27.09 | 41.50 |
| | | Swab | 4423 | 36.08 | 38.68 | 27.36 | 40.29 |
| | | Tapelift | 155 | 10.97 | 9.68 | 19.35 | 76.13 |
| Drinking straw | | Excised | 68 | 55.88 | 47.06 | 33.82 | 32.35 |
| | | All trace | 506 | 50.20 | 46.44 | 28.66 | 33.79 |
| | | Swab | 494 | 49.80 | 46.76 | 28.34 | 34.01 |
| | | Tapelift | 12 | 66.67 | 33.33 | 41.67 | 25.00 |
| Drug pipe/bong | | Swab (majority) | 215 | 26.98 | 11.16 | 30.23 | 61.40 |
| Chewing gum | | Whole item (majority) | 47 | 14.89 | 63.83 | 12.77 | 31.91 |
| Keys | | All trace | 425 | 5.88 | 2.35 | 11.29 | 87.29 |
| | | Swab | 238 | 4.20 | 1.68 | 6.30 | 92.86 |
| | | Tapelift | 187 | 8.02 | 3.21 | 17.65 | 80.21 |
| | Rubber | All trace | 12 | 8.33 | 8.33 | 16.67 | 83.33 |
| | | Swab | 4 | 25.00 | 0.00 | 25.00 | 75.00 |
| | | Tapelift | 8 | 0.00 | 12.50 | 12.50 | 87.50 |
| | Metal | All trace | 166 | 5.42 | 1.81 | 8.43 | 90.36 |
| | | Swab | 106 | 2.83 | 0.94 | 4.72 | 94.34 |
| | | Tapelift | 60 | 5.00 | 3.33 | 15.00 | 83.33 |
| | Plastic | All trace | 161 | 6.21 | 3.73 | 11.80 | 85.09 |
| | | Swab | 70 | 4.29 | 2.86 | 4.29 | 92.86 |
| | | Tapelift | 91 | 7.69 | 4.40 | 17.58 | 79.12 |
| Cartridge cases | | All trace | 212 | 8.96 | 9.91 | 3.77 | 89.62 |
| | | Swab | 127 | 6.30 | 5.51 | 2.36 | 92.91 |
| | | Tapelift | 85 | 12.94 | 16.47 | 5.88 | 82.35 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Discharged | All trace | 70 | 5.71 | 11.43 | 2.86 | 88.57 |
| | | Swab | 41 | 4.88 | 4.88 | 0.00 | 95.12 |
| | | Tapelift | 29 | 6.90 | 20.69 | 6.90 | 79.31 |
| | Live | All trace | 130 | 10.77 | 9.23 | 3.85 | 89.23 |
| | | Swab | 80 | 7.50 | 6.25 | 3.75 | 91.25 |
| | | Tapelift | 50 | 16.00 | 14.00 | 4.00 | 86.00 |
| Firearm | | Swab (blood) | 18 | 44.44 | 83.33 | 11.11 | 22.22 |
| | | All trace | 831 | 9.15 | 2.65 | 10.83 | 87.48 |
| | | Swab | 444 | 7.66 | 2.03 | 9.68 | 89.86 |
| | | Tapelift | 387 | 10.85 | 3.36 | 12.14 | 84.75 |
| | Handle | All trace | 232 | 8.62 | 2.16 | 10.78 | 88.36 |
| | | Swab | 92 | 7.61 | 4.35 | 11.96 | 86.96 |
| | | Tapelift | 140 | 9.29 | 0.71 | 10.00 | 89.29 |
| | Barrel | All trace | 31 | 6.45 | 3.23 | 12.90 | 87.10 |
| | | Swab | 19 | 5.26 | 0.00 | 10.53 | 94.74 |
| | | Tapelift | 12 | 8.33 | 8.33 | 16.67 | 75.00 |
| | Trigger | All trace | 273 | 8.79 | 2.56 | 10.99 | 87.55 |
| | | Swab | 174 | 8.62 | 2.87 | 10.34 | 87.93 |
| | | Tapelift | 99 | 9.09 | 2.02 | 12.12 | 86.87 |
| Knife | | Swab (blood) | 363 | 34.71 | 50.69 | 34.16 | 26.45 |
| | | All trace | 1329 | 15.65 | 7.22 | 18.96 | 77.20 |
| | | Swab | 792 | 14.52 | 7.20 | 17.55 | 78.28 |
| | | Tapelift | 537 | 17.32 | 7.26 | 21.04 | 75.61 |
| | Handle | All trace | 986 | 16.33 | 4.97 | 20.08 | 77.79 |
| | | Swab | 523 | 14.72 | 3.63 | 17.97 | 80.50 |
| | | Tapelift | 463 | 18.14 | 6.48 | 22.46 | 74.73 |
| | Blade | All trace | 236 | 13.56 | 14.83 | 17.37 | 72.03 |
| | | Swab | 219 | 13.70 | 14.61 | 17.35 | 72.15 |
| | | Tapelift | 17 | 11.76 | 17.65 | 17.65 | 70.59 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Gloves | | Swab (blood) | 14 | 57.14 | 50.00 | 21.43 | 35.71 |
| | | Excised | 12 | 50.00 | 8.33 | 41.67 | 50.00 |
| | | All trace | 1686 | 20.23 | 6.47 | 24.67 | 70.82 |
| | | Swab | 384 | 13.02 | 5.99 | 16.67 | 79.69 |
| | | Tapelift | 1302 | 22.35 | 6.61 | 27.04 | 68.20 |
| | Inside surfaces | All trace | 1076 | 20.72 | 7.53 | 26.02 | 68.59 |
| | | Swab | 223 | 15.25 | 8.07 | 18.39 | 75.34 |
| | | Tapelift | 853 | 22.27 | 7.39 | 28.02 | 66.71 |
| Fingermarks | | Swab (blood) | 10 | 20.00 | 40.00 | 20.00 | 40.00 |
| | | All trace | 102 | 2.94 | 0.00 | 5.88 | 94.12 |
| | | Swab | 85 | 3.53 | 0.00 | 7.06 | 92.94 |
| | | Tapelift | 17 | 0.00 | 0.00 | 0.00 | 100.00 |
| Glovemarks | | All trace | 140 | 2.14 | 0.71 | 2.86 | 97.14 |
| | | Swab | 121 | 0.83 | 0.83 | 0.83 | 98.35 |
| | | Tapelift | 19 | 10.53 | 0.00 | 15.79 | 89.47 |
| Sweat smears | Premises | All trace | 181 | 3.87 | 4.42 | 2.76 | 94.48 |
| | | Swab | 157 | 3.82 | 4.46 | 3.18 | 94.27 |
| | | Tapelift | 24 | 4.17 | 4.17 | 0.00 | 95.83 |
| | Cars | All trace | 40 | 0.00 | 5.00 | 2.50 | 95.00 |
| | | Swab | 37 | 0.00 | 5.41 | 2.70 | 94.59 |
| | | Tapelift | 3 | 0.00 | 0.00 | 0.00 | 100.00 |
| Phones | Mobile phone | Swab (blood) | 32 | 43.75 | 65.63 | 34.38 | 18.75 |
| | | All trace | 174 | 13.79 | 4.02 | 23.56 | 74.14 |
| | | Swab | 119 | 11.76 | 1.68 | 21.85 | 77.31 |
| | | Tapelift | 55 | 18.18 | 9.09 | 27.27 | 67.27 |
| | Public phone | Swab (blood) | 2 | 100.00 | 100.00 | 0.00 | 100.00 |
| | | All trace | 10 | 0.00 | 0.00 | 0.00 | 100.00 |
| | | Swab | 6 | 0.00 | 0.00 | 0.00 | 100.00 |
| | | Tape | 4 | 0.00 | 0.00 | 0.00 | 100.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Keypad (eg., safe/alarm) | | Swab (majority) | 26 | 3.85 | 7.69 | 7.69 | 88.46 |
| Computer keyboard | | Swab (blood/trace) | 5 | 20.00 | 60.00 | 0.00 | 40.00 |
| Fingernails | | Scrapings | 549 | 56.83 | 39.89 | 47.91 | 30.42 |
| | | Clippings | 71 | 25.35 | 67.61 | 26.76 | 22.54 |
| Condom | | Swab (majority) | 253 | 50.59 | 23.72 | 45.45 | 46.25 |
| Sexual assault-related | | All | 4586 | 22.50 | 48.95 | 22.55 | 41.95 |
| | | High vaginal | 629 | 25.60 | 54.05 | 30.84 | 30.21 |
| | | Low vaginal | 615 | 20.81 | 53.33 | 25.20 | 33.33 |
| | | Hymen | 11 | 9.09 | 63.64 | 9.09 | 36.36 |
| | | Vaginal other | 65 | 26.15 | 64.62 | 20.00 | 18.46 |
| | | Vulval | 980 | 16.73 | 54.39 | 18.88 | 37.55 |
| | | Labial | 202 | 13.86 | 63.37 | 17.33 | 31.19 |
| | | Perineum | 28 | 0.00 | 50.00 | 0.00 | 50.00 |
| | | Perianal | 442 | 14.03 | 35.75 | 17.19 | 56.79 |
| | | Anal | 147 | 10.88 | 42.18 | 9.52 | 59.18 |
| | | Rectal | 216 | 10.65 | 40.28 | 12.50 | 56.94 |
| | | Breast | 46 | 39.13 | 6.52 | 41.30 | 67.39 |
| | | Oral | 309 | 8.41 | 72.17 | 5.18 | 32.04 |
| | | Penis | 450 | 55.56 | 26.44 | 36.67 | 49.78 |
| Clothing | Collar | Swab (blood/saliva) | 5 | 60.00 | 40.00 | 40.00 | 40.00 |
| | | Fabric | 18 | 38.89 | 33.33 | 38.89 | 33.33 |
| | | All trace | 409 | 27.14 | 7.33 | 34.23 | 61.86 |
| | | Swab | 11 | 27.27 | 0.00 | 36.36 | 63.64 |
| | | Tapelift | 398 | 27.14 | 7.54 | 34.17 | 61.81 |
| | Beanie | Tapelift (majority) | 89 | 34.83 | 6.74 | 38.20 | 57.30 |
| | Balaclava | Tapelift (majority) | 90 | 31.11 | 18.89 | 21.11 | 66.67 |
| | Helmet | Swab (blood) | 12 | 41.67 | 91.67 | 8.33 | 16.67 |
| | | All trace | 148 | 29.05 | 8.11 | 31.76 | 62.84 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Swab | 12 | 0.00 | 0.00 | 0.00 | 100.00 |
| | Tapelift | 136 | 31.62 | 8.82 | 34.56 | 59.56 |
| Hat/cap | Swab (blood) | 37 | 48.65 | 48.65 | 35.14 | 27.03 |
| | All trace | 888 | 28.83 | 10.47 | 33.45 | 60.02 |
| | Swab | 42 | 14.29 | 2.38 | 19.05 | 78.57 |
| | Tapelift | 846 | 29.55 | 10.87 | 34.16 | 59.10 |
| Underwear | Excised/scraped | 189 | 44.44 | 39.68 | 40.74 | 83.07 |
| | All trace | 324 | 40.43 | 25.62 | 66.36 | 68.52 |
| | Swab | 13 | 53.85 | 38.46 | 61.54 | 46.15 |
| | Tapelift | 311 | 39.87 | 25.08 | 66.56 | 69.45 |
| Waistband shorts/pants | Excised/scraped | 29 | 20.69 | 41.38 | 17.24 | 72.41 |
| | All trace | 196 | 20.41 | 5.61 | 35.71 | 62.76 |
| | Swab | 5 | 60.00 | 20.00 | 60.00 | 40.00 |
| | Tapelift | 191 | 19.37 | 5.24 | 35.08 | 63.35 |
| Screwdriver | All trace | 939 | 11.40 | 4.37 | 15.65 | 81.36 |
| | Swab | 469 | 9.81 | 4.05 | 12.15 | 84.86 |
| | Tapelift | 470 | 12.98 | 4.47 | 19.15 | 77.87 |
| Sledge hammer | Swab (blood) | 4 | 0.00 | 75.00 | 0.00 | 50.00 |
| | All trace | 75 | 9.33 | 2.67 | 12.00 | 85.33 |
| | Swab | 22 | 4.55 | 4.55 | 4.55 | 90.91 |
| | Tapelift | 53 | 11.32 | 1.89 | 15.09 | 83.02 |
| Hammer | Swab (blood) | 22 | 27.27 | 63.64 | 13.64 | 59.09 |
| | All trace | 356 | 10.39 | 3.65 | 13.48 | 83.71 |
| | Swab | 116 | 9.48 | 3.45 | 11.21 | 85.34 |
| | Tapelift | 240 | 10.83 | 3.75 | 14.58 | 82.92 |
| Spanner | Swab (blood) | 5 | 20.00 | 100.00 | 0.00 | 0.00 |
| | All trace | 104 | 8.65 | 2.88 | 8.65 | 89.42 |
| | Swab | 55 | 7.27 | 3.64 | 5.45 | 92.73 |
| | Tapelift | 49 | 10.20 | 2.04 | 12.24 | 85.71 |

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|---|---|---|---|---|---|---|
| Chisel | All trace | 66 | 16.67 | 3.03 | 16.67 | 81.82 |
| | Swab | 25 | 0.00 | 0.00 | 0.00 | 100.00 |
| | Tapelift | 41 | 26.83 | 4.88 | 26.83 | 70.73 |
| Shovel | Swab (blood) | 2 | 0.00 | 100.00 | 0.00 | 100.00 |
| | All trace | 66 | 10.47 | 4.65 | 8.14 | 87.21 |
| | Swab | 25 | 7.14 | 0.00 | 7.14 | 92.86 |
| | Tapelift | 41 | 12.07 | 6.90 | 8.62 | 84.48 |
| Crow bar | All trace | 268 | 5.97 | 2.99 | 7.09 | 91.79 |
| | Swab | 108 | 3.70 | 1.85 | 5.56 | 94.44 |
| | Tapelift | 160 | 7.50 | 3.75 | 8.13 | 90.00 |
| Axe | Swab (blood) | 3 | 33.33 | 66.67 | 33.33 | 33.33 |
| | All trace | 114 | 12.28 | 3.51 | 13.16 | 84.21 |
| | Swab | 24 | 4.17 | 0.00 | 8.33 | 91.67 |
| | Tapelift | 90 | 14.44 | 4.44 | 14.44 | 82.22 |
| Mattock/Pickaxe | All trace | 41 | 4.88 | 2.44 | 9.76 | 87.80 |
| | Swab | 7 | 0.00 | 14.29 | 14.29 | 71.43 |
| | Tapelift | 34 | 5.88 | 0.00 | 8.82 | 91.18 |
| Torch | All trace | 376 | 19.95 | 10.11 | 19.68 | 72.87 |
| | Swab | 163 | 14.11 | 13.50 | 12.88 | 78.53 |
| | Tapelift | 213 | 24.41 | 7.51 | 24.88 | 68.54 |
| Brick/rock | All | 527 | 8.73 | 10.82 | 7.40 | 89.18 |
| | Rock | Swab (blood) | 14 | 14.29 | 64.29 | 7.14 | 28.57 |
| | | All trace | 287 | 3.83 | 3.48 | 5.92 | 91.29 |
| | | Swab | 21 | 0.00 | 0.00 | 4.76 | 95.24 |
| | | Tapelift | 266 | 4.14 | 3.76 | 6.02 | 90.98 |
| | Brick/paver | Swab (blood) | 29 | 41.38 | 79.31 | 3.45 | 20.69 |
| | | All trace | 227 | 9.25 | 6.61 | 8.81 | 87.22 |
| | | Swab | 18 | 0.00 | 5.56 | 0.00 | 100.00 |
| | | Tapelift | 209 | 10.05 | 6.70 | 9.57 | 86.12 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Clip-seal plastic bag | | All trace | 267 | 14.98 | 8.24 | 13.48 | 81.27 |
| | | Swab | 213 | 15.02 | 7.51 | 13.15 | 81.69 |
| | | Tapelift | 54 | 14.81 | 11.11 | 14.81 | 79.63 |
| Bedding | | All | 1440 | 25.76 | 28.47 | 23.19 | 60.97 |
| | | Excised | 491 | 28.11 | 38.29 | 24.85 | 57.64 |
| | | Scraping | 348 | 25.00 | 8.91 | 28.74 | 49.43 |
| | | Other | 278 | 28.42 | 41.37 | 12.95 | 83.45 |
| | | Swab (blood) | 96 | 31.25 | 56.25 | 27.08 | 27.08 |
| | | All trace | 226 | 16.37 | 9.73 | 22.12 | 73.01 |
| | | Swab | 5 | 0.00 | 40.00 | 20.00 | 60.00 |
| | | Tapelift | 221 | 16.74 | 9.05 | 22.17 | 73.30 |
| | Mattress | All | 158 | 11.39 | 31.01 | 12.66 | 71.52 |
| | Mattress protector | All | 63 | 52.38 | 19.05 | 39.68 | 63.49 |
| | Sheets | All | 679 | 28.57 | 27.54 | 24.30 | 58.62 |
| | Blanket | All | 403 | 21.09 | 31.27 | 20.35 | 62.03 |
| | Pillow | All | 179 | 23.46 | 24.02 | 25.70 | 60.89 |

**Table 3.** Comparison of percentage success in DNA sampling between porous and non-porous items/surfaces from Table 2.

| Surface | Collection method | Total results | Percentage suspect identification | Percentage full profile | Percentage partial/mixed profile | Percentage no DNA |
|---|---|---|---|---|---|---|
| Non-porous | All trace | 23234 | 12.35 | 7.61 | 14.30 | 80.38 |
| | Swab | 11836 | 9.87 | 6.88 | 11.11 | 83.99 |
| | Tapelift | 11398 | 13.97 | 7.33 | 17.08 | 77.95 |
| Porous | All trace | 3125 | 20.82 | 11.67 | 26.52 | 71.74 |
| | Swab | 134 | 20.44 | 13.41 | 25.59 | 72.78 |
| | Tapelift | 2991 | 21.20 | 9.93 | 27.46 | 70.71 |

**Table 4.** Comparison of Queensland DNA profiling success data for specific items against equivalent data from the literature.

| Exhibit category | | This study | Netherlands[6] | Singapore[7] | Switzerland[4] | Switzerland[9] | New Zealand[3] | New South Wales[8] |
|---|---|---|---|---|---|---|---|---|
| | Profile / Collection | Full | Single | Single | Full/partial>5 loci | Single | Full | Full/partial>12 loci |
| Cigarette butt | Excised | 55 | 84 | 81 | | 70.6 | | |
| Hat/cap | Swab | 2 | 42 | | | | | |
| | Tapelift | 11 | | | | | 25 | |
| Collar | Swab | 0* | 34 | | | | | |
| Glove (inside) | Swab | 8 | 25a | 11 | | 18.8b | | |
| | Tapelift | 7 | | | | | 25 | |
| Torch | Swab | 14 | 27 | | | | | |
| Drinking vessels | Swab | 39 | 57 | 34 | | 55.6 | 21c | |
| Knife handle | Swab | 4* | 19 | | | | | |
| Lighter | Swab | 4* | 17 | | | | | |
| Firearm grip | Swab | 4 | 6 | | | | | |
| Firearms (other) | Swab | 2* | | | | | | 15 |
| Handle motorcycle | Swab | 0* | 9 | | | | | |
| Cartridge cases | Swab | 6* | 6 | | | | | |
| Tape | Swab | 11 | 9 | 16 | | | | |
| Keys | Swab | 2* | 12 | | | | | |
| Hair | Excised | 29 | | 21.1 | | | | |
| Drug apparatus | Swab | 11 | | 15 | | | 21c | |
| Thrown stones | Swab | 0* | | | 7 | 7.5 | | |
| Cables/power cords | Swab | 0* | | | 29 | 12.2 | | |
| Tools | Swab | 4*d | 5e | 10 | 22 | | | 15 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Clothing | Swab | 29f | | 5 | 18.8b | | |
| | Tapelift | 12g | | | | 15h | |
| | Excised | 38i | | | | | |
| Blood | Swab | 74 | 68 | | 87.5 | | |
| Dataset average | All trace | 15j | 25k | 12 | 12k | 16 | 14 |

*greater percentage full profiles from tapelifts where relevant
a combined here from latex & fabric glove results
b combined category clothing/gloves
c combined category drinking vessels/drug pipes
d averaged over all tools analysed in Table 2
e combined here from screwdriver/crowbar/hand-tools (other)
f averaged over underwear and waistband shorts/pants in Table 2
g averaged over collar/beanie/balaclava/helmet/hat/cap/underwear/waistband shorts/pants in Table 2
h combined here from underwear/socks/upper garments results
i averaged over collar/underwear/waistband shorts/pants in Table 2
j average profiling success for trace samples only (i.e., excludes biological fluids, hair, cigarette butts)
k included bloodstain profiling results

s.47(3)(b)

**From:** Neville.DavidH[OSC] @police.qld.gov.au>
**Sent:** Friday, 14 February 2020 2:42 PM
**To:** Cathie Allen @health.qld.gov.au>
**Cc:** Krosch.MattN[OSC] @police.qld.gov.au>; McNab.BruceJ[OSC] @police.qld.gov.au>; Keatinge.DavidJ[OSC] < @police.qld.gov.au>
**Subject:** FW: DNA success rates manuscript



Hi Cathie

Matt has forwarded me the below email and we have had a discussion in relation to this. Thanks for taking the time to review his work. This paper is aimed at crime scene examiners to help them better focus their sampling methodology. It is not aimed at the laboratory and the introduction of additional lab factors might unnecessarily complicate the matter. It is important that the possible the impact of micron be covered in the discussion, however I don't think it is necessary for us to rerun the data. In this instance we were looking to provide QHFSS an acknowledgement in the paper, however it was not anticipated that the article would be become lab focused. As a result, a general review is probably all that is needed, if possible please.

Regards

David Neville

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**From:** Allison Lloyd [redacted]@health.qld.gov.au>
**Sent:** Friday, 14 February 2020 10:31
**To:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Subject:** FW: DNA success rates manuscript

Hi Matt,

I've been asked to go through your manuscript. I've given it a good read and have a few questions/comments… I'm more than happy to meet up or talk on the phone, whatever suits you better.

My number is [redacted] or [redacted].

Looking forward to working with you on this.

Kind regards,

**Allison Lloyd**
A/Senior Scientist - Intelligence Team

**Forensic DNA Analysis, Police Services Stream**
Forensic & Scientific Services, Health Support Queensland, Queensland Health

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---

**From:** Cathie Allen [redacted]@health.qld.gov.au>
**Sent:** Tuesday, 11 February 2020 12:04 PM
**To:** Allison Lloyd [redacted]@health.qld.gov.au>

**Cc:** Justin Howes [redacted]@health.qld.gov.au>; Paula Brisotto [redacted]@health.qld.gov.au>
**Subject:** FW: DNA success rates manuscript

Hi Allison

Thanks so much for agreeing to be the FSS collaborator on this paper – I really appreciate it, given your busy role.

Attached is the manuscript and also the raw data.

I've discussed with Matt that the Government would be expecting a collaboration on this, given the significant investment they have made in the Forensic DNA Analysis lab to undertake DNA testing solely for the purpose of the QPS. I appreciate that Matt has driven this work himself and has focussed on sampling, however my perspective is that the lab has tailored it's processes to ensure success for a sample that's submitted, so it's a collaboration and Matt readily agreed. Matt has done all of the evaluation of the data to date, so I suggested that perhaps the FSS rep (as we spoke on Friday, prior to offering you the opportunity so wasn't able to name you) would be able to review some data, as I believe he hasn't taken into account any microcons that we've done to achieve the profiles. So they may need to run the report in the FR again, to capture the post extraction techniques so that we can review them to see if they have affected the outcome. If the report needs to be re-run, Matt will be able to achieve that, given he's within the QPS.

Please let me know if you have any questions. I'm excited that we're able to collaborate with the QPS on this and am excited for you to be given this opportunity, given your vast experience with profiles and NCIDD.

Cheers
Cathie

[redacted]

**Cathie Allen**
Managing Scientist

**Police Services Stream, Forensic & Scientific Services**
Health Support Queensland, Queensland Health

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**a** 39 Kessels Road, Coopers Plains, QLD 4108
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[redacted]

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---

**From:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Sent:** Tuesday, 7 January 2020 1:02 PM
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>
**Subject:** DNA success rates manuscript



Dear Cathie,

Over the latter months of last year I spent some time summarising FR data for DNA results with a view to establish percentage successes for common items/substrates and collection methods. This was essentially a self-driven project that grew out of conversations with SOCOs and OICs and so the focus was on our side of the process to

ensure we're making the best decisions on sampling to maximise success in the lab. In a nutshell it involved pulling information on the DNA results for every exhibit that was submitted over a set time period and searching the item description/location fields for keywords that allowed extraction of specific items/substrate results. The aim was to develop an evidence base on the success rates of sampling certain items to inform procedures and make recommendations to our officers on which collection methods were most effective for specific items based on recent data from actual casework.

I've now completed the analysis and have written the results up as a short paper that I hope to submit to AJFS as I believe this information is important to communicate to the forensic community. However, because the paper necessarily contains information about DNA profiling in Queensland we wish to offer you the opportunity to review the draft manuscript before submission to ensure that you and QHFSS are happy for the contents to be published. Please find attached the draft manuscript as a word document and the tables both at the end of the manuscript and as a separate excel file on individual sheets.

If you would like any further explanation on the methods or outcomes, please don't hesitate to get in touch.

Kind regards,

Matt

**Dr. Matt Krosch**
Research Officer
Quality Management Section, Forensic Services Group
Queensland Police Service
Ph: (07) [redacted] | M: [redacted] | Email: [redacted]@police.qld.gov.au

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**********

## Allison Lloyd

**From:** Allison Lloyd
**Sent:** Friday, 14 February 2020 1:04 PM
**To:** Krosch.MattN[OSC]
**Subject:** RE: DNA success rates manuscript

Hi Matt,

Monday is better for me due to on and off meetings all day. Have a good weekend.

Thanks,

Allison

---

**From:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Sent:** Friday, 14 February 2020 10:59 AM
**To:** Allison Lloyd [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]@police.qld.gov.au>
**Subject:** RE: DNA success rates manuscript

Hi Allison,

I'm out of the office today, but on email. Otherwise I'll be back at the desk on Monday. Happy to hear your thoughts.

Cheers
Matt

**Dr. Matt Krosch**
Research Officer
Quality Management Section, Forensic Services Group
Queensland Police Service
Ph: (07) [redacted] | M: [redacted] | Email: Krosch.MatthewN@police.qld.gov.au

---

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**Sent:** Friday, 14 February 2020 10:31
**To:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Subject:** FW: DNA success rates manuscript

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My number is [redacted] or [redacted].

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Kind regards,

**Allison Lloyd**
A/Senior Scientist - Intelligence Team

**Forensic DNA Analysis, Police Services Stream**
Forensic & Scientific Services, Health Support Queensland, Queensland Health

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**a** 39 Kessels Road, Coopers Plains, QLD 4108
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**Cc:** Justin Howes [redacted]@health.qld.gov.au>; Paula Brisotto [redacted]@health.qld.gov.au>
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Cheers
Cathie

[redacted]

**Cathie Allen**
Managing Scientist

**Police Services Stream, Forensic & Scientific Services**
Health Support Queensland, Queensland Health

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[redacted]

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**From:** Krosch.MattN[OSC] [redacted]@police.qld.gov.au>
**Sent:** Tuesday, 7 January 2020 1:02 PM
**To:** Cathie Allen [redacted]@health.qld.gov.au>
**Cc:** Keatinge.DavidJ[OSC] [redacted]J@police.qld.gov.au>
**Subject:** DNA success rates manuscript

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Kind regards,

Matt



**Dr. Matt Krosch**
Research Officer
Quality Management Section, Forensic Services Group

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## Allison Lloyd

**From:** Allison Lloyd
**Sent:** Monday, 17 February 2020 11:57 AM
**To:** Krosch.MattN[OSC]
**Subject:** Thresholds

Hi Matt,

One thing I forgot to mention… Sub threshold peaks for PowerPlex 21 are under 40 RFU but for Profiler Plus ( all of 2017 for volume crime) were less than 50 RFU.

Kind regards

**Allison Lloyd**
A/Senior Scientist - Intelligence Team

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## Allison Lloyd

**From:** Allison Lloyd
**Sent:** Tuesday, 18 February 2020 1:34 PM
**To:** Cathie Allen
**Cc:** Justin Howes
**Subject:** QPS Manuscript Feedback given via phone call 17/02/2020

Hi Cathie,

Here is a breakdown of the feedback I gave to Dr Matt Krosch yesterday morning via phone call regarding the 'Variation in Forensic DNA profiling… ' manuscript.

Points discussed:

1. Page 4/Methods – We were still using Profiler Plus for volume crime samples for the most part of 2017 which was not mentioned. This also had implications for results obtained in the second paragraph of Methods as we were using a binary method of interpretation which would affect the profiles that could be counted as a 'successful' profile.
2. Page 4/Methods – QIA symphony was not mentioned
3. Page 5/Methods, line 1: Sub-threshold information (<150rfu) was incorrect and different for the different kits used.
4. Page 4/Methods, bottom line: (no DNA+full) what does this mean? This is when a 'NO DNA' result line was released and most likely the quant was not right, the batch requanted and corrected results released. I said these results should be considered as being the 'updated/corrected' results.
5. General discussion on what was considered a 'full' profile/mixed/partial. These results were taken directly from result lines in the FR. I offered to go through them in more detail. In my opinion, Dr Krosch did not have a particularly strong understanding of the results or what they meant.
6. General discussion on what was considered a 'successful' profile. I said that in my opinion, obtaining a profile regardless of whether is was able to be interpreted would be considered successful. It is my understanding that the QPS version of a successful result was obtaining a suspect identification/LR favouring contribution for a suspect (Page 6, 1st paragraph). I suggested that some definitions around 'success' and even the types of results such as 'full/mixed/partial etc' were put in the manuscript to avoid ambiguity.
7. General discussion that the processes/reworking strategies that DNA Analysis used were not vital to the manuscript as this was generally looking at different sampling methods and the different types of results obtained from those sampling methods and substrates and the point of the paper was for SOCOs to have some printed advice to take to Investigators for discussions as to why certain samples might not be as worthwhile as others (as per the anecdotal experience mentioned on page 3/Introduction). I expressed enthusiasm for this as I could see that might be less complex or uninterpretable profiles and our analysts could focus more time on potentially meaningful samples which would benefit us all. The impression I got from this was that we were both on the same wavelength.
8. General discussion on the success of the tape lifts (page 7/Discussion). I gave anecdotal stories of where I had seen unexpected profiles obtained on objects such as tapelifted rocks/bricks and that the success of the tapelifts was pleasantly surprising.

Thanks,



**Allison Lloyd**
A/Senior Scientist - Intelligence Team

**Forensic DNA Analysis, Police Services Stream**
Forensic & Scientific Services, Health Support Queensland, Queensland Health

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