Ivory

Identification and Regulation of a Precious Material

This educational resource provides an overview of the context around the use of and demand for African elephant ivory for art and artifacts and its intersection with elephant conservation protections. Written by conservator Stephanie Hornbeck, this article was originally published in 2010 and updated in 2016. It was hosted on the website of the National Museum of African Art, Smithsonian Institution from 2010-2016.

Elephant ivory has been considered a prized luxury material across cultures from ancient times to the present day. Artifacts with ivory components have been found at archaeological sites in Asia, Africa and Europe for at least the past 5000 years. Ivory is a relatively soft material that can be worked with nonmetal tools, and its surface can be highly polished, yielding the characteristic glossy, creamy and semitranslucent surface for which it is much admired. As it ages it often develops a yellow-golden patina. Ivory can be bleached and/or stained with dyes and colorants. Ivory—from the elephants that produce it to the intricately carved artifact—is a material closely associated with Africa (2005-6-9, 2005-6-36, 2005-6-8). Carved artifacts from Africa range in color from bright white (69-20-4) to a deep red-brown from the application of palm oils (86-2-1). In Africa (as elsewhere in the world), the inherent value of ivory, its beautiful visual qualities and its ability to be carved and worked, combined with royal patronage for the creations of highly skilled carvers, have yielded master artworks. Because elephant ivory is so costly, a number of natural

STEPHANIE HORNBECK

left
Hunting horn
Sapi-Portuguese style,
Bullom or Temne peoples, Sierra Leone
Late 15th century
Ivory, metal
64.2 x 16.4 x 9 cm (25 1/4 x 6 7/16 x 3 9/16 in.)
National Museum of African Art, gift of
Walt Disney World Co., a subsidiary of
The Walt Disney Company, 2005-6-9

top
Elephant in Kabalega Falls National Park, Uganda
Photograph by Eliot Elisofon, 1966
eepa eecl 24872

above
Saltcellar
Benin kingdom, Bini-Portuguese style,
Edo peoples, Nigeria
16th century
Ivory
8.3 x 7.6 x 7.6 cm (3 1/4 x 3 x 3 in.)
National Museum of African Art, gift of
Walt Disney World Co., a subsidiary of
The Walt Disney Company, 2005-6-36

Note the difference in coloration; the figural group derives its dark color from the application of oils.

left
Spoon
Benin kingdom, Bini-Portuguese style, Edo peoples, Nigeria
16th to 17th century
Ivory
16.5 x 4.8 x 3.2 cm (6 1/2 x 1 7/8 x 1 1/4 in.)
National Museum of African Art, bequest of Mrs. Robert Woods Bliss, 69-20-4

right
Staff finial
Kongo peoples, Democratic Republic of the Congo
Late 19th to early 20th century
Ivory, mirror, resin, pigment
13.3 x 5.1 x 5.7 cm (5 1/4 x 2 x 2 1/4 in.)
National Museum of African Art, museum purchase, 86-2-1

and synthetic materials that evoke ivory have been used in the creation of artifacts and art objects (see Ivory Substitutes sidebar).

Because elephants do not shed their tusks while living (as deer shed antlers), their removal from the elephant requires the animal to be dead; thus, the incessant international demand for ivory has dangerously diminished elephant populations in Africa. It is noteworthy that while ivory has historically been prized by cultures within Africa (perhaps most famously by the ancient Egyptians and the Benin kingdom), internal consumption was limited—often restricted to royalty—and did not put elephant populations at risk. The establishment of international trade with Africa had dire consequences for elephant populations throughout the continent. Demand for ivory, variously under the ancient Roman Empire, trade with India and the Far East and eventually with Europe and the Americas, historically impacted elephant populations in various regions of Africa. Demand in the 20th and 21st centuries, however, has seen the greatest decimation of African elephants, continent-wide. Consequently, the intersection of the ivory trade with elephant conservation efforts has resulted in an international consensus for ivory regulation. A number of acts and laws instituted over the past 35 years strictly regulate its legal trade (see Laws & Regulations). These have broad application and affect museums and individual collectors, among other entities.

Description

The material ivory includes the highly valued tusks and teeth of the following mammals: mammoths and mastodons (both extinct), elephants, hippopotami, walruses, warthogs, sperm whales and narwhals. This description focuses on elephant ivory. Elephant ivory is the most highly valued of all ivories and describes the material comprising the tusks of Asian male elephants, African male and female elephants, as well as that from their relative, the mammoth. It is worth noting that it is impossible to distinguish between African and Asian elephant ivory visually or by most analytical methods, with the exception of DNA analysis.

The tusks of elephants, although differing in function, are directly related anatomically and compositionally, to the teeth of other mammals. Elephant tusks correspond to incisors. (In addition to their tusks, elephants have six teeth/molars that they use to grind their food.) Tusks of some African males can be up to three and a half meters in length (11 1/2 feet) and weigh up to 90 kilograms (165 pounds) each. Like teeth, tusks have a pulp cavity where the root and soft tissue attach it to the jaw of the animal. The pulp cavity extends for approximately two-thirds of the tusk; its presence or absence on a carved ivory artifact can indicate the part of the tusk that was used and the original length of the tusk. Like teeth, tusks are comprised of dentine and cementum; teeth, however, also have a hard outer layer of enamel, which is found only at the tip of tusks.

Identification of Ivory

When considering the question of whether an object is composed of elephant ivory, it is useful to gather as much information as possible about the object. Often it is the combination of available documentation with methods of examination that will yield the answer.

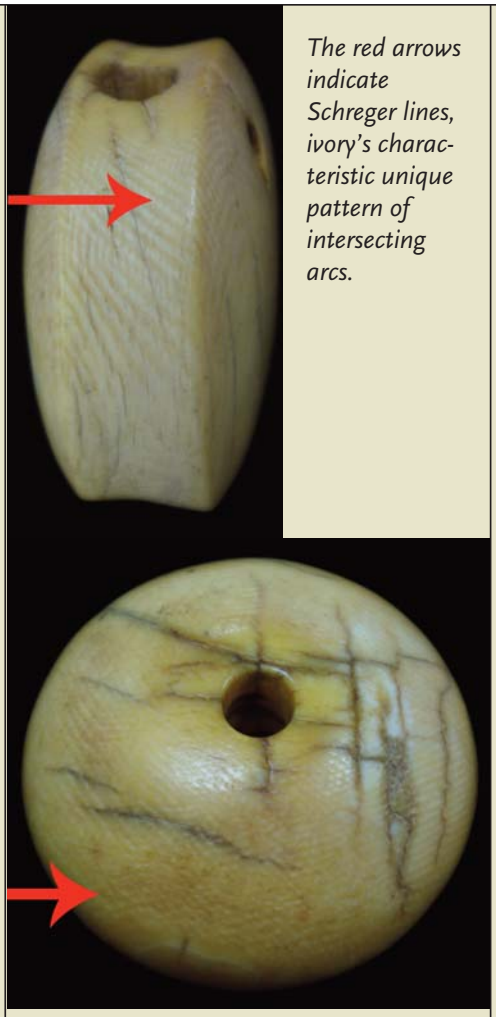
The provenance and age of an ivory artifact may shed light on the geographic origin of the material, which

can narrow down the possibilities for identification. For example, elephants are not indigenous to North and South America; consequently, elephant ivory could not have been used in these regions prior to the establishment of international trade routes in the mid-16th century. If the ivory object was fabricated in the northernmost regions of Europe, Asia and North America, it is as likely to be walrus ivory as elephant ivory. If the artifact was fabricated after the mid-19th century, it could be plastic.

The size of the artifact can indicate the source of its material. Elephant tusks are much longer than other mammal ivories, most bones, vegetable ivory and shells. Hence, a long uninterrupted section may be indicative of elephant ivory. Similarly, because vegetable ivory derives from palm nuts that are a maximum of 5.08 cm (two inches) in diameter, only whole artifacts which are small in size (e.g., miniatures, snuff boxes, cane heads) could be fabricated from this material. The weight of the object can also be a telling qualifier. Ivory and bone are heavier than shell, horn, composite mixtures and plastics, which are all lightweight materials.

Visual examination is one of the most useful methods to identify ivory. While doing so, it is useful to compare the object in question against samples and good detail images of elephant ivory and ivory substitutes. The websites for United States Fish and Wildlife Service and the World Wildlife Fund (see Selected Bibliography) have excellent diagnostic images. The characteristic visual identifier of elephant ivory is the presence of a pattern of intersecting arcs (2004-9-3, 2004-9-2) seen in cross section. These arcs are sometimes called "engine turnings," cross-hatching or Schreger lines, named after the German anatomist Bernhard Gottlob Schreger, who first described them in 1800. This pattern is present only on elephant and mammoth ivory; obtuse arc angles on elephant ivory distinguish it from mammoth ivory, which has acute arc angles. None of the other mammal ivories have the pattern, nor does bone, vegetable ivory, shell, ivory dust/glue composites or celluloid plastics, all of which are sometimes used as ivory substitutes. The pattern can be viewed with the naked eye or under low magnification. The absence of the pattern, however, does not absolutely negate a material, as working/cutting the ivory from different angles, especially tangential, may yield sections that do not show the pattern.

In the absence of the intersecting-arcs pattern, elephant ivory can be distinguished from like materials if characteristic anatomical features are present. The Haversian System of elongated holes (from blood vessels) are typically visible all over the surface of bone (72-29-4). Although built up in carbonate layers, the surface of shell is typically smooth and uniform. Vegetable ivory also exhibits a smooth, regular surface. Because they are created synthetically, plastics



The red arrows indicate Schreger lines, ivory's characteristic unique pattern of intersecting arcs.

top
Labret
Turkana peoples, Kenya
Mid-20th century
Ivory
5.0 x 5.5 x 3.3 cm (1 15/16 x 2 3/16 x 1 5/16 in.)
National Museum of African Art, gift of Eileen Sobeck, 2004-9-3

center
Labret
Turkana peoples, Kenya
Mid-20th century
Ivory and wood
5.0 x 5.0 x 5.0 cm (1 15/16 x 1 15/16 x 1 15/16 in.)
National Museum of African Art, gift of Eileen Sobeck, 2004-9-2

This plastic box—likely celluloid—has a striated surface, an attempt to emulate ivory's intersecting-arc pattern.

Photographs by Stephanie Hornbeck

are devoid of the distinguishing surface irregularities found on natural materials. Under microscopic examination, small bubbles may be present that are air bubbles trapped as the resin cured or dried.

Examination under ultra-violet light can be diagnostic. Ivory fluoresces a bluish-white color, as do bone and shell. Vegetable ivory, however, fluoresces slightly orange, and plastics absorb light giving them a dull, matte appearance.

Testing a small, obscure area of the object (i.e., the bottom) with a hot needle will indicate the presence of plastic or horn. Plastics will typically soften and emit a chemical odor (camphor in the case of celluloid), and horn will soften and smell like burned hair, whereas true ivory will not soften, though it may eventually char. This method is not recommended or practiced by conservators as it will leave a permanent mark on the object.

If a more precise quantitative

Bracelet
Yoruba peoples, Owo region, Nigeria
16th century
Ivory
14.5 x 10.5 x 10.5 cm (5 11/16 x 4 1/8 x 4 1/8 in.)
National Museum of African Art, gift of Walt Disney World Co., a subsidiary of The Walt Disney Company, 2005-6-8

Elephants in Kabalega Falls National Park, Uganda
Photograph by Eliot Elisofon, 1959
eepa eecl 24750
Eliot Elisofon Photographic Archives, National Museum of African Art

Ivory Substitutes

As with other natural materials of high value (i.e., precious minerals, noble metals, exotic skins and hides), a number of other mammal ivories as well as imitation natural and synthetic materials have been used as substitutes for elephant ivory. See Photo Gallery on page 5.

Hippopotamus ivory (teeth)—harder and more opaque than elephant or walrus ivory, it has a thick enamel coating; in cross section it exhibits chatoancy, the reflectance pattern found in tiger's eye stones.

Sperm whale and killer whale ivory (teeth)—second in hardness to hippopotamus ivory, the dentine forms in layers that alternate directions yielding a characteristic banded appearance; may grow up to 20.0 cm (8 inches) in length.

Warthog (tusk)—typically has a mottled appearance with long furrows and usually a squared cross-section.

Narwhal ivory (tusk)—a single left incisor produced by males of this rare Artic-dwelling whale; distin-guished by its spiral form; grows 2.0–7.0 meters (6 1/2–23 feet) in length.

Walrus ivory (tusk)—solid its entire length; instead of a pulp cavity, the center is comprised of secondary dentine, which has a characteristic, bumpy, nodular surface, often described as visually similar to tapioca pudding; may grow up to 1.0 meter (3 1/4 feet) in length.

Antler—outgrowths of bone that are shed each year by deer and moose.

Bone—the same composition as ivory (calcium hydroxyapatite); close in appearance and historically most often substituted material for ivory; slightly harder and lacks the translucency of elephant ivory; characterized by the Haversian System of elongated holes (from blood vessels), typically visible all over the surface; if present, the central canal with swirling lacunae is specific to bone.

Horn—(as from rhinocerous) a keratinaceous material comprised of compact hair.

Shell—the hard calcium carbonate outer coverings of mollusks; because of their relatively small size and the thinness of their walls, shell would most typically be used to emulate ivory inlay.

Vegetable ivory (also known as "ivory nuts")—a cellulosic material derived from several dense palm nuts native to Africa, South America and the South Pacific; grow to a maximum of 5.0 cm (approx. 2 inches) in diameter.

Composite mixtures—various proprietary mixtures, including ivory dust and casein, ivory dust and styrene resin, calcium carbonate and adhesive, casein and hardener.

Plastic—typically celluloid, a proprietary plastic consisting of cellulose nitrate and camphor; it was developed in the mid-19th century and one of its primary uses was as an ivory substitute. Other plastics include polyester and phenolic resins. Plastics are sometimes laminated to yield a striated surface that emulates ivory; ivory's characteristic intersecting-arc pattern, however, was never successfully reproduced.

Photo Gallery

Elephant ivory substitutes shown on this page are described in detail on page 4.

left

Whale teeth

Photograph courtesy Canadian Ivory, Inc.

left

Hippopotamus ivory

Photograph courtesy Boone Trading Company

above

Walrus ivory

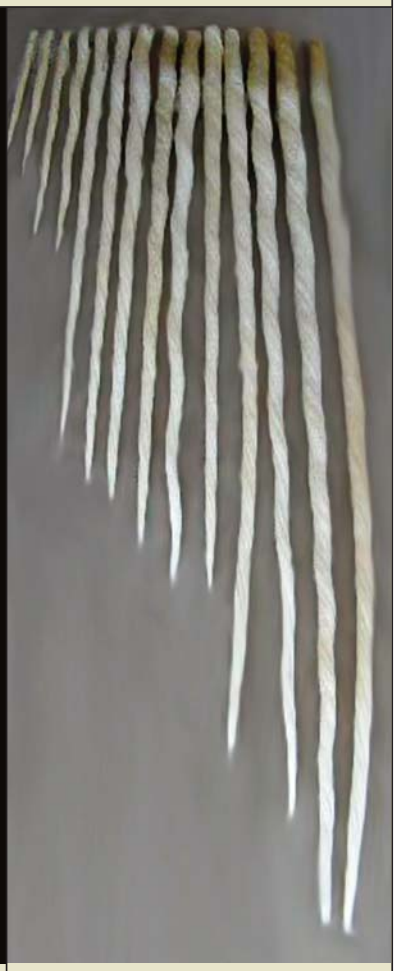
Note the absence of a pulp cavity on this cross section. Instead, the center is comprised of a nodular formation of dentine.

Photograph courtesy Canadian Ivory, Inc.

above

Note the elongated holes from blood vessels (the Haversian System), which are characteristic of bone.

Spoon (detail)
Lega peoples, Democratic Republic of the Congo
Bone
19.7 x 5.4 x 1.3 cm (7 3/4 x 2 1/8 x 1/2 in.)
National Museum of African Art, gift of Mrs. Edith Drucker, 72-29-4
Photograph by Stephanie Hornbeck



above

Ivory from the tusks of an Arctic-dwelling whale, the narwhal. Note the characteristic spiral form.

Photograph courtesy Arctic Art

below

A pod of male narwhals gather at the Arctic ice edge to eat cod.

Photograph by Paul Nicklen/ National Geographic Stock

characterization is required, a tiny sample may be submitted to analytical testing with Fourier Transform Infrared Spectroscopy (FTIR). FTIR is an analytical method that characterizes organic materials based on the energy emitted by the bonds of specific chemical compounds comprising the composition of a sample when submitted to infrared radiation. FTIR can immediately differentiate ivory from its imitators, with the exception of bone, which is very similar in chemical composition.

DNA analysis has emerged as a precise method of identification and geographic sourcing. The method utilizes a small sample of ivory from which mitochondrial and microsatellite DNA can be isolated for comparison against data sets. This analytical method can differentiate between African and Asian elephants and within a species can distinguish forest from savannah dwellers. Further, genetic variation within a geographic region indicates that ivory could be traced back to specific countries, and within those countries, even to specific forests. If enough organic material remains in aged samples, it is possible to extract DNA data from them as well. This method is promising for sourcing ivory confiscated from illegal trade, potentially enabling surveillance of specific geographic regions suspected of poaching.

Characteristics of Ivory Deterioration

The deterioration of ivory is directly related to its composition and formation. Unlike the teeth of living mammals, the dentine layers of tusks are produced annually (somewhat similar to tree growth in concentric layers). Like living bone and dental tissues, tusks are composed mostly of an inorganic component, calcium hydroxyapatite (60%) and an organic component, collagen (40%). Once these mammals are no longer living, the organic components deteriorate over time. As ivory desiccates (dries out), its susceptibility to fluctuations in humidity increases. Low humidity levels (below 35%) can result in separation or delamination (79-16-47) of the layers of dentine, visible in cross section as a cone-within-a-cone pattern. Checks (79-16-47) and cracks occur in longitudinal (96-30-1) and transverse planes (2005-6-3) in locations related to gaps in formation. Radial cracks form the way wood splits along the grain. In combination, directional cracking patterns can cause the ivory to exfoliate in curved rectangles (79-16-47).

Ivory is a porous material and while it can be stained intentionally

Directional cracking can eventually yield delamination of ivory layers.

(SEE OBJECT ID AND CREDIT FOR OBJECT 79-16-47 AT RIGHT)

PHOTOGRAPHS BY STEPHANIE HORNBECK

Checks in longitudinal plane

TUSK (DETAIL)
YORUBA PEOPLES, NIGERIA
19TH CENTURY
IVORY
130 X 12.2 X 10.4 CM
(51 3/16 X 4 13/16 X 4 1/8 IN.)
NATIONAL MUSEUM OF AFRICAN ART, BEQUEST OF SAMUEL RUBIN, 79-16-47

Cracks in longitudinal plane

TUSK (DETAIL)
BENIN KINGDOM COURT STYLE, EDO PEOPLES, NIGERIA
C. 1850
IVORY
189 X 12.1 CM (74 1/2 X 4 3/4 IN.)
NATIONAL MUSEUM OF AFRICAN ART, PURCHASED WITH FUNDS PROVIDED BY THE SMITHSONIAN COLLECTIONS ACQUISITION PROGRAM, 96-30-1

Cracks in transverse (cross section) plane

FIGURE (DETAIL)
BENIN KINGDOM COURT STYLE, EDO PEOPLES, NIGERIA
EARLY 19TH CENTURY
IVORY
37 X 9.4 X 10.3 CM (14 1/2 X 3 3/4 X 4 IN.)
NATIONAL MUSEUM OF AFRICAN ART, GIFT OF WALT DISNEY WORLD CO., A SUBSIDIARY OF THE WALT DISNEY COMPANY, 2005-6-3

Elephants in Amboseli National Park
West of Namanga, Kenya
Photograph by Eliot Elisofon, 1959
eepa eecl 24721, Eliot Elisofon Photographic Archives, National Museum of African Art

with colorants, it can also be stained by the dirts and oils associated with handling.

As ivory desiccates it loses its surface luster and becomes harder. With the passage of time, these changes can make visual identification more difficult. Indeed, ancient ivory, bone and wood (as from archaeological contexts) can appear quite similar, requiring the use of analytical testing for identification (see Identification of Ivory).

Laws & Regulations

The populations of both African and Asian elephants have declined dramatically since the mid-20th century. According to the United States Fish and Wildlife Service (which regulates and enforces compliance with national and international importation laws that apply to fauna and flora), while habitation destruction and fragmentation increasingly threaten elephant populations, the greatest threat to their survival is poaching (illegal killing) to supply the highly lucrative ivory market. African elephants are particularly susceptible to poaching and in the 1980s their population declined alarmingly from 1.5 million to 600,000 in just one decade. Recent estimates approximate that 35,000

Regulations

Since the 1970s, the international trade of elephant ivory has been highly regulated by a number of acts and laws; these apply to the importation and travel of artifacts across international borders. Sometimes the laws overlap, in which case the stricter law applies.

- The Lacey Act (1900 and later amendments)—prohibits trade of wildlife taken in violation of any state or foreign wildlife law or regulation; affects interstate commerce.
- The Endangered Species Act (1973)—designed to prevent the extinction of native and foreign species of wild fauna and flora; lists Asian elephants as "endangered" (in danger of extinction) and African elephants as "threatened" (in danger of becoming endangered). This act prohibits elephant parts and products from being imported into the United States except under certain conditions. Artifacts carved of elephant ivory may travel legally if accompanied by documentation proving that their provenance pre-dates this act.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)—an agreement, first instituted in 1975, among 173 nations to eliminate illegal trade in animals and plants, their parts, and associated products. Although legally binding on the parties (countries that have voluntarily agreed to be bound by the convention), CITES regulations do not take the place of national laws. The CITES Ivory Control System focuses on the ivory trade.
- The African Elephant Conservation Act (1988)—prohibits the import of raw or worked ivory into the U.S. with certain exceptions. This act also established a grant program to fund elephant conservation efforts.

To be fully compliant with the laws and regulations on elephant ivory, it is important to have documentation providing dates of ownership and provenance. Only ivory artifacts that are older than 100 years, were acquired before 1977 and have documentation to prove it, may travel legally over international borders. When ivory (and ivory composite) artifacts travel, they must be accompanied by a CITES Permit or Pre-Convention Certificate. This applies not only during initial acquisition but whenever an object crosses borders. Lack of compliance may result in artifact confiscation and personal liability for civil and criminal penalties.

elephants are illegally killed each year. In Africa, the fates of elephants are affected for good or ill by human activity. In regions with effective wildlife conservation methods in place, their populations demonstrate increases while those in regions of civil strife, show a population decline.

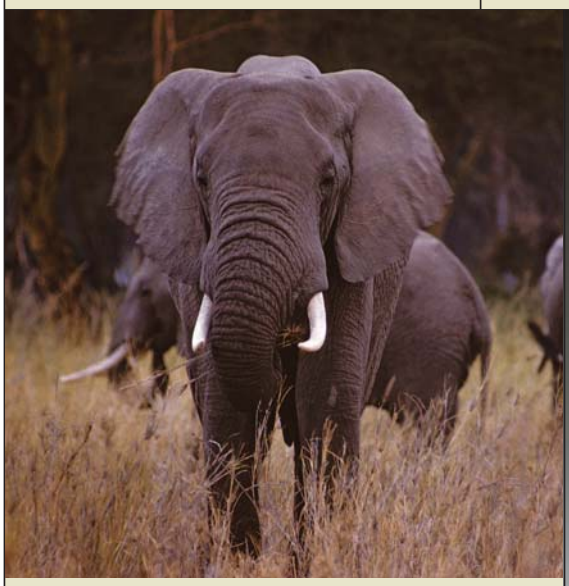
Some regions (mainly Botswana, Namibia, South Africa and Zimbabwe) are experiencing such an increase in population that government-sanctioned culling (targeted hunting) of herds is periodically undertaken to manage the population growth. Yet, poaching continues to be an enormous issue for regions that cannot adequately oversee elephant ranges. Attempts to staunch poaching and illicit trade, while addressing increasing stockpiles of ivory from elephants that have died of natural causes, are dilemmas that have international implications. A series of collaborative efforts have resulted in the establishment of laws and regulations (see Regulations sidebar). An important step for the popular art market was achieved in July 2008, when eBay announced that it was suspending trade of ivory (except for small quantities, such as decorative inlays).

Embargoes

The dramatic decline in elephant populations from the poaching of the 1980s led to several important international efforts. In 1989, member countries of CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, agreed on a worldwide ban on the trade of ivory. This historic vote came after the African elephant was deemed "threatened" due to excessive poaching to meet market demand. To call international attention to the devastating effects of the ivory trade, Kenyans chose in 1989 to burn 12 tons of elephant tusks rather than sell them.

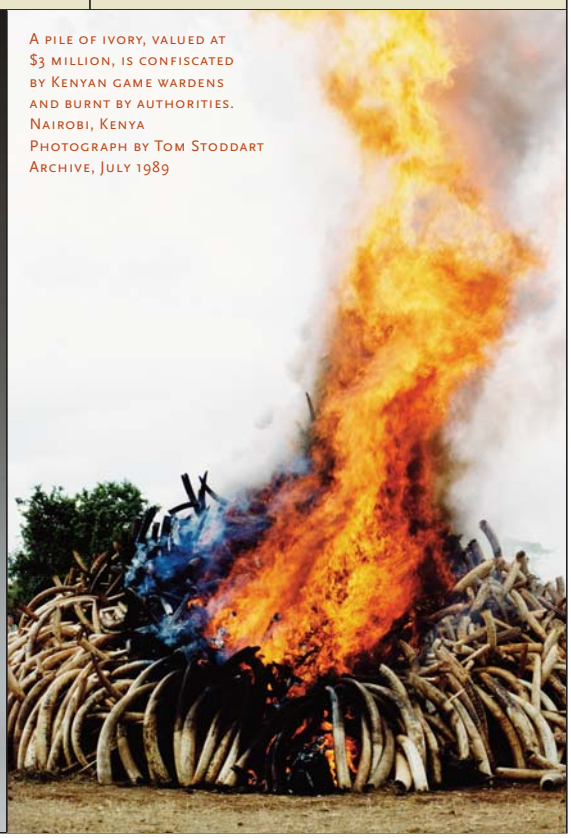
In 1999, CITES eased the ivory trade embargo by allowing South Africa, Namibia, Botswana and Zimbabwe to sell government-owned ivory amassed before 1989 to Japan. In 2007 CITES deemed that China and Japan could import 106 tons of ivory from stockpiles held in these four African countries provided that a percentange of the proceeds are directed towards elephant conservation. The sales to Japan and China are restricted to use within domestic markets; ivory from these sales cannot be traded internationally. Despite the effort to periodically alter market dynamics with strictly controlled legal sales, several major seizures of illegal ivory were confiscated in 2009 alone from Kenya, Cameroon and Mozambique; the largest of these was a six-ton shipment seized in Vietnam in March 2009.

The fates of elephant populations over the past 30 years bear witness to the contemporary demand for ivory. Intricately carved artifacts, billiard



above
Elephants in Amboseli National Park
West of Namanga, Kenya
Photograph by Eliot Elisofon, 1959
EEPA EECL 24732
Eliot Elisofon Photographic Archives, National Museum of African Art

right
Female figure
Yoruba peoples, Oyo or Owo region, Nigeria
Mid-19th century
Ivory, black stone
H. 30 cm (11 7/8 in.)
Acquisition grant from the James Smithson Society and museum purchase, 85-9-1

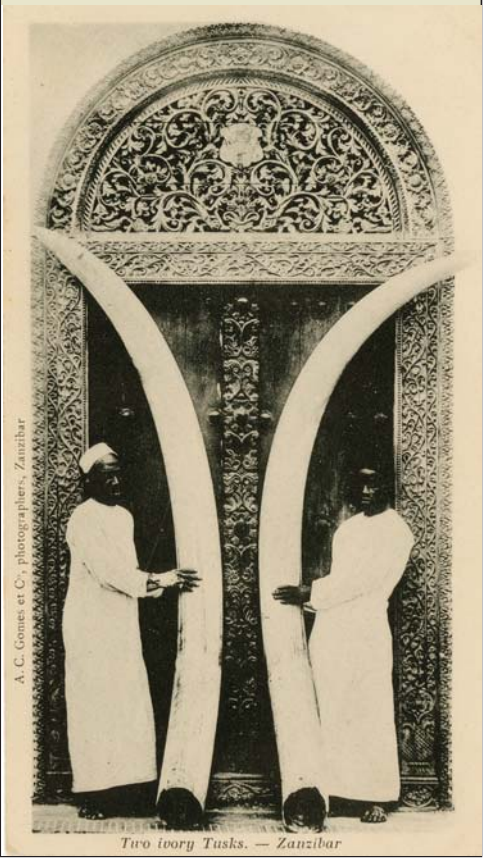


A pile of ivory, valued at $3 million, is confiscated by Kenyan game wardens and burnt by authorities. Nairobi, Kenya
Photograph by Tom Stoddart Archive, July 1989

balls, piano keys and medicinal substances attest to the value of ivory for multiple markets. Yet, it is incumbent upon the individual buyer to be informed about the legal aspects of ivory acquisition. While the National Museum of African Art's collection includes numerous ivory masterpieces, all of them pre-date the 1989 ivory trade embargo. It is hoped that the information provided here will assist with ivory identification, promote the responsible collection of ivory and foster appreciation of the remarkable animals that produce it. [*Published March 2010*]

left + inset detail
Tusk
Kongo peoples, Democratic Republic of the Congo and Angola
c. 1860
Ivory
72.4 x 14.6 x 6 cm (28 1/2 x 5 3/4 x 2 3/8 in.)
National Museum of African Art, museum purchase, 96-28-1

below
"Two Ivory Tusks—Zanzibar"
Photograph by A.C. Gomes and Company, Zanzibar, c. 1910
Postcard, collotype
eepa Postcard Collection, Tanzania/Zanzibar
Eliot Elisofon Photographic Archives, National Museum of African Art



Addendum

Market & Regulatory Changes

Since this article was published in 2010, important regulatory changes have been implemented to increase protections for African elephants, with the goal of achieving a near total-ban on commerce of African elephant ivory. Asian elephants (*Elephas maximus*), a separate species from African elephants (*Loxodonta africana*), are also endangered and have their own set of protections; these are not addressed in detail in this document, which focuses on African elephant ivory.

In response to a steep increase in elephant ivory poaching in Africa from 2002-2013, largely in response to demand throughout Asia, an international outcry led to increased restrictions in trade and to sanctioned destruction of ivory stockpiles in many cities around the world. Substantive data from this time period was gathered by the Great Elephant Census (GEC), which surveyed savannah elephant populations in 18 African countries from 2007-2014 and recorded a dramatic 30% decline in populations.

In concert with these events and its stated strategy to combat wildlife trafficking, on June 2, 2016, the Obama administration announced a near-total ban on the commercial trade of African elephant ivory, as the US Fish and Wildlife Service (FWS) completed a rulemaking process to Section 4(d) under the Endangered Species Act (ESA) to increase protections for African elephants. This rule follows President Obama's 2013 Executive Order (13648) Combatting Wildlife Trafficking and Director's Order 210, issued by the Director of the FWS, to establish policies and guidelines.

The rule more stringently controls U.S. trade in ivory and prohibits import and export of African elephant ivory with limited exemptions for musical instruments, items that are part of a traveling exhibition and part of a household move or inheritance, when specific criteria are met. Exemptions to the ban in interstate and foreign commerce include legally documented ESA antiques (documented objects older than 100 years) and legally documented manufactured objects with small amounts of ivory, where ivory is not the primary component (referred to as the *de minimis* exemption). FWS provides guidance on their website about how to determine whether an object qualifies for one of these exemptions and what type of documentation will be acceptable. Because the laws and restrictions are complex and may be revised in the future, it is important to check with FWS for updated information. In complement to this federal law, individual state laws regulate intrastate commerce.

Potential Increase of Analytical Testing

Because the new regulations protecting African elephants note the criteria of age and species identification for documented worked ivory objects, conservators may be increasingly involved in the visual identification, sampling and technical analysis of elephant ivory. At present only the destructive tests for DNA and stable isotope analysis, both useful forensic methods, can differentiate African from Asian elephant species. A promising method that requires only micro-samples is peptide mass fingerprinting (PMF), which has successfully been applied to taxonomic family-level identification of collagen-based mammalian materials. The search for additional markers in PMF spectra that might allow in-family identification remains a future goal.

The position paper developed by the American Institute for Conservation of Historic and Artistic Works (AIC) states support of elephant conservation efforts and advocates for protecting permitted worked ivories of documented provenance from unnecessary destruction and destructive testing. An understanding of ivory features and identification methods, as well as knowledge of ivory substitute materials will inform examination of these objects. [*Published October 2016*]

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All photographs by Franko Khoury, NMAfA, unless noted otherwise.

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