

# Organization of OSAC Overview

Green Mountain DNA Conference  
August 2, 2016

M. Katherine Moore, M.S.  
Chair, OSAC Wildlife Subcommittee



## OSAC Objective

To create a sustainable organizational infrastructure dedicated to identifying and fostering the development of technically sound, consensus-based documentary standards and guidelines for widespread adoption throughout the forensic science community

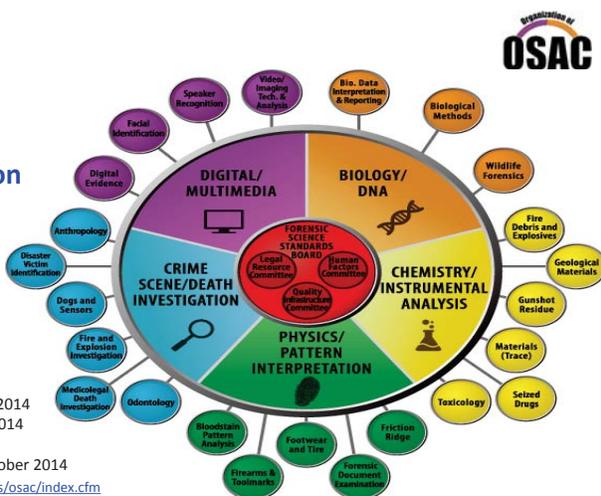


**NIST**  
National Institute of Standards and Technology  
U.S. Department of Commerce

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## OSAC Functional Organization Chart

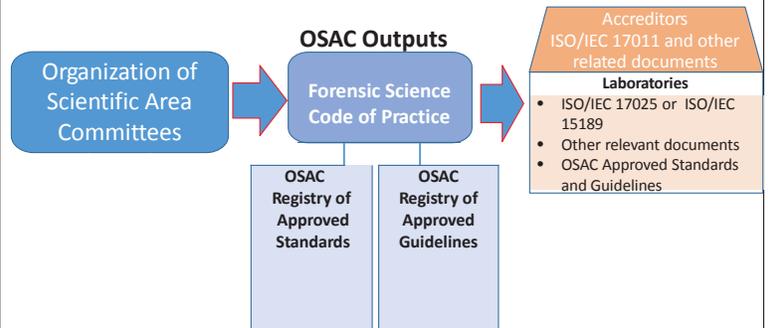


FSSB appointed June 2014  
QIC, LRC, HFC – July 2014  
SAC – August 2014  
Subcommittees – October 2014  
<http://nist.gov/forensics/osac/index.cfm>

**NIST**  
National Institute of Standards and Technology  
U.S. Department of Commerce



## Key OSAC Outputs



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National Institute of Standards and Technology  
U.S. Department of Commerce



## OSAC Biology SAC Summary



- A number of documents are expected to be completed by the end of this year for submission to a Standards Developing Organization (SDO).
- The Biology SAC will use the AAFS's new Academy Standards Board as our SDO.
- The Biology/DNA SAC and Subcommittees are working collaboratively with SWGDAM.
  - Approximately 27% of the Bio/DNA members are current or former SWGDAM participants.



## Biological Methods



The Biological Methods Subcommittee will focus on establishing standards and guidelines that support molecular and biochemical methods used to analyze evidence and reference items.



## SAC-Wide Projects



- Terminology ★

★ = has undergone SAC-level review, SC is adjudicating comments



## Biological Methods



- Training Standard for DNA Analysis ★
- Training Standard for DNA Isolation and Purification Methods ★
- Best practices for assessing educational requirements ★
- Standard for Internal Validation of DNA Analysis Methods ★
- Serological methods standards:
  - Training
  - Validation ★
  - Analytical Procedures and Report Writing ★



★ = has undergone SAC-level review, SC is adjudicating comments



## Biological Data Interpretation and Reporting



The Biological Data Interpretation and Reporting Subcommittee will focus on standards and guidelines related to scientifically valid methods of interpretation, statistical analysis and reporting of biological results.



## Wildlife Forensics



The Wildlife Forensics Subcommittee will focus on standards and guidelines related to taxonomic identification, individualization, and geographic origin of non-human biological evidence based on morphological and genetic analyses.



## Biological Data, Interpretation, and Reporting



- Statistical Interpretation
- Standards for Probabilistic Genotyping Systems ★
- Software Validation Standards
- Mixture Interpretation

★ = has undergone SAC-level review, SC is adjudicating comments



## Wildlife



- General Standards for all Subdisciplines ★
- Standards for DNA ★
- Standards for Morphology ★
- Report Writing ★
- Validation

★ = has undergone SAC-level review, SC is adjudicating comments

★ = has been approved by SAC and sent to SDO



## Research Gaps Identified - DNA Methods

*(in order of evidence analysis process)*



- More efficient collection of DNA at the scene and from evidence items
- Quantitative interpretation of color signals for serology testing results
- More efficient extraction of DNA from evidence items
- Assessment of specific classes of evidence types to determine the necessity to quantify DNA before amplification



## Research Gaps Identified - Wildlife



- Develop STR/SNP panels (including any necessary allelic ladders and databases) for current species of forensic interest.
- Validate STR/SNP panels for species of forensic interest using the OSAC DNA Validation Standards.
- Development of new technologies for discovery and characterization of forensically useful markers of relevant species' biogeography



## Research Gaps Identified - DNA Interpretation

*(in order of evidence analysis process)*



- Develop software to tools to assist in characterization and utilization of STR typing validation data
- Software solutions for Y-STR mixture deconvolution
- Research on how to design proficiency tests for complex data interpretation and probabilistic genotyping
- Impacts of laboratory, assumptions, and model decisions on continuous likelihood ratios
- Best practices to avoid biases in interpretation of DNA profiles



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**Thank You!**



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### How is WF different from human forensics?

- The animal (or plant) is the subject of analysis, and there are many, many species
- Often the question is whether a crime has occurred, not who the perpetrator was
- Classification (that is from a cow) often more important than individual ID (that is from Hank the cow)
- When DNA is used:
  - No kits
  - Loci seldom standardized between labs
  - No CODIS
  - No NDIS
  - No SRMs
  - No allelic ladders
- Small labs: an analyst is responsible for “soup to nuts”



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## A Walk on the Wild Side of Forensics

Kathy Moore  
Marine Forensic Laboratory, Charleston, SC

August 2, 2016



NOAA Fisheries  
Northwest Fisheries Science Center

### Estimated Value (USD billion) of Major Categories of Transnational Organized Crime

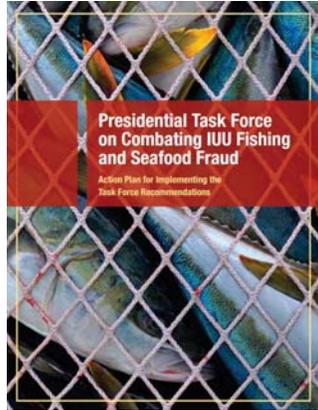
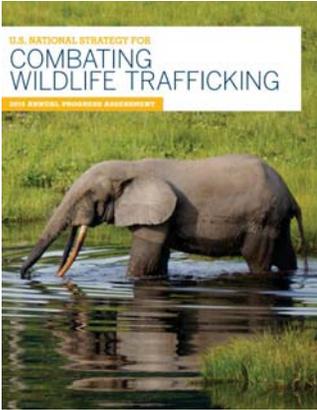
| Category                           | Value (USD billion) |
|------------------------------------|---------------------|
| Cocaine                            | \$72                |
| Heroin                             | \$55                |
| Firearms                           | \$53                |
| Wildlife trade                     | \$32                |
| IUU Fishing                        | \$17                |
| Counterfeit goods (Asia to Europe) | \$8                 |
| Human smuggling                    | \$10                |
| Counterfeit drugs                  | \$2                 |
| Cyber Crime                        | \$1                 |
| <b>Wildlife (Total)</b>            | <b>\$53bn</b>       |

(SWGILD 2012)

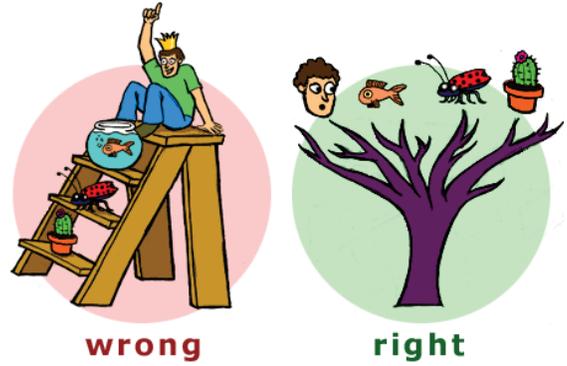


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## Two Presidential Taskforces



## Evolution



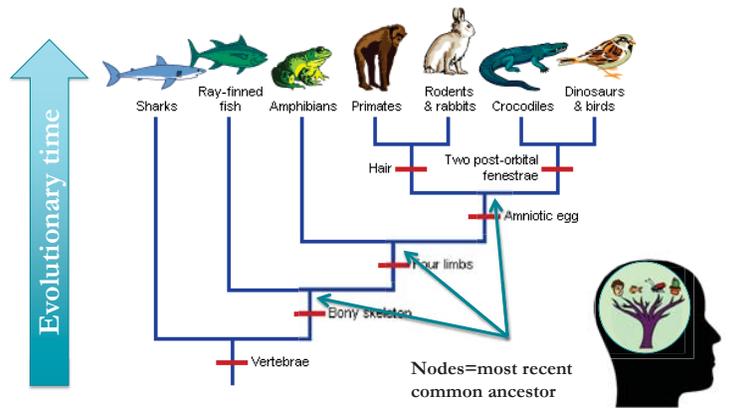
wrong

right

## Taxonomy of a coyote



A branch of science that encompasses the description, identification, nomenclature, and classification of organisms (Wikipedia)



From U California Museum of Paleontology's Understanding Evolution (<http://evolution.berkeley.edu>)

## Subdiscipline: DNA

- nDNA (90% of State labs' work)
  - Individualization (that gut pile matches that trophy mount...)
- mtDNA (90% of Federal labs' work)
  - Identification to genus, species, etc.



## NOAA Office of Law Enforcement



- Enforce 39 federal statutes
- 3 million square miles of open ocean
- 85,000 miles of U.S. coastline
- 93 special agents
- 29 enforcement officers
- 28 investigative/enforcement support positions



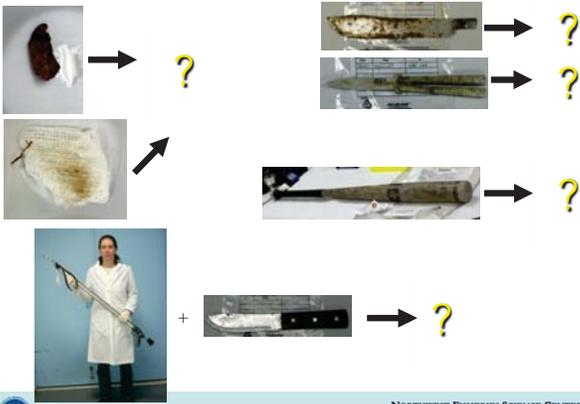
## Mitochondrial DNA vs. Nuclear DNA

| mtDNA                                                              | nDNA                                                       |
|--------------------------------------------------------------------|------------------------------------------------------------|
| Usually sequencing                                                 | STRs or SNPs                                               |
| Can not detect hybrids                                             | Can detect hybrids                                         |
| Population and species (genus, etc.)-level ID, not for individuals | ID of individuals, populations, species                    |
| V. conservative estimate of minimum # of individuals               | Requires a large database for individual and population ID |

## mtDNA applications



## Case: sea turtle weapons



## All DNA methods: publicly available data

- Can guide choice of locus
- Can supplement in-house vouchers
- Must be validated w/knowns

Barcode of Life Database

Genbank

DNA Surveillance

WITNESS FOR THE WHALES

## All methods: literature review

Molecular Ecology (2017) doi:10.1111/mec.14628

**INVITED REVIEW**  
**Population genetics and phylogeography of sea turtles**  
B. W. BOWEN and S. A. KARL  
Hawaii Institute of Marine Biology, University of Hawaii, PO Box 1346, Kaneohe, HI 96744, USA

Proc. Natl. Acad. Sci. USA Vol. 96, pp. 5574-5577, June 1999  
Evolution

**A molecular phylogeny for marine turtles: Trait mapping, rate assessment, and conservation relevance**  
(conservation genetics / cytogenetics / molecular systematics / mitochondrial DNA)  
BRIAN W. BOWEN\*, WILLIAM S. NELSON, and JOHN C. AVISE  
Department of Genetics, University of Georgia, Athens, GA 30602

NATURE GENETICS | LETTER OPEN

**The draft genomes of soft-shell turtle and green sea turtle yield insights into the development and evolution of the turtle-specific body plan**  
Zhuo Wang, Jovan Prasad-Aranya, Amoneta Zedlitz, Wenge Li, Yoshiko Nomura, Zhongyong Huang, Chuyi Li, Simon White, Zhiqiang Xiang, Dongming Fang, Bi Wang, Yao Wang, Yan Chen, Yuan Zheng, Shigetaro Kuraku, Miguel Pignatelli, Javier Herrera, Kathryn Best, Masafumi Nozawa, Qiye Li, Juan Wang, Hongyan Zhang, Lili Yu, Shuji Shigenobu, Junyi Wang + et al.

## All methods: data analysis

- Database construction, THEN
- Analyst may identify unknowns
  - Sequence similarity
  - Biology
  - Biogeography
  - Phylogeny

Use of restriction fragment length polymorphisms to identify sea turtle eggs and cooked meats to species  
M. Katherine Moore<sup>1,\*</sup>, John A. Bemis<sup>1</sup>, Susan M. Rice<sup>2</sup>, Joseph M. Quattro<sup>3</sup> & Cheryl M. Woodley<sup>1</sup>

### Case: sea turtle weapons

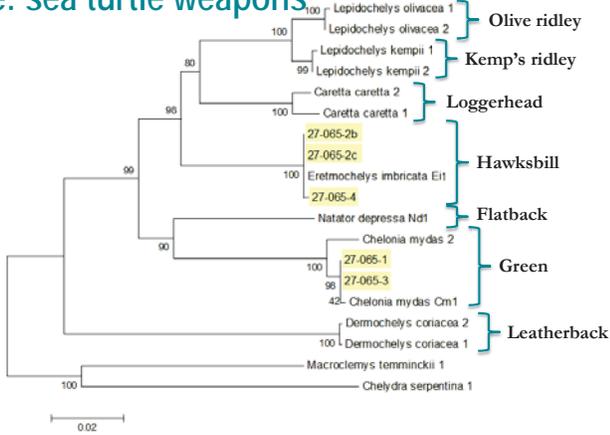
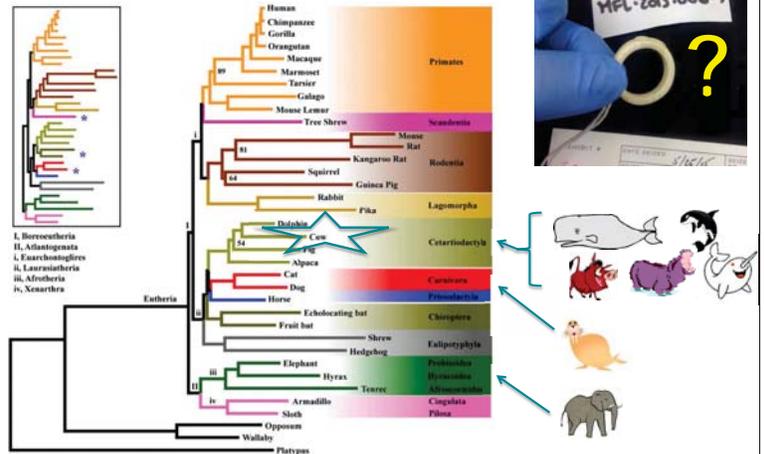


Figure 3 Neighbor-joining tree depicting relationships between sea turtle standards and 27-065 evidence samples.



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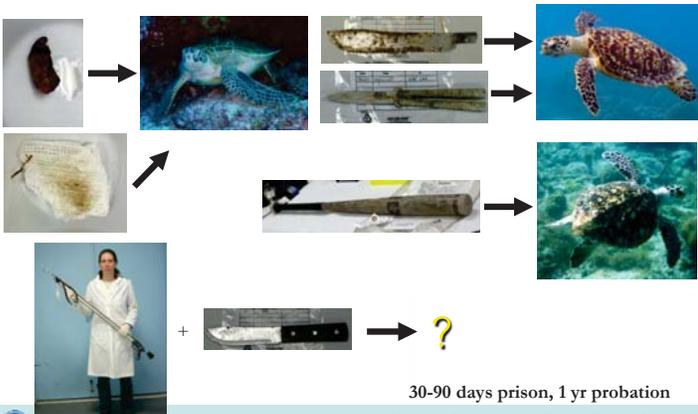
### Case: ivory ring



Tree from Song et al (2012) PNAS 109(37):14942-14947

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### Case: sea turtle weapons

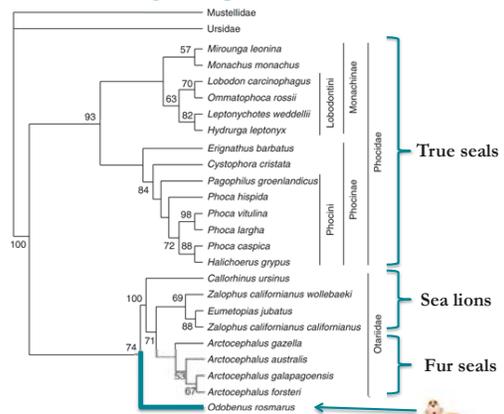


30-90 days prison, 1 yr probation



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### Case: Ivory ring



Consensus parsimony tree with % bootstrap support. From Dasmahapatra et al. (2009) Heredity 103:168-177



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## Case: Ivory ring

**Evidence Examination Report**

Investigator: EO SCOTT ADAMS Lab Case #: MPL-2015-006  
Agency: NOAA OLE Agency Case #: C150043

**Administrative Information**

Enclosure received: 4/2/15  
Date: EO Scott Adams  
From: CPO Harding # 22 WSI V24 BY 924 3218  
Site: Twp Coast STEPH Forensic Laboratory  
By: M. Kufner-Mason, STEPH Forensic Laboratory, on 4/3/15  
Re: person: Transair to  
Brief Description: One ring, suspected to be carved marine mammal bone

Analyst Performed by: M. Kufner-Mason

Case summary and examination requested: EO Adams asked if we would "determine if this is made from a marine mammal bone and identify species if possible."

Disposition of Evidence: Enclosure was returned during analysis.

**Conclusions**

I identified the submitted evidence item as ivory originating from walrus, *Odobenus rosmarus* (see Conclusions Table).

**Conclusions Table: Laboratory item number, sample information, and identification conclusion for the submitted evidence.**

| Laboratory Item # | NOAA OLE Item # | Laboratory description | Identification                    |
|-------------------|-----------------|------------------------|-----------------------------------|
| 2015-006-1        | E1500167        | ivory ring             | <i>Odobenus rosmarus</i> , walrus |

**Details of Examination**

Methods: Item 2015-006-1 was subjected to a morphological examination in accordance with Espinoza & Mann (2000) to determine if the item was authentic bone or ivory. Subsequently, the evidence item was ground in liquid nitrogen, and standard laboratory protocols were used for molecular genetic analysis. DNA was extracted from the evidence. Two non-contiguous fragments of the mitochondrial 12s region were amplified and sequenced from extracted DNA and controls. The resulting sequences were evaluated for quality, edited, aligned, and concatenated, following standard procedures.

The sequence data from 2015-006-1 was compared with appropriate in-house and publicly available reference sequences, and a species identification was made based on sequence similarity. A full record of the work is available from the laboratory.

Results: The evidence item produced a 719 bp concatenated sequence alignment. This evidence sequence was 99.7% similar to publicly-available reference sequences for *Odobenus rosmarus*, walrus. (see Results Table).

Results table: Laboratory item and evidence bag numbers, most similar reference sequence and source species, and the number of base pairs (bp) in the evidence sequence identical to those in the most similar reference sequence.

| Laboratory Item # | NOAA OLE Item # | Most similar species              | Most similar reference sequence | # Identical bp/ Total # bp |
|-------------------|-----------------|-----------------------------------|---------------------------------|----------------------------|
| 2015-006-1        | E1500167        | <i>Odobenus rosmarus</i> , walrus | GU174604.1, A1428576.2          | 717/719                    |

Reference Material (DNA): Marine Mammal 12s:FIR1 v 1, Marine Mammal 12s:F3R3 v1, NCBI GenBank

References Cited: Espinoza EO and Mann M-J (2000) *Identification guide for ivory and ivory substitutes*, 3rd. ed. Ivory Identification, Inc., Richmond, VA.

## Case: Ivory ring

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## Case: ivory and bones



Morphology:  
Sperm whale



Morphology:  
Whale epiphyseal disc  
DNA: ?



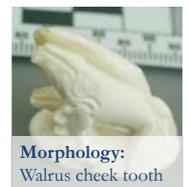
DNA: Humpback whale



Morphology: Walrus tusk



Morphology:  
unk. ivory



Morphology:  
Walrus check tooth

## Seafood Fraud

- ~ 90% of US seafood imported
- Global trade source options
- Species substitution
- False labeling
- Consumer fraud and health concerns

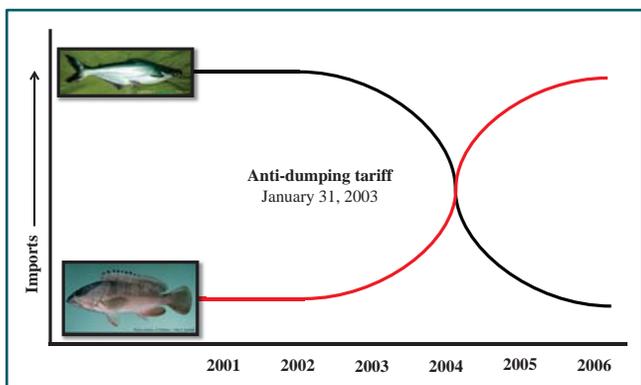


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## Seafood Fraud



## Catfish Imports from Vietnam Curious Changes in the Trade Dynamic



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## Seafood Fraud

- Not isolated incidents
  - ~70% of “grouper” sold in FL was thought to be catfish
  - 77% of American red snapper is not
  - 56% of “wild” salmon is farmed
  - Voluntary inspection program in NMFS: mislabeling ~ 37%
- Not always an “environmental” crime, BUT
  - Defrauds consumer
  - Hurts domestic fishermen, drives down price of “real” product
  - Defeats consumers’ intent to buy “sustainable seafood”
  - Health hazard (antibiotics in farmed fish; allergies to unknown species)
  - Tax evasion, conspiracy, smuggling, money laundering, mislabeling...



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**US v. Panhandle Seafood**  
 51 months imprisonment  
 96 months probation  
 \$1.13 million restitution  
 Forfeiture of two businesses


**US v. Virginia Star**  
 75 months imprisonment  
 126 months probation  
 \$291,000 fines  
 Forfeiture of \$12 million  
 Held up to 9<sup>th</sup> Circuit Appeal

**US v. Consolidated/Reel Fish**  
 103 months imprisonment  
 Three year ban from seafood industry

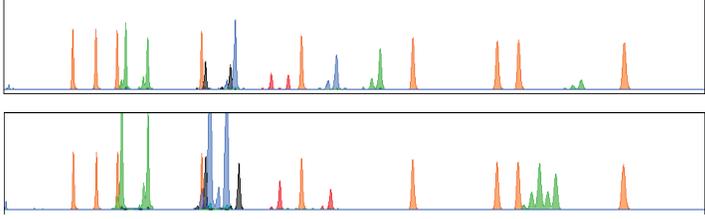
**US v. Stephen Delaney**  
 3 months home confinement  
 12 months probation  
 \$5,000 fine



NATIONAL CENTER FOR COASTAL OCEAN SCIENCE  
NATIONAL OCEAN SERVICE



## DNA: Population ID



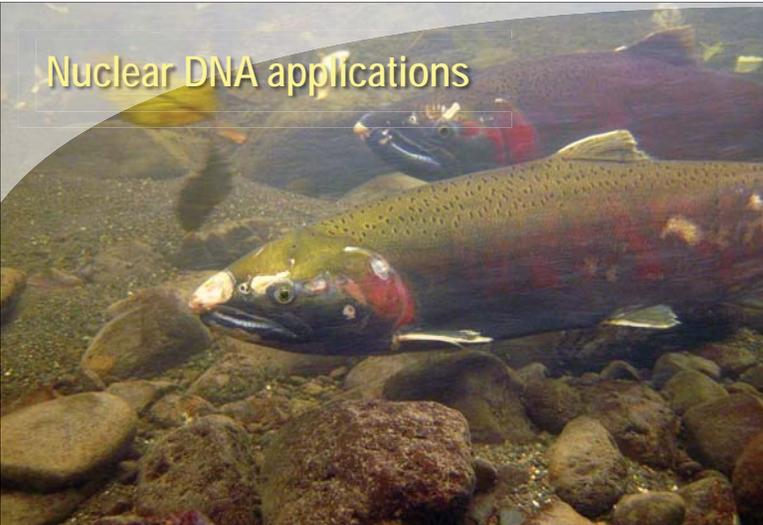
### Microsatellites (STRs)

- DNA markers that are variable within species
- Can establish individual ID
- Population ID



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## Nuclear DNA applications





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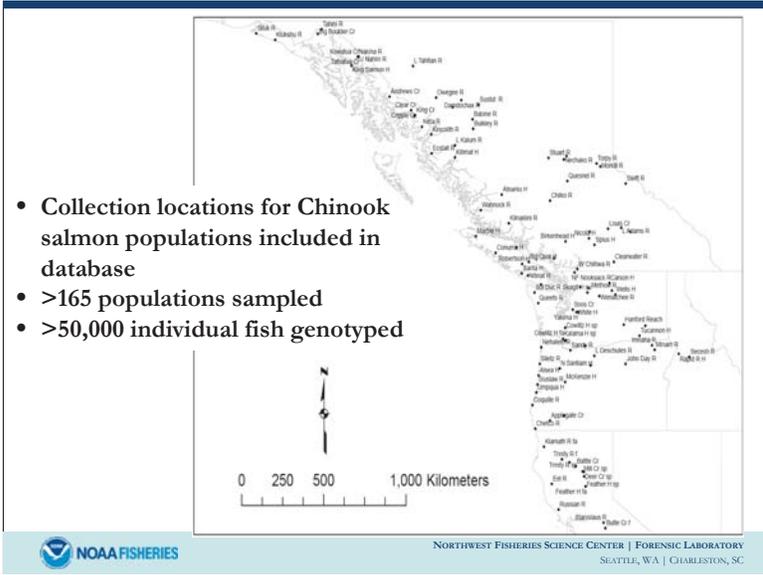
## Chinook Baseline

- Different runs and rivers are genetically distinct
- Methow Valley Irrigation District drained UCR stream, killed salmon
- Were these ESA salmon?



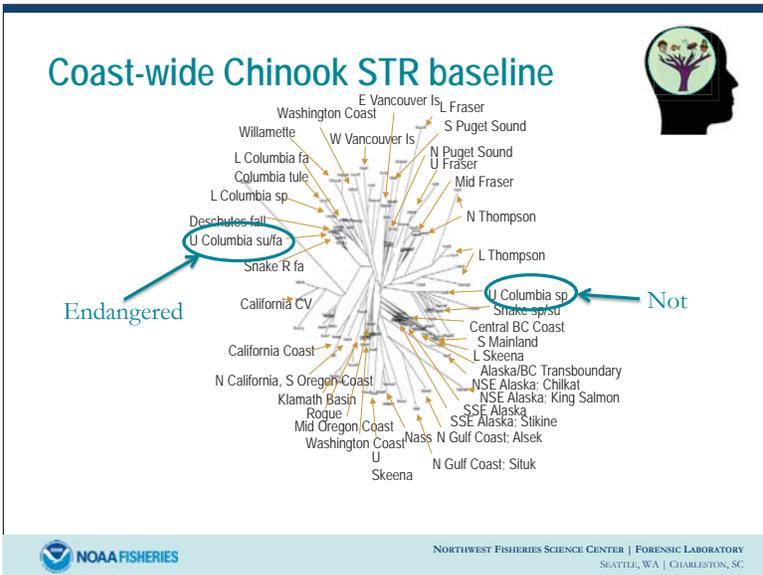


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## Grizzly Bear vs. Human

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## Trophy Elk Case

- Elk was killed in Dec: closed season
- Standing in YNP when he shot the trophy elk in Montana; brought back into park to get to road
- Park service found headless carcass (still warm) & collected femur sample

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## Trophy Elk Case



- Convicted poacher: Elk was taken legally in November.
- NOPE!
- Convicted in Federal court- charged \$1,000 in fines, \$6,000 in restitution and 4 years in federal prison

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Many thanks to:  
Green Mountain Conference/VT forensics lab; Eric Buel, Trisha Conti  
OSAC  
Wyoming Game and Fish

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## Wildlife Forensics

- Even when tools are the same, different:
  - application
  - legal framework
  - knowledge base
- Challenges:
  - Taxonomic expertise needed
  - DB Construction
  - Expressing uncertainty for SpID



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