A52 A Metric Approach to Human and Non-Human Species Identification of Skeletal Remains Using Machine Learning

Heather M. Garvin, PhD, Des Moines University, Des Moines, IA 50312-4198; Michael W. Kenyhercz, PhD, Defense POW/MIA Accounting Agency, Joint Base Pearl Harbor-Hickam, HI 96816; Rachel Dunn, PhD, Des Moines University, Des Moines, IA 50312; Sabrina Sholts, PhD, Smithsonian Institution, Washington, DC 20013-7012; M. Schuyler Litten, MA, Smithsonian Institution, Washington, DC, DC 20013*

Learning Overview: After attending this presentation, attendees will understand the advantages and limitations of using basic postcranial measurements to evaluate human versus non-human remains and species identification.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by illustrating how a few simple skeletal measurements that can be taken without extensive osteological knowledge can be used to objectively evaluate whether skeletal elements are human or non-human and estimate the non-human species.

Forensic anthropologists are routinely consulted by medicolegal and law enforcement agencies to evaluate whether skeletal remains are human, and thus of forensic significance, or non-human (i.e., animal). Most of these unknown elements turn out to be non-human, at which point anthropologists are commonly asked to identify the species. Although the question may be asked out of curiosity, a correct faunal species identification boosts agency confidence in the non-human determination and may be relevant to forensic investigations. Current macroscopic species identification methods rely primarily on visual assessments, which can be subjective and dependent on analyst experience. This study thus aimed to evaluate the utility of bone length and breadths measurements in human and non-human species identification.

Humeral and femoral maximum bone lengths, epiphyseal anteroposterior and mediolateral maximum breadths, and midshaft maximum and minimum diameters were collected or compiled from published data from humans and 26 common North American faunal species. Sample sizes varied by species, element, and measurement, but in total 16,049 measurements were collected from 436 human and 984 non-human specimens. Random forest models were run on the pooled sample for each skeletal element (e.g., pooled humerus data) using a training subsample (70% of the sample), then a testing sample (unused 30% of the sample), and correct classification rates and variable importance were recorded. For each model, 500 trees were employed, with three variables tested at each node. Humerus and femur datasets were used separately to create models to differentiate human versus non-human (all non-human samples pooled) and identify individual species. An additional model was created to test if both species and bone could be estimated from analogous measurements. For human versus non-human classification, accuracy rates were over 99% (humerus = 99.77%; femur = 99.40%). Species identification rates were similar for the femur (85.3% overall) and humerus (84.46% overall). As might be expected, misclassifications were highest among related taxa (e.g., brown bear versus black bear). Last, the correct classification for both species and bone was 82.18%, which is quite high given there are 54 response categories, making random chance of success 1.85%.

Despite the 27 species included in these analyses and some of the large variations in size and morphology within some of the species (e.g., domestic dog), the random forest models returned relatively high correct classification rates. Therefore, the use of simple postcranial metrics can assist those without extensive comparative osteology experience in identifying, or at the very least, narrowing down the possibility of species to facilitate a visual identification from other resources. The metric classifications can also be used to statistically support forensic anthropological assessments of human versus non-human, or faunal species identifications. Such metrics also have the potential to assist in the species identification of fragmented remains. Given the success rates with the humerus and femur, additional analyses are being conducted on the remaining long bone elements, with the aim of creating a freely available online tool to facilitate species identification from skeletal remains across and beyond the forensic community.

Random Forest Modeling, Osteometrics, Species

Copyright 2021 by the AAFS. Permission to reprint, publish, or otherwise reproduce such material in any form other than photocopying must be obtained by the AAFS.

*Presenting Author