DNA Mixture Analysis:

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

---

Training Your Staff to Consistently Interpret Mixtures

Ray Wickenheiser

Montgomery County Police Crime Lab

AAFS 2011 Workshop #17

Chicago, IL

February 22, 2011

Outline

- Underlying principles
- The process
- Identify decision points
- Move from areas of agreement
- Identify zones of disagreement
- Seek objective authority
- Mixture flowcharts
- ROI

Underlying principles

- Consistent approach
- Scientifically valid
- Conservative
- Does not leave data on the table
- Easy to understand and explain

Does your lab interpret mixtures consistently?

DNA MIXTURES

Harness the power?

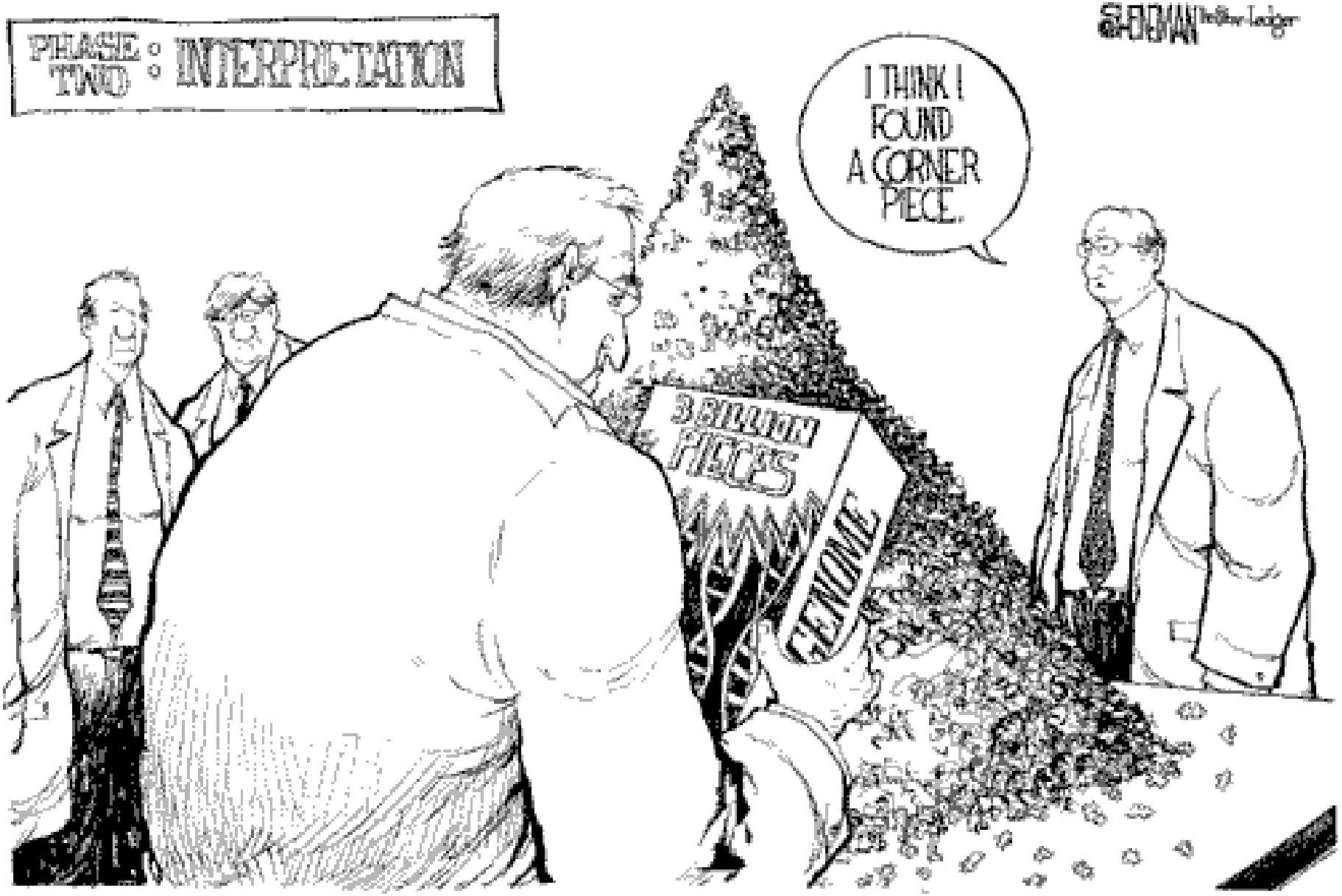
- Or prepare for meltdown?

The process

- It is a continuous process, built over time
- Staff built rather than dictated by management
- Management support and direction, but content driven by analysts and TL
- Same data, different conclusion? Consistency a scientific imperative, but also leads to efficiency which in turn creates cost savings!

Identify the decision points

- Making decisions on tipping points (Peak height ratios, thresholds, major to minor ratios)
- Quantifying the indecision and establishing thresholds
- 100 cut-off, what about 99, then 98, then 95. This is the slippery slope. There is always a line in the sand. Quantify the line.


PHASE TWO: INTERPRETATION
SHERMAN Inquirer-Ledger
I THINK I FOUND A CORNER PIECE.
3 BILLION PIECES
GENOME

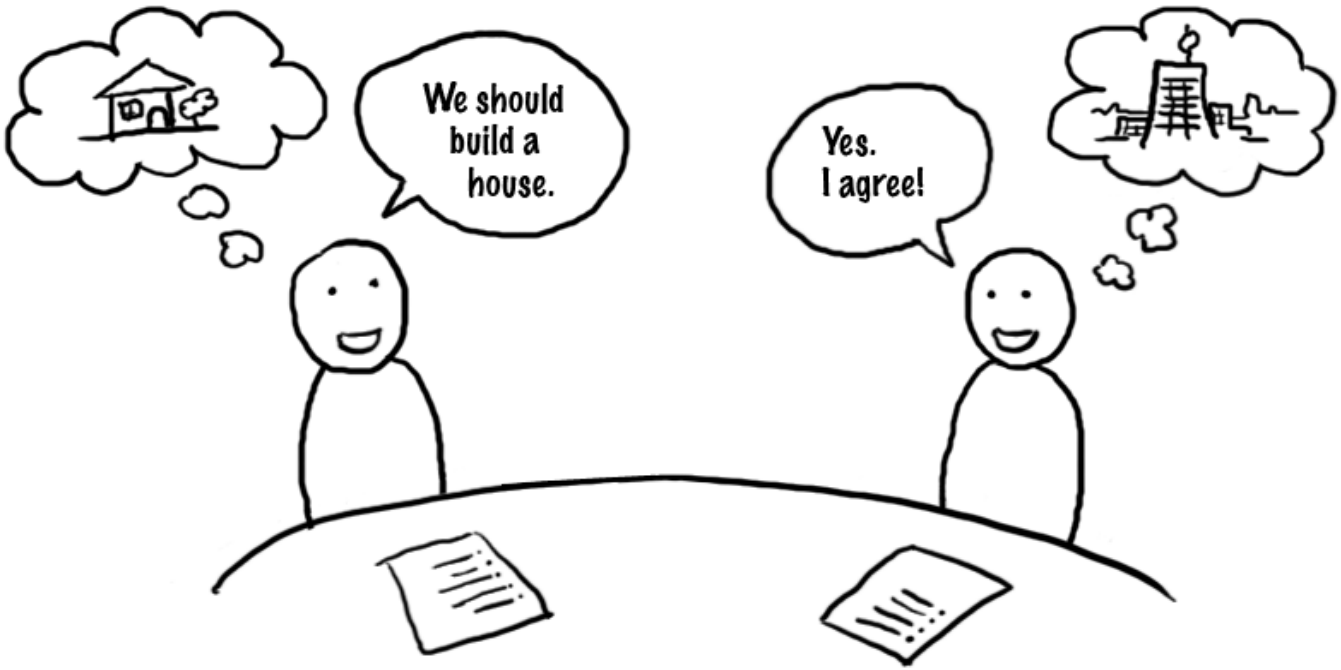
Use common themes

- Recognizing recurring themes of mixture types
- Sharing joint experiences (the experience of one becomes the experience of all)
- Nurturing a atmosphere of oper debate and sharing of opinions
- Management support rather than micromanagement and dictation

Move from areas of agreement

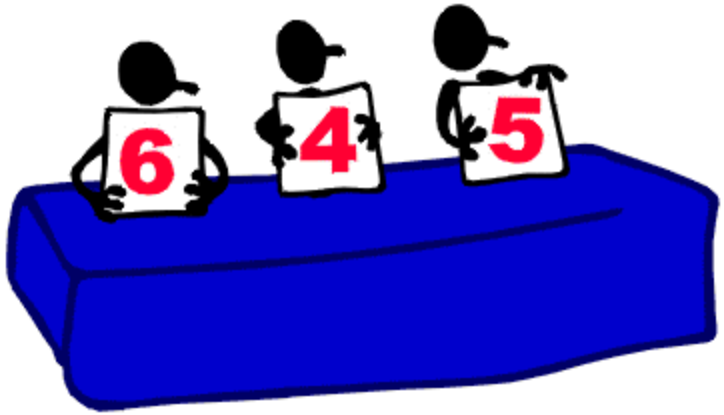
- Retaining best practices while moving forward
- Establishing zones of agreement while highlighting differences for further debat and refinement
- Keeping an open mind
- Moving from rigid positions to focusing on the issue
- Facilitated technique of conflict resolution – putting it up on the board for all to see, shifts the focus to the problem, then brainstorm.

Sharing a joint vision



Identify areas of disagreement

- Identifying and winning over the “Russian Judge”
- Pinpoint areas where you disagree
- Agree to disagree, then come back to them later
- This permit individuals to move slowly away from entrenched positions while “saving face”
- Tough on the problem, easy on individuals
- Retaining case examples to pinpoint issues in real case examples



Consider using a image projector

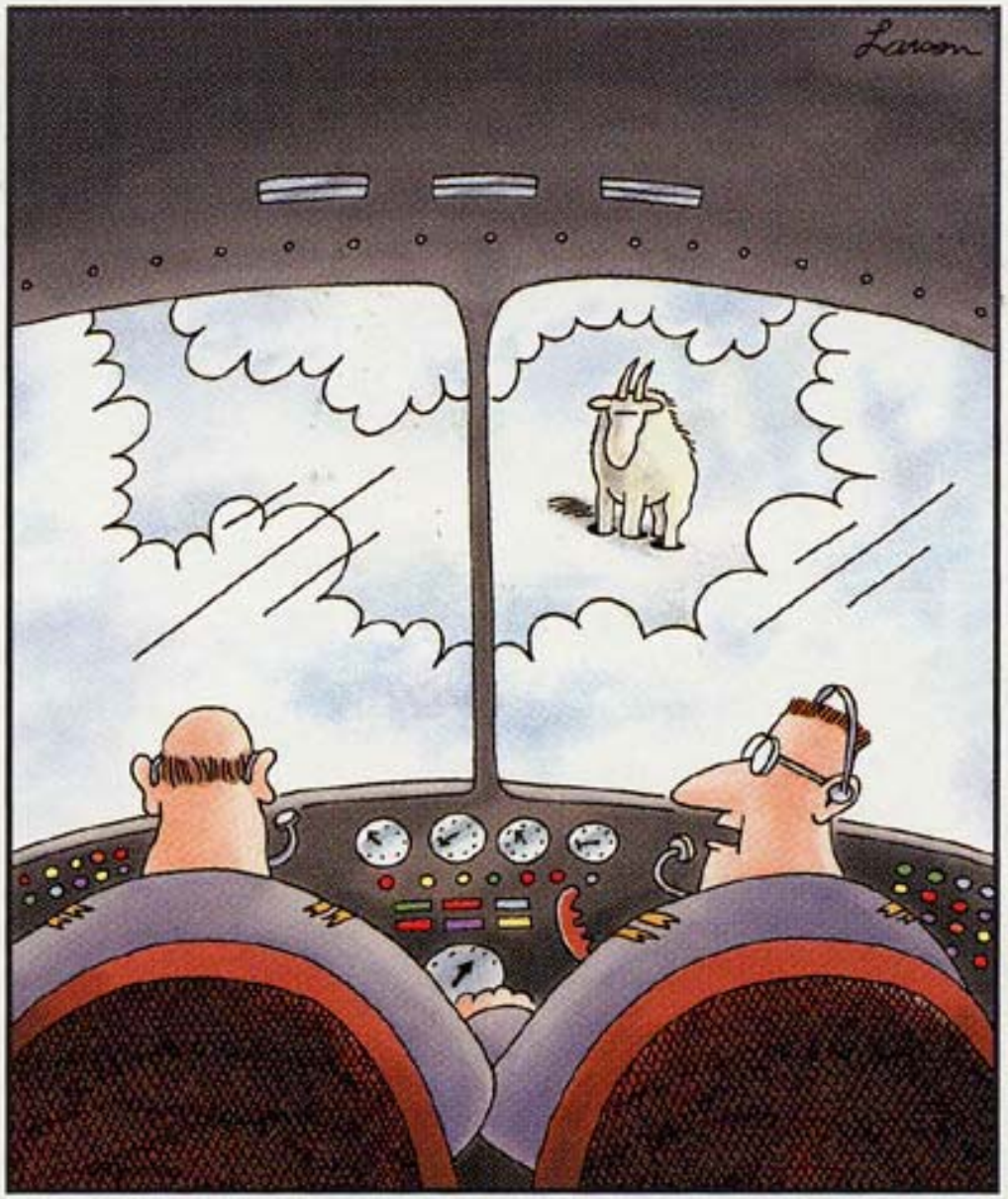
- Display evolving document in full view of all
- Moves the focus from person against person to people against the issues
- Ensures full communication
- Ensures everyone feels part of the solution
- Making the solution your own – everyone has a stake

Seek Objective Authority

- What are other labs doing?
- Scientists love to have their work “borrowed”
- Remember to use references
- Meeting and debating with other labs in user forums such as the CE user group meetings
- Obtaining outside training to expose to different ways of solving areas of disagreement

Quantify the grey areas

- Permitting examiner discretion within a framework
- Constantly checking and improving the framework based on other labs, developments in the field and ongoing case experience.
- Common point of agreement: Picking a major over a minor in a two person mixture
- Disagreement: When can I call the major or when can I use a known to subtract
- The time to have the debate is before the case is yours.



"Say ... what's a mountain goat doing
way up here in a cloud bank?"

10 Steps to Mixture Interpretation

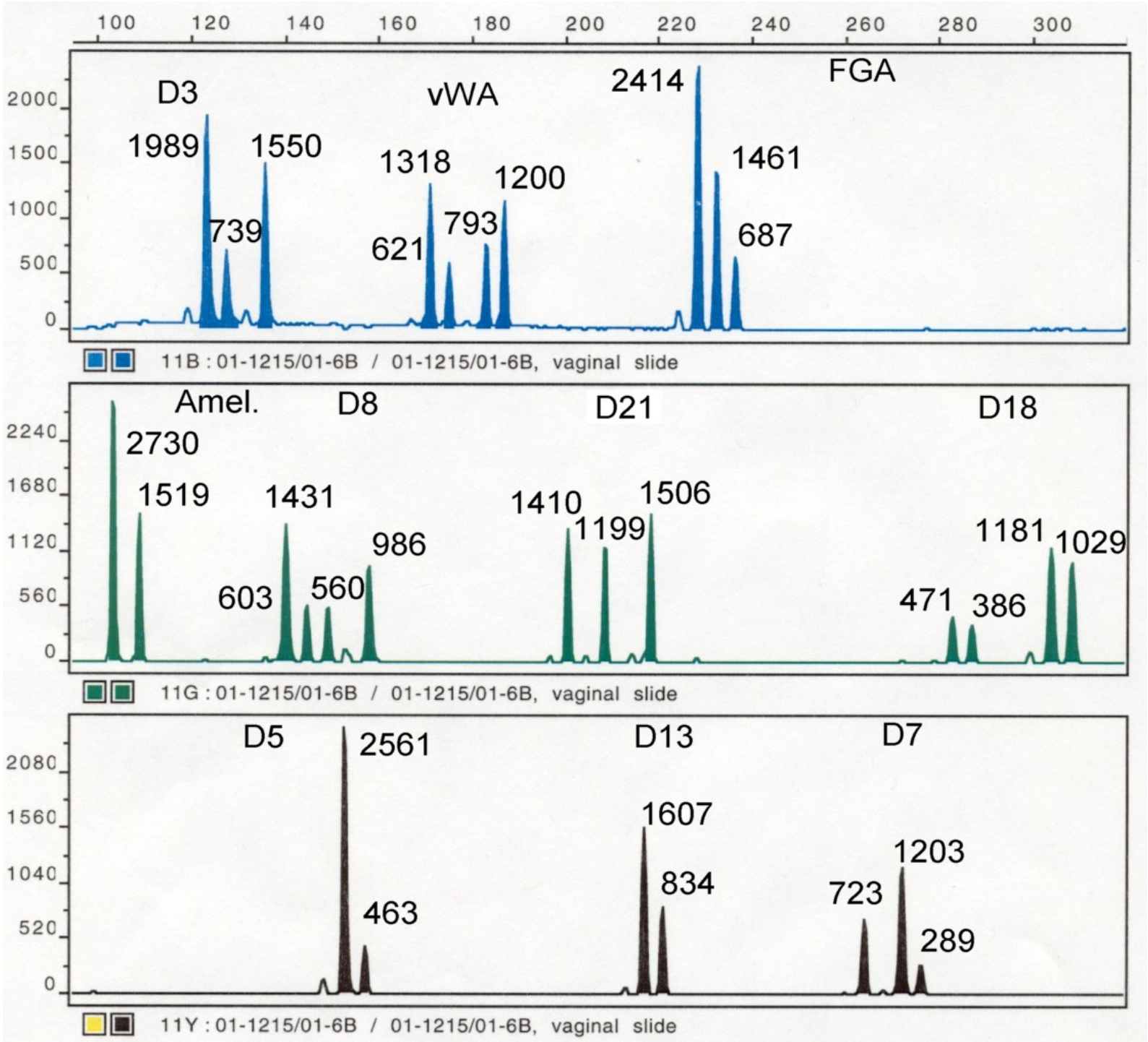
1. Know your **sample** and its forensic context
2. Develop the DNA **profile**
3. **Survey** the profile (entire profile overview)
4. **Sift** – arrive at the callable peaks and profile
5. Does sample **context** or features add value?

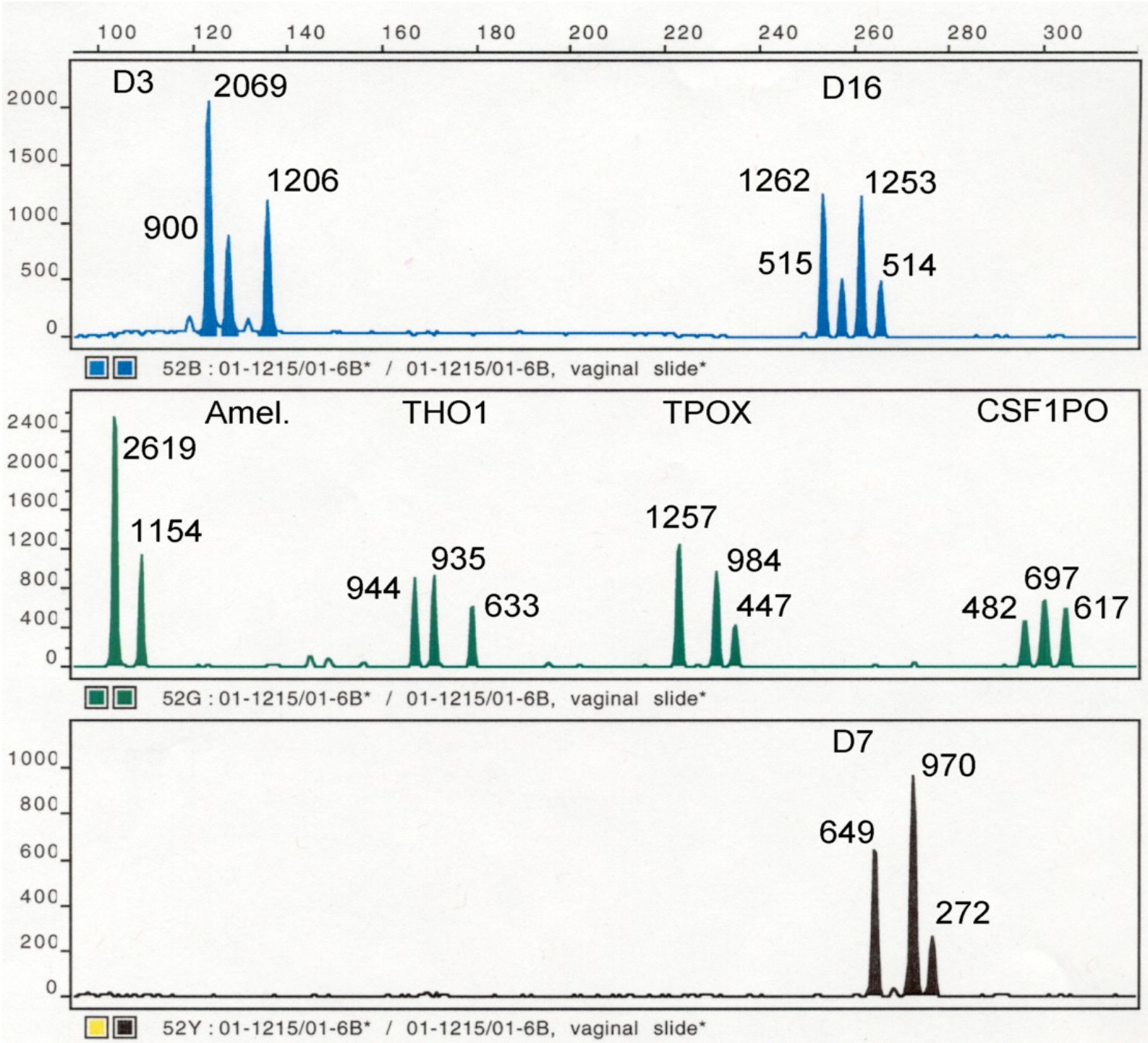
©2010 Ray Wickenheiser

10 Steps (cont.)

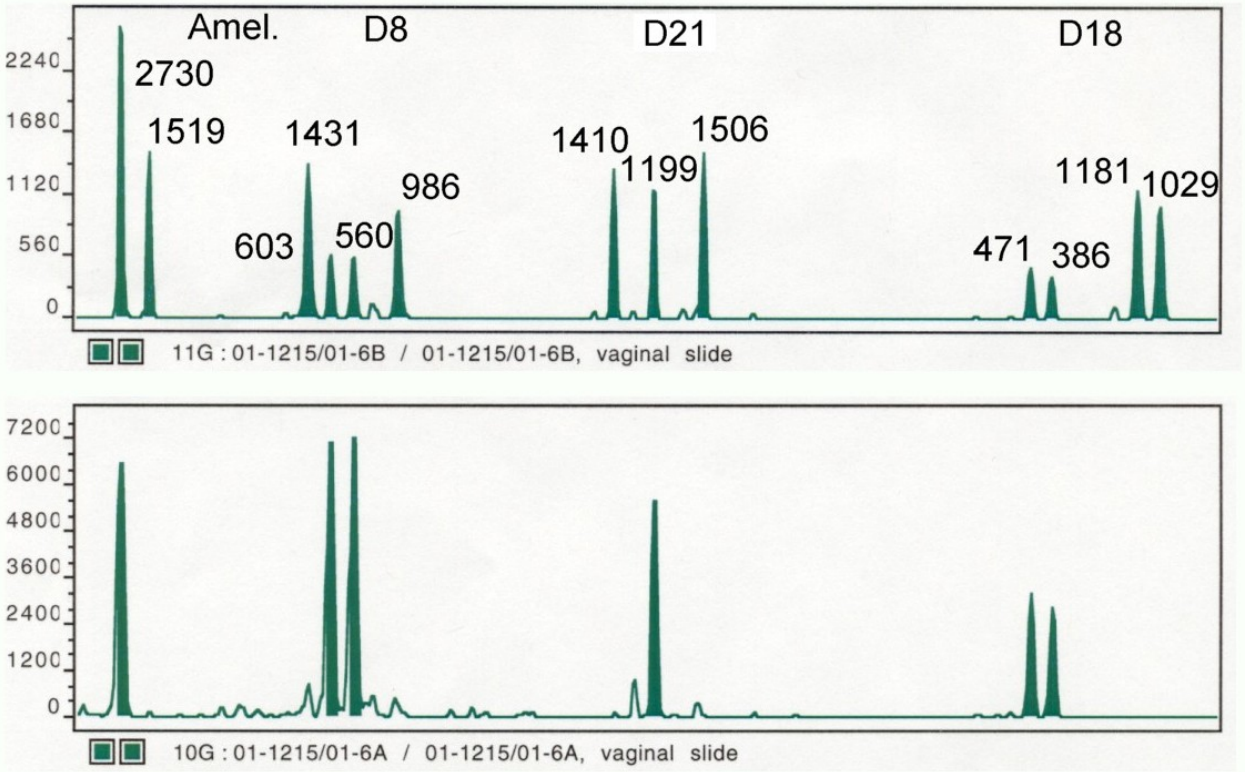
6. Do peak **heights** add value?
7. Sort - If profile is a mixture, determine mixture **type**
8. Can a sole **source** be identified?
9. What confidence can be applied to **minor** contributors?
10. **Compare** to known profiles – if included, with how much reliability?

©2010 Ray Wickenheiser

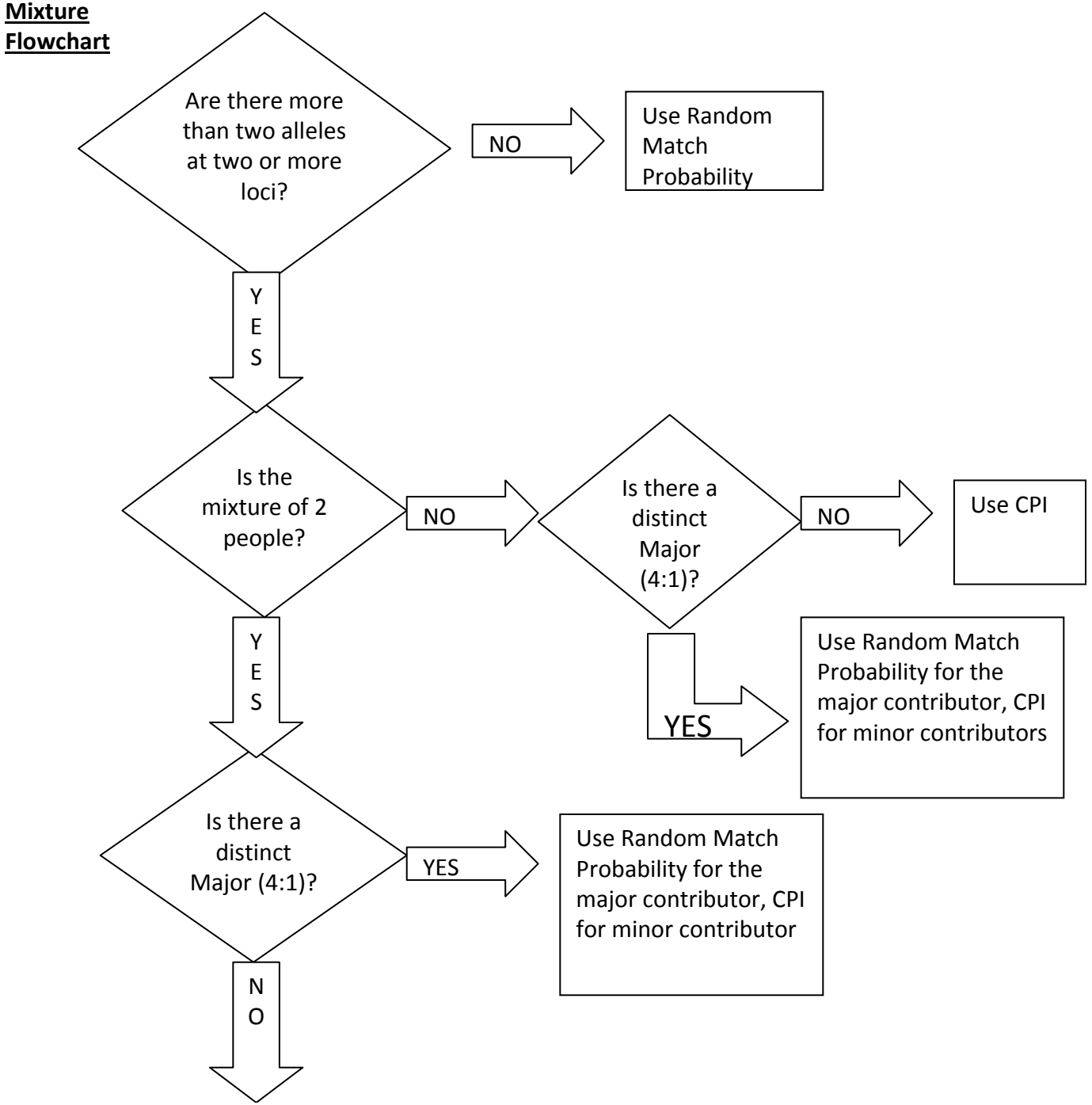

100 120 140 160 180 200 220 240 260 280 300
2000 1500 1000 500 0
D3
1989
1550
739
vWA
1318
1200
793
621
2414
FGA
1461
687
11B : 01-1215/01-6B / 01-1215/01-6B, vaginal slide
2240 1680 1120 560 0
Amel.
2730
1519
D8
1431
603
560
986
D21
1410
1199
1506
D18
1181
1029
471
386
11G : 01-1215/01-6B / 01-1215/01-6B, vaginal slide
2080 1560 1040 520 0
D5
2561
463
D13
1607
834
D7
1203
723
289
11Y : 01-1215/01-6B / 01-1215/01-6B, vaginal slide

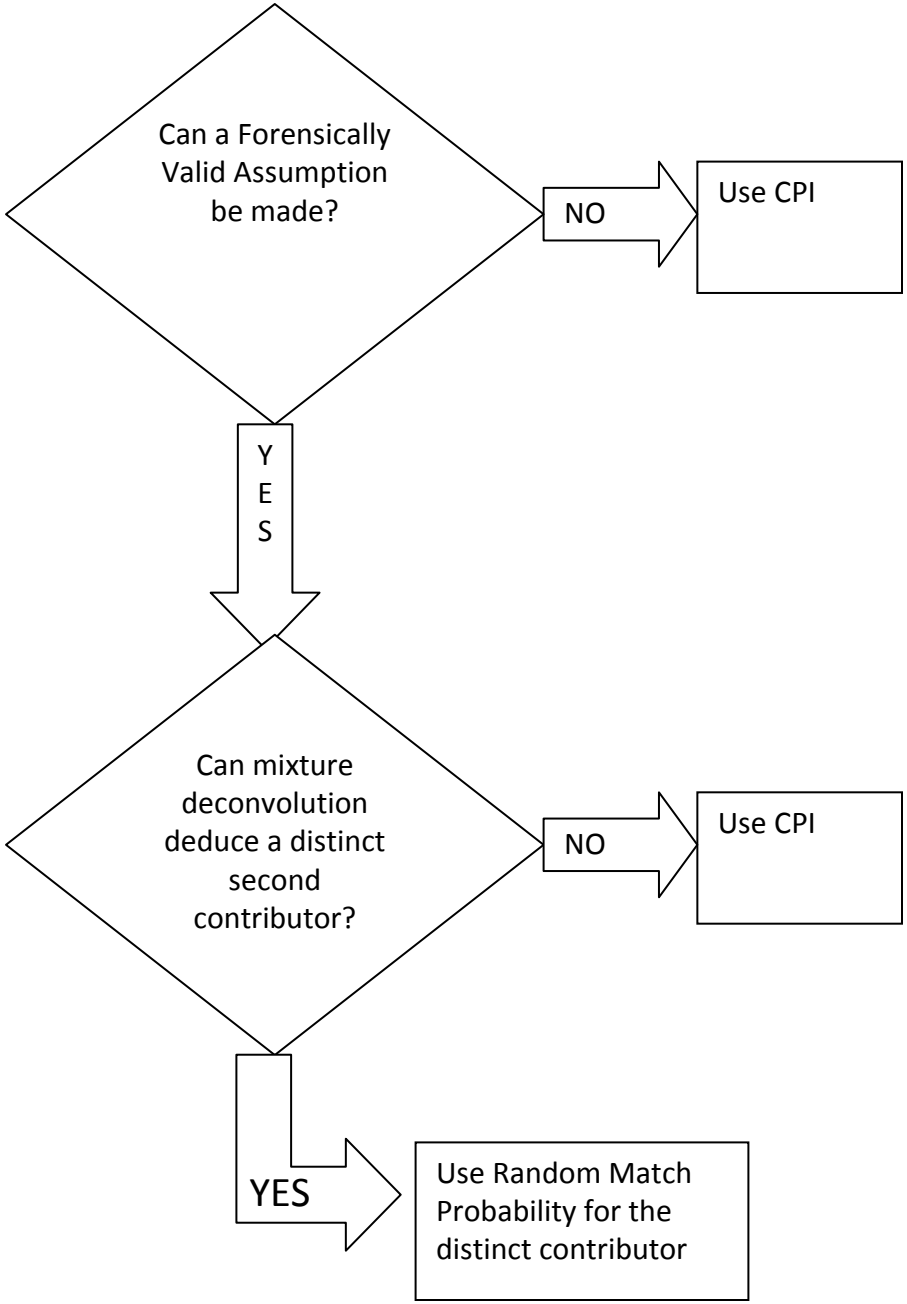

100 120 140 160 180 200 220 240 260 280 300
2000 1500 1000 500 0
D3
2069
1206
900
D16
1262
1253
515
514
52B : 01-1215/01-6B* / 01-1215/01-6B, vaginal slide*
2400 2000 1600 1200 800 400 0
Amel.
THO1
TPOX
CSF1PO
2619
1154
944
935
633
1257
984
447
482
697
617
52G : 01-1215/01-6B* / 01-1215/01-6B, vaginal slide*
1000 800 600 400 200 0
D7
970
649
272
52Y : 01-1215/01-6B* / 01-1215/01-6B, vaginal slide*

D21, D5, THO1 and CSF are ambiguous, unless you use another profile


Amel.
D8
D21
D18
2730
1519
1431
986
603
560
1410
1199
1506
1181
1029
471
386
2240
1680
1120
560
0
11G : 01-1215/01-6B / 01-1215/01-6B, vaginal slide
7200
6000
4800
3600
2400
1200
0
10G : 01-1215/01-6A / 01-1215/01-6A, vaginal slide

Mixture Flowchart




Can a Forensically Valid Assumption be made?
NO
Use CPI
Y E S
Can mixture deconvolution deduce a distinct second contributor?
NO
Use CPI
YES
Use Random Match Probability for the distinct contributor

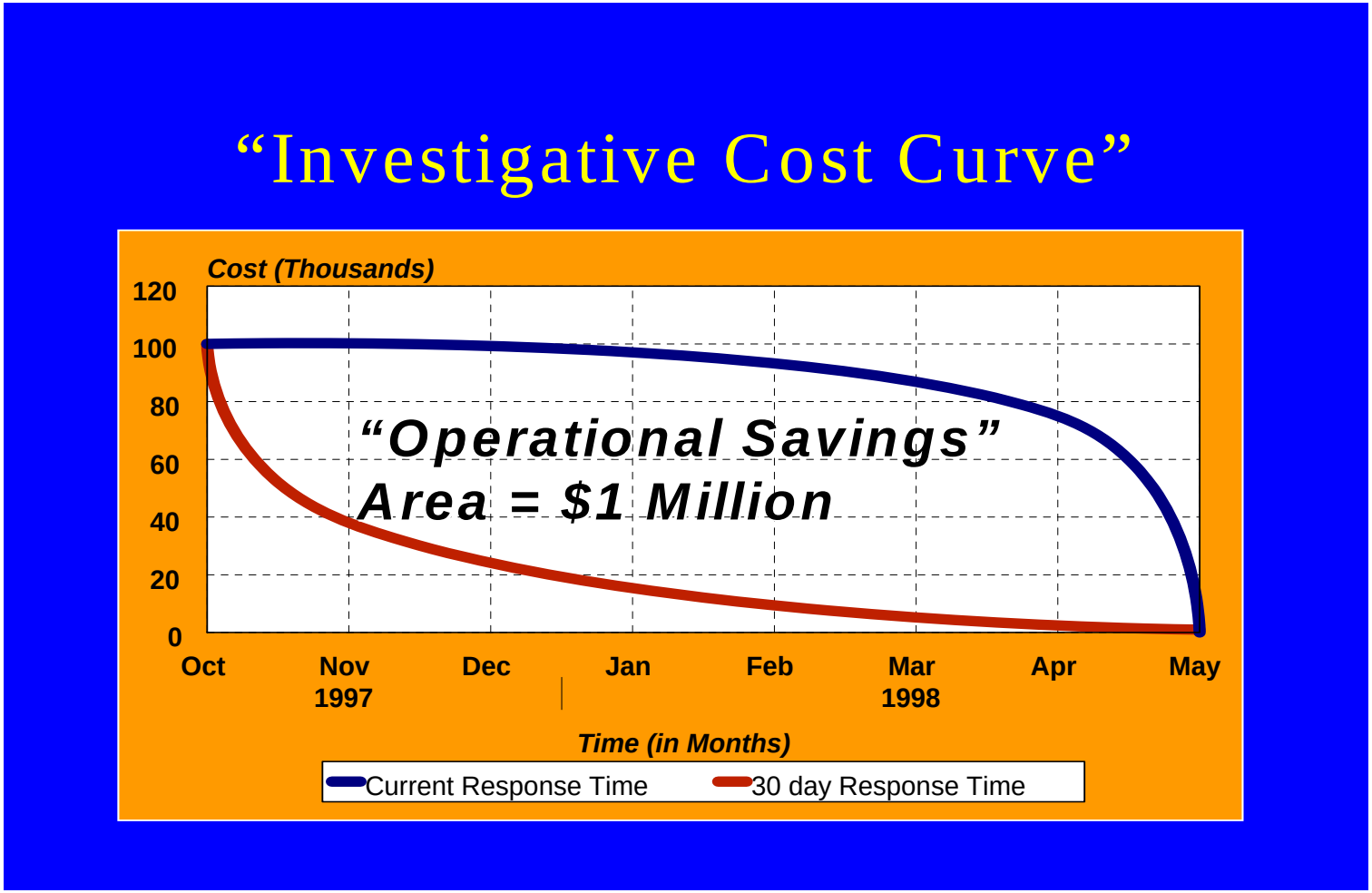
- So why do we want to do this?

"I like art I can understand."

Why Tighten Mixture Interpretation ?

- Process improvement: why do we want to do this from a management perspective?
- Less time spent means less money. We really have the same amount of resources, but if we can do more cases, this means fewer backlogs, in turn quicker response time. A quicker response time means savings to the investigation.
- Investigative cost curve and the front end loading of case costs.

Investigative cost curve



Source: G.H. MacLeod, Lab Manager (retired), Royal Canadian Mounted Police Forensic Laboratory, Regina, Saskatchewan, Canada

Reduction in Interpretation Time

- Average interpretation time 4 hours per case estimated
- Estimated 30% savings in interpretation time
- Average output 1 case per 19 hours
- That savings can produce a 6.8% increase in output
- Reduction of 1.3 hours per case permits over 6 additional cases completed per year

Analyst Output

	Cases	Items Examined	DNA Samples
Analyst 1	93	236	290
Analyst 2	100	258	318
Average	97	247	304

Cost Savings Calculation

- The average number of DNA profiles developed for CODIS per case in MCPD is 1.0
- With a total of 130 offender hits (09/2010) out of a total of 773 profiles entered into CODIS, the MCPD hit rate is 16.8 %
- With 6 extra cases per analyst, that would permit one additional hit per analyst annually.

Return on investment

- Prove this approach is a sound investment
- Rapes cost $111,238 each (1,2)
- Recidivism rate is 8 rapes per rapist
- Cost for each burglary is $1500 (3)
- Recidivism rate is 20 burglaries per burglar

Montgomery County ROI

- In 2009 CODIS hits on 8 rapes and 24 burglary/robbery cases
- Combined savings of $6.17 million
- Biology Unit has a estimated cost of $724,794 annually
- Return on investment is 851%
- $8.51 for each dollar spent

That is a $422,000 saving by improving 6.8% through implementing improved interpretation.

Good mixture interpretation guidelines

- Increase consistency
- Reduce conflict
- Improve efficiency
- Save costs
- = HAPPINESS!

For more information …

Ray Wickenheiser
Montgomery County Police Crime Lab
2350 Research Blvd
Rockville, MD 20850
(240)-773-5177

Ray Wickenheiser
Ray.Wickenheiser@MontgomeryCountyMD.gov

References

- 1. Wickenheiser, R.A., “The Business Case for Using Forensic DNA Technology to Solve and Prevent Crime”, Journal of Biolaw and Business, Vol. 7, No 3 (2004) pp 34-50.
- *2.* Miller,T.R., Cohen, M.A., and Weirsema, B., “Victim Costs and Consequences: A New Look”, U.S. Dept. of Justice, Office of Justice Programs, National Institute of Justice, http://www.ncjrs.org/txtfiles/victcost.txt, January 1996.
- 3. DNA in “Minor” Crimes Yields Major Benefits in Public Safety, NIJ Publication November 2004, NCJ 207203