A79 Modeling the Fluvial Transport of Human Remains in the Sacramento River of California

Colleen F. Milligan, PhD, California State University, Chico, Chico, CA 95929-0400; Eric J. Bartelink, PhD, California State University, Chico, Chico, CA 95929-0400*

Learning Overview: After attending this presentation, attendees will better understand the relationship between water discharge rates and the transport of human remains in riverine systems. The primary goal of this presentation is to discuss the development of a predictive fluvial transport model to aid in the search and recovery of human remains in the Sacramento River of California.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by discussing the use of fluvial transport rates of rescue manikins to predict search parameters for human bodies from riverine systems. This presentation will discuss the variables that contribute to differences in transport rates, such as postmortem interval, flow rates, river dimensions and curvature, riverbed substrate, and the prevalence of snags or obstacles.

The fluvial transport of human remains is a topic of interest in paleoanthropology, bioarchaeology, and forensic anthropology. In the context of taphonomy, fluvial transport focuses on the potential of a riverine system or body of water to physically move human remains from one location to another. Missing person's cases involving riverine systems pose major challenges to law enforcement given that human remains may be moved a long distance from their initial point of entry, especially under high flow rate conditions. However, very little actualistic research has been conducted to model the movement of human bodies in riverine systems, such as the Sacramento River.

The Sacramento River is California's largest fluvial system. Flow rates are regulated by Shasta Dam at the river's source and are influenced by the numerous tributaries that feed into the river, as well as by the physical characteristics of the river. The highest flow rates occur during winter storm events and the lowest during the late fall, after irrigation season has ended. Each year, the river claims more than two dozen victims, most commonly due to accidental drowning. A much smaller number of bodies recovered from the river represent suicides, homicides, or have an undetermined manner of death.

Although the Sacramento River spans eight counties, the project area includes the five counties from the southern half of the Sacramento River. This research adapts an existing hydraulic model (Hydrologic Engineering Center's River Analysis System (HEC-RAS)) to generate a predictive model of fluvial transport rates of victims who entered the river with known dates and locations under low, medium, and high flow rate conditions. The HEC-RAS was originally designed for flood control management, but also has capabilities to simulate advective and dispersive transport of water quality constituents. The HEC-RAS model treats a human body as a "pollutant" and can be used to predict distance from the source given a number of parameters, such as flow rate conditions and river channel properties. The model is calibrated using two sources of information: historical case data on river victims collected from sheriff-coroner's offices and data generated from rescue manikins placed in the river under different flow rate conditions.

Historical data was collected on 150 river victim cases from three counties in the project area (spanning 1972–2012), 62 (41.3%) of which had known postmortem interval and transport distance data. This initial stage of data collection demonstrated that most victims are male, and most deaths are accidental. A moderate relationship between postmortem interval and transport distance was found, but postmortem interval only explained a small part of the variation in transport distance. To supplement the historical data, this study used two types of rescue manikins to simulate the body positions in water of "floaters" and "sinkers." Controlled releases of the floating manikins were conducted under low, moderate, and high flow rate conditions from six locations along the Sacramento River. The results of these simulations have shown that the river curvature and flow rate play a large role in the route of travel a body takes, with repeated tests in the same locations showing similarity in the path the body travels. The project has also used sinker manikins to study the transport of human remains along the riverbed. Data collected at four locations, including a concrete test flume, has shown that there is a significant relationship between type of riverbed substrate and the flow rate (measured in feet/second) and transport distances of human remains.

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Forensic Anthropology, Taphonomy, Fluvial Transport