DNA Mixture Interpretation:
Principles and Practice in Component Deconvolution and Statistical Analysis

Training Your Staff to Consistently Interpret Mixtures

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Panel Discussion

John Butler
(moderator)

Ann Marie Gross
Gary Shutler
Joanne B. Sgueglia

Responses to Questions
from a Previous Mixture Workshop (Fall 2007)

What are the biggest obstacles you face in your lab in terms of mixture interpretation?

- Trying to be consistent in my interpretation and with coworkers
- Consistency between analysts
- No consistency – based on analysts discretion/experience; due to lack of consistent training
- Vague SOP leading to inconsistency between analysts due to differences in how "conservative" or not each analyst is
- There is a lot of "individual interpretation" in our lab
- Varying opinions between interpreting analysts due to lack of uniform guidelines
- Resistance to change from other analysts/supervisors
- Getting management to commit to guidelines that will be followed by everyone

Panelists

- Ann Gross (MN)
- Gary Shutler (WA)
- Joanne Sgueglia (MA)

- Have served or are serving as **DNA Technical Leaders** for their state forensic DNA labs

- Have trained numerous forensic scientists

Questions for the Panelists

- How do you know that someone is well enough trained to do mixture interpretation?
- Do you use a qualifying test on mixture interpretation?
- How do you verify proficiency of analysts in terms of mixture interpretation over time?
- What types of tools would be helpful to you as a technical leader to aid your lab's training program?

Minnesota BCA

Washington State Patrol Crime Lab

- Mixture training program has been developed
  - One of the last Modules in training manual and consists of instruction and tasks in mixture interpretation, report writing and CODIS issues
- Includes a day of hands-on training from CLD HQ, mentorship from local lab Supervisor (and/or senior FS designate)
- Training module has requirement for 20 sets of case mixture data that trainees get to provide their written interpretations
- Literature references and validation reports

Massachusetts State Police Crime Lab

- NERFI DNA Academies
  - 4 Academies to date (trained 41 students)
  - Intensive 4 month curriculum
    - Fundamental and Applied Molecular Biology
    - SWGDAM Guidelines of > 50 samples and 20 data sets
    - Mixture Interpretation and Statistical Analyses week training with Carmody, Sgueglia and Wickenheiser.
    - Moot Court
  - Additional in house training to go over years of data and experiences from previous analysts, kits, instruments, etc. for mix and stats with JBS
  - Two follow up months with MSP direct supervisor to oversee technique, following of protocols, interpretations and case reporting.

NorthEast Regional Forensic Institute (NERFI):

The DNA Academy Model

UNIVERSITY AT ALBANY
State University of New York

A Partnership Between Crime Labs and the Northeast Regional Forensic Institute at the University at Albany

Curriculum Design & Implementation

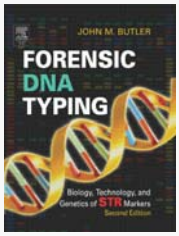
SOURCES: **Forensic Scientists**, **UAlbany**, **NIJ**, **CRIME LAB**

CUSTOMIZE COURSE CONTENT: **Jointly *Select*, *Identify*, and *Develop* Curriculum with Customer Laboratory**

DELIVERABLES:

1) ***Launch DNA Academy***
2) ***Produce Bench-Ready, Competency Tested Forensic Scientists***
3) ***Provide Continuing Education***

Distance Education I



- Combination of Videoconference and On-Site Lectures
  - Scientific and Technical Literature
  - Quality Assurance
  - Ethics Review and Issues

Mentor vs. Academy

- One DNA Unit Supervisor training approximately 7 new hires
- Over 14 months of time resulting in lower productivity
  - Limited casework processing
  - Less assistance with technical reviews
  - No time for validation studies
  - Lots of redundancy in training and demonstrations/observations/exams

DATA SETS

- Wet sample sets (8 mock cases) to include blood, semen and saliva and inhibitors (assess evidentiary handling, technique for differentials, contamination events, yields, instrument operation, etc.).
- Simulation sets (12) -electronic data for interpretation and report writing (no differences from processing in the laboratory---creates consistency amongst analysts).
- Encompass single source, simple and complex mixtures and various statistical calculations.

SAMPLE SETS

- Eight simulated casework sample sets include bloodstains, oral swabs, cigarette butts, chewing gum, hair roots, fingernail swabbings, semen and vasectomized seminal fluid residue. Difficult substrates and inhibited samples shall also be included (e.g. denim material and biological material exposed to soil bacteria).
- These sample sets shall mimic forensic case type scenarios and encompass organic and differential organic extractions. This will include mixed stains and various dilutions for different quantities of DNA. The number of samples must be such that when routine analysis is complete greater than 50 electropherograms would be generated as required by SWGDAM (including controls).
- Three of the eight sets need be set up as competency challenges. The first two competencies shall address organic and differential organic extraction and quantification. The final competency shall encompass extraction, quantification, amplification, electrophoretic separation, interpretation and reporting. The competencies shall contain a minimum of 2 samples for extraction.
- All sample sets shall be quality controlled to yield appropriate data. Verification of results must be performed and answer keys provided for each set.
- All students process the same items and are held to the same standard of competency.

MOOT COURT

- Students are trained to present scientific evidence to members of the jury and the court. **I**nstruction provided on the rules of criminal and civil procedure applicable to expert witnesses. Focus on how to translate highly technical and complex concepts from the sciences (biology, chemistry, and human population genetics) into language that can be understood clearly by members of the court. Addresses ethical issues confronting the expert witness as well as issues relating to establishing the weight of the evidence through the application of statistical methods as utilized by the MA State Police Crime Laboratory.
- Moot court training is to include mock case file preparation and pretrial conferences on a one to one basis. Thereafter, individual moot courts will be conducted and critiqued. A videotape and written evaluation shall be provided for each student. This training shall be administered by a forensic scientist and qualified attorneys experienced in DNA testimonies and abreast of current legal issues facing DNA in the courtroom. Cross examination shall focus on issues including quality assurance, accreditation, qualifications, policies and procedures (e.g. MSPCL analyses), evidentiary handling, instrumentation, contamination, and statistics.
- All students observe each other and joint discussions with the class and attendees.

MIXTURE INTERPRETATION AND STATISTICAL ANALYSES

- Week of mixture and statistics training to comply with the SWGDAM requirement for Statistics as applied to Forensic DNA Analyses. Such training shall be provided by two or more instructors whereby one must be an expert in Population Genetics and one must have extensive casework experience with mixture interpretations (@ least 5 years and be a current or previous qualified DNA analyst).
- This course includes sections on the following:
- Probability and Introductory Statistics
- Population Genetics
  - Hardy Weinberg Equilibrium
  - National Research Council Reports and Recommendations
  - Allele and Genotype Frequencies
  - Random Match Probability Estimates
  - Combined Probability of Exclusion
  - Likelihood Ratios as applied to Paternities and Family Analyses
  - Source Attribution

MIXTURE INTERPRETATION AND STATISTICAL ANALYSES

- Mixture Interpretation
  - Single Source and Major Profiles
  - Probative Minor Profiles and Statistical Calculations
  - Complex Mixtures and Exclusion/Inclusion Probabilities
  - Problem Sets and Exercises
- A final examination must be administered and, upon passing grade, issuance of a certificate of successful completion for documentation of SWGDAM compliance.

Components that assist with Consistency

- Rotation through evidence, LIMS proficiency.
- Rotation through Criminalistics-processing pre-DNA (Biological fluid ID).
- Protocols—customized to MSP and train appropriately
- Oral Quizzes
- Exams
- Reading Material List (Text-Butler, Manuals, Articles, Readings)
- Personal and videotaped demonstrations of procedures
- Mentor program-trainee has senior analyst as mentor
- Guest Lecturers –Validation, Criminalistics, CODIS, Legal, Safety, GMID, QA/QC & Mix/Stats
- Training Checklist
- DNA user groups and journal clubs with entire unit
- Labwide memos

Responses to Questions

from a Previous Mixture Workshop (Fall 2007)

What are the biggest obstacles you face in your lab in terms of mixture interpretation?

- 1st Getting analysts to open their minds that “this is how we have always done it” is not always the best; Experience and comfort level of explaining these difficult concepts when majority of current analysts only training is on the job and not during training program

Responses to Questions
from a Previous Mixture Workshop (Fall 2007)

Suggestions for training staff to have more analyst consistency within your lab (1):

- Standardized training sets
- A clear defined protocol with mandatory training
- More training opportunities – also make them mandatory for all DNA analysts
- More communication/discussions during interpretations; more casework examples
- Examples, guidelines, flowchart → to try to make sure everyone is consistently doing it the same way
- Following our current SOPs, we should be fairly consistent with the way we report minor/major mixtures and 1:1 mixtures. Our problem is we can't agree on how to handle the other types so it's hard to train new people consistently

Responses to Questions
from a Previous Mixture Workshop (Fall 2007)

Suggestions for training staff to have more analyst consistency within your lab (2):

- We should have fewer things that are up to analysts' discretion – but not so few that we feel like robots.
- The flowchart and classifying mixtures with standardized guidelines; more workshops at conferences with a combination of speakers that can come to a consensus and present a unified plan…
- Labs could have flow charts and set protocols for interpretations
- We'd like to but I feel that people will always vary based on experience and comfort levels, even with guidelines!
- Provide training examples

Responses to Questions
from a Previous Mixture Workshop (Fall 2007)

Suggestions for training staff to have more analyst consistency within your lab (3):

- Utilize some sets of data/examples for all analysts. Perhaps provide more regular training of established recommendations. Provide review material (perhaps tutorials) breaking down recommendations/guidelines. This may also be done via on-line set-up.
- Standardized flowchart; stat. training course; training packet/handout/book with specific electropherogram examples
- We need step by step guidelines and flowcharts so that everyone is on the same page.

Responses to Questions
from a Previous Mixture Workshop (Fall 2007)

Suggestions for training staff to have more analyst consistency within your lab (4):

- Regular training for everyone. It seems that once signed off, minimal continuing education within lab procedures is obtained – **SOP drift**
- Ongoing mandatory training for staff. Module in training solely on mixture interpretation. I like the idea of mixture of the month.

"Mixture of the Month" Idea

Questions from the Audience

Thank you for your attention…

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Website for this workshop:

- **http://www.cstl.nist.gov/biotech/strbase/training/AAFS2008_MixtureWorkshop.htm**