

Forensic and Scientific Services

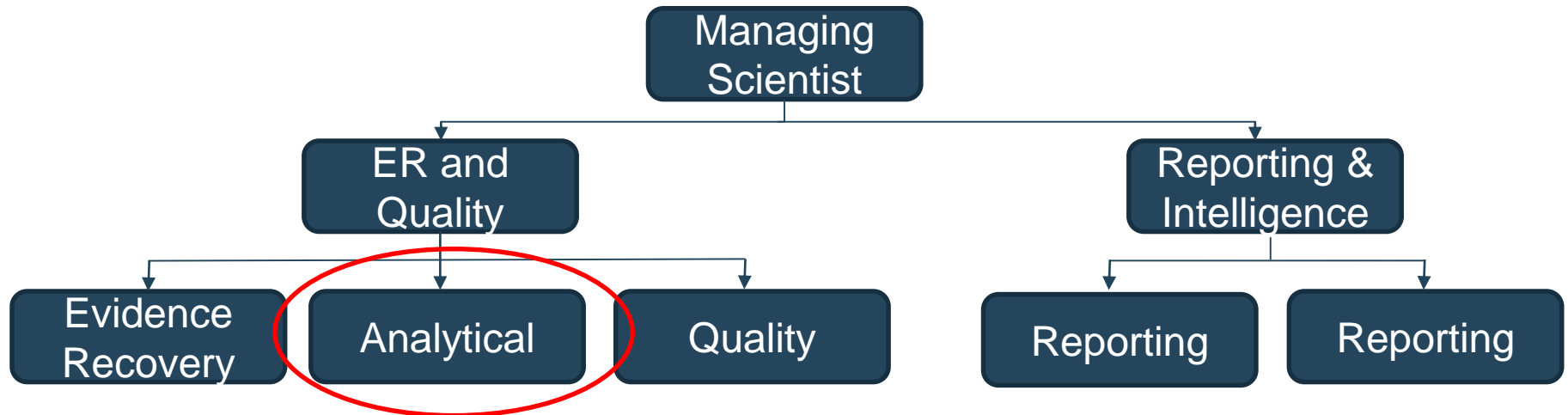
Working with the Queensland Police Service to Assess Operational Effectiveness of MPS in Criminal Investigations

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Queensland Forensic DNA

- Queensland Police Service (QPS) collect crime scene and reference samples
- Forensic DNA Analysis conducts forensic DNA testing for state of Queensland
- Forensic DNA Analysis (FDNA) is a part of Queensland Health, separate from QPS



- Please note: In Australia we call NGS – MPS.

Forensic DNA Analysis



- High throughput NATA Accredited forensic laboratory
- 25,000 casework samples per year
 - 450-500 per week
- 16,000 reference samples per year
 - 300 per week
- Electronic interface with LIMS



Validation Approach

- Historically validations initiated, conducted and implemented by Forensic DNA Analysis
- Consultation/collaboration with QPS in assessing client needs has been limited:
 - Particularly in respect of operational utility/effectiveness
- Given MPS vs STRs difference - important to consult with QPS (client) to assess:

QPS desire
for MPS

MPS
Operational
Effectiveness

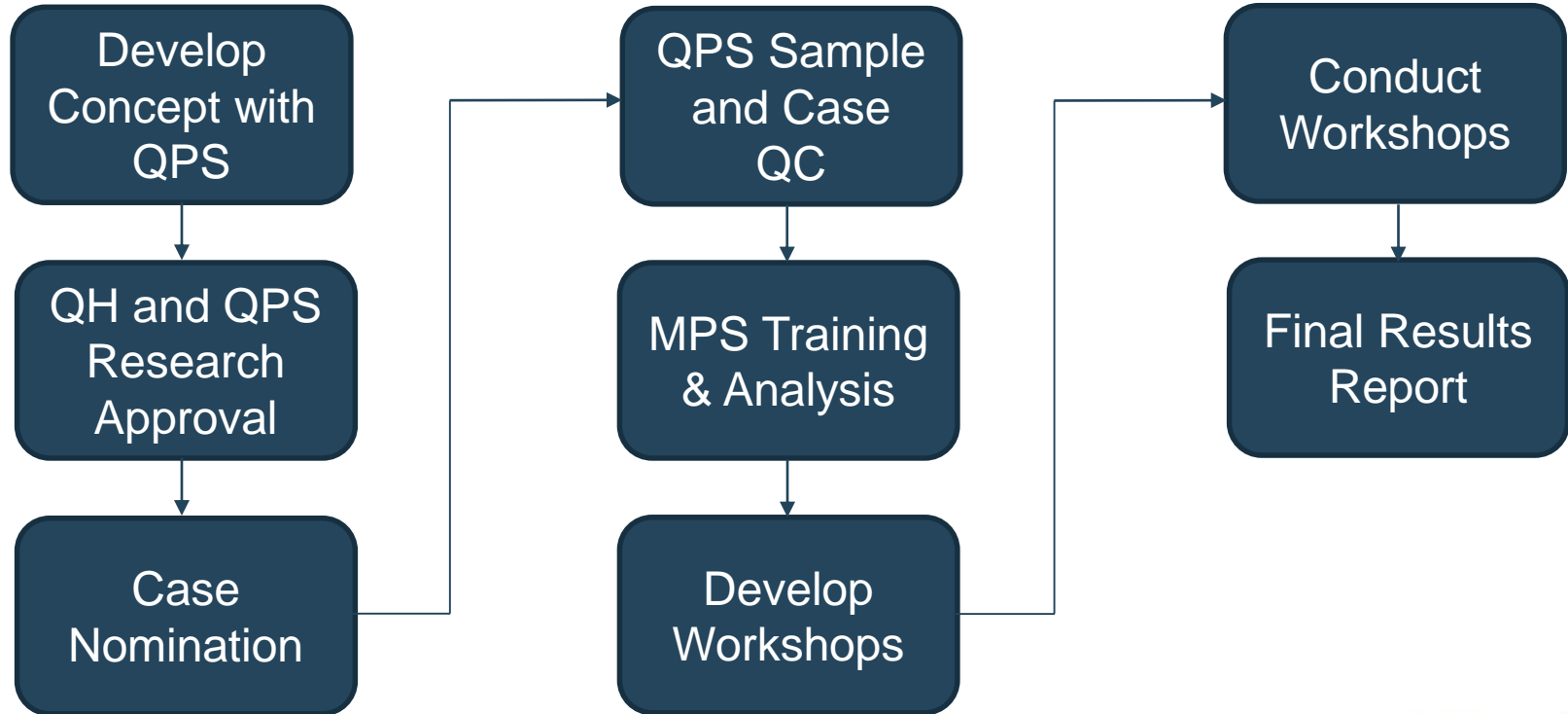
MPS use in
investigations

Reporting
format and
timeframes

Validation and
Training

Joint capital
bid?

Research Approach



Workshop Intent – Full Scenario

- Real QLD Cases with unknown offender and/or multiple suspects
- Reference samples only used
- All persons, MO, locations de-identified
- Offender photo, ethnicity, eye colour, hair colour
- Full case scenario presented to Investigators
- Blind assessment of utility of MPS intelligence
- MPS influence on investigation?
- How did this vary from the actual investigation?

Workshop Intent

- MPS verification cases
 - Cases with single or multiple offenders
 - Offenders with a range of appearances and ancestry
 - Assessment of accuracy and utility of MPS results
 - Larger sample set than Scenario cases.
- Current Status
 - Fully blind Investigator Workshops are yet to be conducted (end June)
 - Current findings are based on initial assessment with Homicide Detectives who are part of project team.

MPS Technology Used

- Extraction and Quantification performed in Qld.
- All MPS labwork performed in Thermo Fisher Scientific Laboratory (Melbourne)
- Panels:
 - Precision ID Ancestry Panel
 - DNA Phenotyping Panel
- Chemistry
 - Precision ID DL8 Kit
 - Precision ID Chef & Sequencing Kit
- Instruments:
 - Ion Chef™ and Ion S5™ XL Systems
 - Limited hands on, simple, intuitive



Initial Outcomes – Case 1

- Scenario:
 - Female person sexually assaulted and murdered. Located in suburban street.
 - Violent sexual assault.
- Suspects
 - Partner of deceased – Caucasian male
 - Known sex offenders in local area – Caucasian males
 - A number of property offenders known to be in offence area – Aboriginal and Torres Strait Islander (ATSI) males

Initial Outcomes – Case 1


- Investigation
 - Three suspect groups were investigated:
 - Caucasian partner of deceased
 - Caucasian known sex offenders
 - ATSI persons known to be in proximity to offence location
 - Each suspect group investigated thoroughly
 - Large investigative effort in terms of time and resources
- DNA Evidence
 - Unknown male DNA profile obtained from deceased's clothing
 - Nil other DNA evidence

Initial Outcomes – Case 1

- MPS Hirisplex results
 - Brown eyes
 - Dark Hair
 - Black Hair

Predicted phenotype		
	p-value	AUC Loss
blue eye	0.001	0
intermediate eye	0.017	0
brown eye	0.983	0
blond hair	0.004	0.003
brown hair	0.316	-0
red hair	0	0.013
black hair	0.681	0
light hair	0.012	0
dark hair	0.988	0

The HirisPlex System



Gene	SNP	Allele	No. of Alleles
1 <i>MC1R</i>	rs312262906	A	0 1 2 NA
2 <i>MC1R</i>	rs11547464	A	0 1 2 NA
3 <i>MC1R</i>	rs885479	T	0 1 2 NA
4 <i>MC1R</i>	rs1805008	T	0 1 2 NA
5 <i>MC1R</i>	rs1805005	T	0 1 2 NA
6 <i>MC1R</i>	rs1805006	A	0 1 2 NA
7 <i>MC1R</i>	rs1805007	T	0 1 2 NA
8 <i>TUBB3</i>	rs1805009	C	0 1 2 NA
9 <i>MC1R</i>	rs201326893	A	0 1 2 NA
10 <i>MC1R</i>	rs2228479	A	0 1 2 NA
11 <i>MC1R</i>	rs1110400	C	0 1 2 NA
12 <i>SLC45A2</i>	rs28777	C	0 1 2 NA
13 <i>SLC45A2</i>	rs16891982	C	0 1 2 NA
14 <i>KITLG</i>	rs12821256	G	0 1 2 NA
15 <i>LOC105374875</i>	rs4959270	A	0 1 2 NA
16 <i>IRF4</i>	rs12203592	T	0 1 2 NA
17 <i>TYR</i>	rs1042602	T	0 1 2 NA
18 <i>OCA2</i>	rs1800407	A	0 1 2 NA
19 <i>SLC24A4</i>	rs2402130	G	0 1 2 NA
20 <i>HERC2</i>	rs12913832	T	0 1 2 NA
21 <i>PIGU</i>	rs2378249	C	0 1 2 NA
22 <i>LOC105370627</i>	rs12896399	T	0 1 2 NA
23 <i>TYR</i>	rs1393350	T	0 1 2 NA
24 <i>TYRP1</i>	rs683	G	0 1 2 NA

Initial Outcomes – Case 1



Population Name	Percentage
Europe	5.0
Oceania	75.0
East Asia	0.0
Africa	0.0
South Asia	0.0
America	0.0
Southwest Asia	20.0



Population Name	Geo Region	Likelihood
Papuan New Guinean	Oceania	5.59E-47
Melanesian, Nasioi	Oceania	1.82E-50
Micronesians	Oceania	4.08E-52
Samoans	Oceania	4.13E-55
Hazara	Asia	2.08E-55
Malaysians	EastAsia	1.28E-59

Initial Outcomes – Case 1

- MPS Operational Effectiveness
 - ATSI males were known to be in vicinity of offence location, however limited evidence beyond this.
 - MPS information unlikely to be used to exclude Caucasians.
 - MPS information likely to provide additional support for further investigation of ATSI males and evidence collection.
- Enhancements
 - Skin colour/tone
 - Better ability to interpret ATSI BGA

Initial Outcomes – Case 2

- Scenario:
 - Sexual assault and murder of female victim. Located in park.
- Suspects
 - CCTV shows unknown male person in the vicinity of the crime.
- Investigation
 - CCTV enabled tracking of suspect to residence (inner city).
 - Suspect located and confessed.
 - Workshop scenario modified to remove tracking to residence.

Initial Outcomes – Case 2

- DNA Evidence
 - Unknown male DNA profile obtained from samples taken from deceased's clothing/body.
- MPS Hirisplex results
 - Brown eyes
 - Dark hair
 - Black Hair

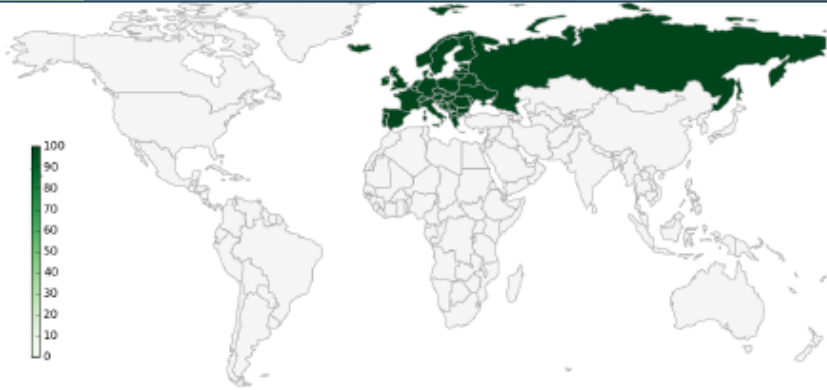
Predicted phenotype		
	p-value	AUC Loss
blue eye	0.005	0
intermediate eye	0.038	0
brown eye	0.957	0
blond hair	0.003	0.003
brown hair	0.297	-0
red hair	0	0.013
black hair	0.7	0
light hair	0.017	0
dark hair	0.983	0

The HirisPlex System



	Gene	SNP	Allele	No. of Alleles
1	<i>MC1R</i>	rs312262906	A	0 1 2 NA
2	<i>MC1R</i>	rs11547464	A	0 1 2 NA
3	<i>MC1R</i>	rs885479	T	0 1 2 NA
4	<i>MC1R</i>	rs1805008	T	0 1 2 NA
5	<i>MC1R</i>	rs1805005	T	0 1 2 NA
6	<i>MC1R</i>	rs1805006	A	0 1 2 NA
7	<i>MC1R</i>	rs1805007	T	0 1 2 NA
8	<i>TUBB3</i>	rs1805009	C	0 1 2 NA
9	<i>MC1R</i>	rs201326893	A	0 1 2 NA
10	<i>MC1R</i>	rs2228479	A	0 1 2 NA
11	<i>MC1R</i>	rs1110400	C	0 1 2 NA
12	<i>SLC45A2</i>	rs28777	C	0 1 2 NA
13	<i>SLC45A2</i>	rs16891982	C	0 1 2 NA
14	<i>KITLG</i>	rs12821256	G	0 1 2 NA
15	<i>LOC105374875</i>	rs4959270	A	0 1 2 NA
16	<i>IRF4</i>	rs12203592	T	0 1 2 NA
17	<i>TYR</i>	rs1042602	T	0 1 2 NA
18	<i>OCA2</i>	rs1800407	A	0 1 2 NA
19	<i>SLC24A4</i>	rs2402130	G	0 1 2 NA
20	<i>HERC2</i>	rs12913832	T	0 1 2 NA
21	<i>PIGU</i>	rs2378249	C	0 1 2 NA
22	<i>LOC105370627</i>	rs12896399	T	0 1 2 NA
23	<i>TYR</i>	rs1393350	T	0 1 2 NA
24	<i>TYRP1</i>	rs683	G	0 1 2 NA

Initial Outcomes – Case 2



Population Name	Percentage
Europe	100.0
Oceania	0.0
East Asia	0.0
Africa	0.0
South Asia	0.0
America	0.0
Southwest Asia	0.0



Population Name	Geo Region	Likelihood
European Americans	Europe	4.26E-35
Europeans-HapMap	Europe	2.59E-35
Danes	Europe	1.67E-35
Irish	Europe	1.52E-35
Hungarian	Europe	4.37E-36
Russians	Europe	1.54E-36
Finns	Europe	5.16E-37
Jews, Ashkenazi	Europe	4.99E-37

Initial Outcomes – Case 2

- MPS Operational Effectiveness
 - Case selected to assess ability to verify MPS results against CCTV.
 - CCTV images are from night time, and are of poor quality.
 - Unable to compare MPS results to CCTV images.
- Future considerations
 - The ability to track offender from offence location to residence is uncommon.
 - The ability to use CCTV to compare to MPS results would be useful. Particularly to corroborate eye witness descriptions.
 - Better quality CCTV would be required to compare against MPS results.

Initial Outcomes – Case 3

- Scenario:
 - Serial sexual offender. Break and Enter offences with sexual assault.
 - Offences occurred over a number of years.
- Suspects
 - Offender not initially identified as a suspect.
- Investigation
 - Large number of suspects investigated over approximately 8 year period.
 - Suspects from a range of nationalities, but large proportion were Caucasian (representative of Qld population).

Initial Outcomes – Case 3

- DNA Evidence
 - Multiple scenes with seminal stains which all gave the same unknown male DNA profile.
 - Nil suspects identified through national DNA database

- MPS EVC
 - Brown eyes
 - Dark Hair
 - Brown/Black Hair

Predicted phenotype		
	p-value	AUC Loss
blue eye	0	0
intermediate eye	0.016	0
brown eye	0.984	0
blond hair	0.006	0.003
brown hair	0.42	-0
red hair	0	0.013
black hair	0.573	0
light hair	0.018	0
dark hair	0.982	0

The HirisPlex System



	Gene	SNP	Allele	No. of Alleles
1	MC1R	rs312262906	A	0 1 2 NA
2	MC1R	rs11547464	A	0 1 2 NA
3	MC1R	rs885479	T	0 1 2 NA
4	MC1R	rs1805008	T	0 1 2 NA
5	MC1R	rs1805005	T	0 1 2 NA
6	MC1R	rs1805006	A	0 1 2 NA
7	MC1R	rs1805007	T	0 1 2 NA
8	TUBB3	rs1805009	C	0 1 2 NA
9	MC1R	rs201326893	A	0 1 2 NA
10	MC1R	rs2228479	A	0 1 2 NA
11	MC1R	rs1110400	C	0 1 2 NA
12	SLC45A2	rs27877	C	0 1 2 NA
13	SLC45A2	rs16891982	C	0 1 2 NA
14	KITLG	rs12821256	G	0 1 2 NA
15	LOC105374875	rs4959270	A	0 1 2 NA
16	IRF4	rs12203592	T	0 1 2 NA
17	TYR	rs1042602	T	0 1 2 NA
18	OCA2	rs1800407	A	0 1 2 NA
19	SLC24A4	rs2402130	G	0 1 2 NA
20	HERC2	rs12913832	T	0 1 2 NA
21	PIGU	rs2378249	C	0 1 2 NA
22	LOC105370627	rs12896399	T	0 1 2 NA
23	TYR	rs1393350	T	0 1 2 NA
24	TYRP1	rs683	G	0 1 2 NA

Initial Outcomes – Case 3



Population Name	Percentage
Europe	60.0
Oceania	30.0
East Asia	0.0
Africa	10.0
South Asia	0.0
America	0.0
Southwest Asia	0.0



Population Name	Geo Region	Likelihood
Negroid Makrani	Asia	6.84E-55
Kuwaiti	Asia	3.13E-57
Mohanna	Asia	1.18E-57
Pashtun	Asia	8.62E-58
Palestinian	Asia	1.83E-58
Keralite	Asia	7.32E-59

Initial Outcomes – Case 3

- MPS Operational Effectiveness
 - Offender was identified through a DNA link from an unrelated offence.
 - Offender is not Caucasian (ATSI)
 - MPS results could have been used to verify the DNA link information.
 - MPS results could not be used to exclude Caucasian suspects.
 - MPS used in conjunction with other evidence to develop the investigation.

- Enhancement: skin colour/tone

Further Notes

- Murder offence with multiple offenders of Maori and Polynesian ancestry.
 - BGA results were largely inconclusive.
 - Hirisplex results were accurate.
 - Further work required to develop representative Maori and Polynesian data sets
- Sexual assault with two males both with high p-values for Blue Eyes
 - Offence occurred in night club district – drivers licences are scanned.
 - MPS in conjunction with CCTV (clothing and location) could be used to link to driver's licence.
- Current MPS capability useful in attributing suspects to large population groups.

Future Research

- Conduct Investigator Workshops.
- Contribute to and expand ATSI, Maori and Polynesian population datasets.
- Continue to work with QPS to assess operational use and potential for active casework.

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 - Detective Sergeant Marcus Edwards
 - Sergeant Libby Harris
- Thermo Fisher Scientific
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 - Lucy Dagostino
 - Dan Power

Questions?

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