DNA Mixture Analysis:
Principles and Practice of Mixture Interpretation and Statistical Analysis Using the SWGDAM STR Interpretation Guidelines

Numbers and Types of Casework Mixtures

John M. Butler
Michael D. Coble

NIST

AAFS 2011 Workshop #17

Chicago, IL

February 22, 2011

Torres et al. 4 year Spanish study

Torres *et al.* (2003) *Forensic Sci. Int.* 134:180-186

- Four year study (1/1997 to 12/2000)
- 2424 samples typed
  - 955 samples from sexual assaults
  - 1408 samples from other offenses
  - 49 samples from human remains identifications
- 163/2424 samples (6.7% showed mixed profile)

Torres et al Spanish Case Summary Data

Type of sample

N = 163		Blood	Semen	Saliva
Victims	N = 60	**23%**	**73%**	---
Clothing/ bedding	N = 76	**70%**	**30%**	---
Weapons	N = 15	**100%**	---	---
Crime scene	N = 12	**75%**	---	**25%**

Case type

Spreadsheet Information Requested

http://www.cstl.nist.gov/biotech/strbase/mixture.htm

Labs requested to also provide info on kit, PCR volume used, etc.

- **Case#**
- **Item#**

This information retained by lab and not returned…

- **Type of sample (biological material if ID'd)**
- **Type of substrate**
- **Quantity amp'd**
- **Minimum # of contributors (1, 2, 3, 4, or >4)**
- **Predominant type (major profile) determined?**
- **Stats reported**
- **Comments**

We would love to have your lab mixture numbers…

Email information to michael.coble@nist.gov

MN BCA Case Summary Data #2

 # contributors

N = 373		1	2	3	4	>4
Sexual Assault	N = 144	**57%**	39%	4%	--	--
Major Crime	N = 98	**70%**	21%	8%	1%	--
High Volume	N = 131	**33%**	47%	18%	2%	--

Case type

Single source

Mixtures

Mixture Case Summaries

Collection organized by Ann Gross (July 2007 – Feb 2008)

14 Labs	State	# Samples
MN BCA	Minnesota	334
CA DOJ	California	285
GBI	Georgia	19
Kern Co	California	31
CT	Connecticut	610
USACIL	US Army	119
RCMP	CANADA	1555
NJSP	New Jersey	101
MSP	Michigan	225
WSP	Washington	419
IL	Illinois	76
MT	Montana	408
AA Co MD	Maryland	322
CFS-Toronto	CANADA	276
Total =		**4780**

Sample Type	minimum # of contributors					N	
	1	2	3	4	>4	N	
Blood	1207	296	72	1	0	1576	35.9%
Bone	4	0	0	0	0	4	0.1%
e-cells	215	165	94	13	2	489	11.2%
Hair	62	5	1	0	0	68	1.6%
PBM	183	127	45	7	0	362	8.3%
Rectal swab	0	16	1	0	0	17	0.4%
Saliva	114	81	23	0	0	218	5.0%
Semen/sperm	536	546	92	9	0	1183	27.0%
Sweat	3	3	1	0	0	7	0.2%
Touch	85	143	77	9	0	314	7.2%
Vaginal swab	3	62	4	0	0	69	1.6%
Wearer	17	36	22	2	0	77	1.8%
Total	2429	1480	432	41	2	4384	
	55.4%	33.8%	9.9%	0.9%	0.05%		

This initial data compilation performed by Michelle Burns (NIST 2008 summer intern)

Crime Class	minimum # of contributors					N	
	1	2	3	4	>4	N	
Sexual Assault	884	787	145	11	0	1827	40.2%
Major Crime	1261	519	182	32	0	1994	43.9%
High Volume	344	220	140	11	5	720	15.9%
Total	2489	1526	467	54	5	4541	
	54.8%	33.6%	10.3%	1.2%	0.1%		

Crime Class	minimum # of contributors					N	
	1	2	3	4	>4		
Sexual Assault	884	787	145	11	0	1827	40.2%
Major Crime	1261	519	182	32	0	1994	43.9%
High Volume	344	220	140	11	5	720	15.9%
Total	2489	1526	467	54	5	4541	
	54.8%	33.6%	10.3%	1.2%	0.1%		

Laboratory	Crime Class	Minimum # of Contributors	
		2	3+
Minn.	Sexual Assault	59	5
	High Volume	43	24
Cal DOJ	Sexual Assault	62	15
	High Volume	5	0
Conn.	Sexual Assault	17	3
	High Volume	8	25
NJ	Sexual Assault	8	0
	High Volume	17	4
Michigan	Sexual Assault	63	14
	High Volume	32	21
Wash.	Sexual Assault	64	9
	High Volume	17	13

Laboratory	Crime Class	Minimum # of Contributors	
		2	3+
Illinois	Sexual Assault	122	23
	High Volume	25	35
Montana	Sexual Assault	77	11
	High Volume	22	16
AA (MD)	Sexual Assault	19	1
	High Volume	51	18
Tor-CFS	Sexual Assault	76	13
	High Volume	9	9
RCMP	Sexual Assault	243	64
	High Volume	0	0

Major ID'd	minimum # of contributors					
	2	3	4	>4	N	
yes	920	152	8	2	1082	60.4%
no	402	273	32	3	710	39.6%
Total	1322	425	40	5	1792	
	73.8%	23.7%	2.2%	0.3%		
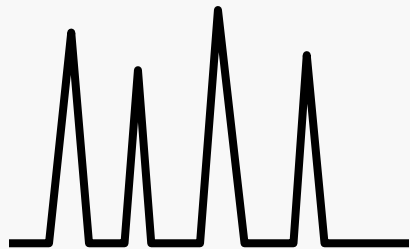
Type A

"Indistinguishable"
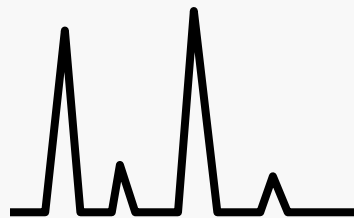
Type B

"Distinguishable"

Type C

"Uninterpretable"

~40% of mixtures are Indistinguishable or Uninterpretable

DNA Quantity

DNA Quantity	minimum # of contributors					N	
	1	2	3	4	>4		
≤0.5ng	72	65	17	3	1	158	4%
0.51-0.99ng	271	198	54	4	0	527	13%
1.0ng-1.49ng	962	476	114	12	1	1565	40%
≥1.5ng	870	576	199	28	2	1675	43%
Total	2175	1315	384	47	4	3925	

Statistics

Statistic	minimum # of contributors					N
	1	2	3	4	>4	
RMP	757	328	69	0	0	1154
PE (CPI/CPE)	14	54	26	7	2	103
LR	2	2	0	0	0	4
None	1018	692	241	38	3	1992
Total	1791	1076	336	45	5	3253

Overall summary of these data

- ~40-50% of samples from all types of cases are single source

- ~30-40% of samples from all types of cases are mixtures of at least two contributors

- ~5-15% of samples from all types of cases are mixtures of at least three contributors

- Complex mixtures were observed equally among sexual assault and high volume crimes, however, this is slightly skewed.

Acknowledgements

- Michelle Burns and Ann Marie Gross

- Thanks to the laboratories who took the time to fill out the spreadsheet

  - Georgia Bureau of Investigation
  - New Jersey State Police
  - Connecticut State Police
  - Michigan State Police
  - Washington State Police
  - Minnesota BCA
  - Anne Arundel County (MD)

  - California DOJ
  - Kern County (CA)
  - USACIL
  - Illinois State Police
  - Montana DOJ Crime Lab
  - Toronto CFS
  - RCMP (Ottawa)

The NIST Human Identity Project Team
(Forensic DNA & DNA Biometrics)
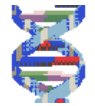
Applied Genetics

Funding from the **National Institute of Justice (NIJ)** through the NIST Office of Law Enforcement Standards and the **FBI S&T Branch** through the NIST Information Access Division

…Bringing traceability and technology to the scales of justice…

John Butler	Erica Butts	Mike Coble	Dave Duewer	Becky Hill	Margaret Kline	Kristen Lewis	Jan Redman	Pete Vallone
Project Leader, Forensic DNA								*Project Leader, DNA Biometrics*
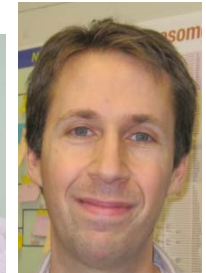
Workshops & Textbooks	Mixtures, mtDNA & Y	Concordance & LT-DNA	Kinship Analysis	Rapid PCR & Biometrics
DNA Extraction Efficiency	Software Tools & Data Analysis	Variant alleles & Cell Line ID	STRBase Support	

http://www.cstl.nist.gov/biotech/strbase/training.htm

michael.coble@nist.gov

301-975-4330